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Source of original article

Item 1

Macromolecules

33, No.6, 21st March 2000, p.2171-83

Title

EFFECT OF THERMAL HISTORY ON THE RHEOLOGICAL BEHAVIOR OF THERMOPLASTIC POLYURETHANES

Pil Joong Yoon; Chang Dae Han

Akron, University

The effect of thermal history on the rheological behaviour of ester- and ether-based commercial thermoplastic PUs (Estane 5701, 5707 and 5714 from B.F.Goodrich) was investigated. It was found that the injection moulding temp. used for specimen preparation had a marked effect on the variations of dynamic storage and loss moduli of specimens with time observed during isothermal annealing. Analysis of FTIR spectra indicated that variations in hydrogen bonding with time during isothermal annealing very much resembled variations of dynamic storage modulus with time during isothermal annealing. Isochronal dynamic temp. sweep experiments indicated that the thermoplastic PUs exhibited a hysteresis effect in the heating and cooling processes. It was concluded that the microphase separation transition or order-disorder transition in thermoplastic PUs could not be determined from the isochronal dynamic temp. sweep experiment. The plots of log dynamic storage modulus versus log loss modulus varied with temp. over the entire range of temps. (110-190°C) investigated. 57 refs.

Authors and affiliation

GOODRICH B.F.
USA

Accession no.771897

Abstract

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<thead>
<tr>
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<th>Volume 2</th>
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<th>Volume 4</th>
<th>Volume 5</th>
<th>Volume 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Report 43</td>
<td>Flammability and Flame Retardants in Plastics, J. Green, FMC Corp.</td>
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<td></td>
</tr>
</tbody>
</table>
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Radiation Curing

R.S. Davidson

(DavRad Services)

Contents

1 Introduction .............................................................................................................................................. 3
  1.1 Aims and Scope ................................................................................................................................... 3
  1.2 What is Radiation Curing? .................................................................................................................. 3
  1.3 Use of the Terms ‘Drying’ and ‘Curing’ ............................................................................................. 3
  1.4 Why Consider Radiation Curing? ...................................................................................................... 3

2 The Chemical Processes Used in Radiation Curing ............................................................................. 3
  2.1 Processes Involving Radicals .............................................................................................................. 4
    2.1.1 Initiation ......................................................................................................................................... 4
    2.1.2 Propagation .................................................................................................................................... 4
    2.1.3 Termination .................................................................................................................................... 4
  2.2 Processes Involving Carbocations - Cationic Curing Systems ........................................................... 5
    2.2.1 Initiation ......................................................................................................................................... 5
    2.2.2 Propagation .................................................................................................................................... 6
    2.2.3 Termination Reactions .............................................................................................................. 6
  2.3 Processes Involving Carbanions - Anionic Curing Systems ............................................................... 6

3 Equipment ................................................................................................................................................. 7
  3.1 Application of Curable Coatings ......................................................................................................... 7
  3.2 Radiation Sources for UV Curing ....................................................................................................... 7

4 General Formulations .............................................................................................................................. 8
  4.1 Initiation of Cure by Photoinitiators ................................................................................................. 9
    4.1.1 Radical Initiators ....................................................................................................................... 9
    4.1.2 Cationic Initiators .................................................................................................................. 9
    4.1.3 Anionic Photoinitiators .......................................................................................................... 10
  4.2 Prepolymers ....................................................................................................................................... 10
  4.3 Reactive Diluents ......................................................................................................................... 10
  4.4 Pigments ............................................................................................................................................. 11
  4.5 Additives ............................................................................................................................................. 11

5 Components of Cationically Cured Formulations Other than Photoinitiators ....................................... 12
  5.1 Reactive Diluents ........................................................................................................................... 12
    5.1.1 Epoxides .............................................................................................................................. 12
    5.1.2 Vinyl and Related Ethers ..................................................................................................... 12
  5.2 Prepolymers ....................................................................................................................................... 12
  5.3 Combinations of Cationic- and Radical-Cured Materials ................................................................. 13

6 Applications of Radiation Curing ........................................................................................................... 13
  6.1 Wood Coating .................................................................................................................................... 13
1 Introduction

1.1 Aims and Scope

The aim of the review is to acquaint the reader with the many and varied applications of the rapidly expanding technology of radiation curing of polymeric materials. In order to fulfil this aim the principles upon which the technology is based, the equipment that is used, the materials which make up a radiation curable formulation and applications are outlined. For anyone wishing to gain a deeper understanding of radiation curing, there are many texts available (359, a.1-a.5).

1.2 What is Radiation Curing?

The term ‘radiation curing’ is used to describe the processes which lead to the physical changes (due to either polymerisation, depolymerisation, crosslinking or grafting), which occur when electromagnetic radiation impinges upon matter. Such physical changes may manifest themselves in many ways. For example, a liquid may be converted into a solid (e.g., as occurs in film formation), a change in solubility may occur (e.g., depolymerisation will increase solubility in a specific solvent and crosslinking will lead to a decrease in solubility in a specific solvent) or there may be a change in hardness/toughness/brittleness (due to crosslinking).

Frequently used sources of electromagnetic radiation include electron beam radiation, ultraviolet (UV) light and γ-radiation. Increasing use is being made of deep UV light (< 200 nm), visible light, near infrared radiation and microwaves. For some purposes X-rays have proven useful, e.g., for curing composites and in the production of microcircuity.

1.3 Use of the Terms ‘Drying’ and ‘Curing’

The drying of an ink or a paint involves loss of a solvent (maybe an organic solvent or water) to the atmosphere by evaporation. This is a purely physical process. Chemical drying, e.g., oxidative drying, occurs as a result of polyunsaturated materials undergoing oxidation which ultimately leads to crosslink formation (e.g., the drying of linseed oil on a cricket bat). The rate of this process can be increased by the use of a catalyst or ‘drier’ (e.g., cobalt naphthenate).

In radiation curing the physical changes to a material are brought about by chemical reactions which are triggered by interaction of the radiation with the material. If the chemical reaction is the polymerisation of an olefinic material the amount of cure will be related to the extent to which the double bonds are utilised.

1.4 Why Consider Radiation Curing?

There has been a big drive through the introduction of legislation to reduce the level of volatile organic compounds (VOCs) emitted into the atmosphere. Therefore manufacturers of surface coatings based on solvent containing formulations have either had to install solvent recovery/incineration systems or change to a non-organic solvent based formulation. Most radiation curable formulations for the production of surface coatings are 100% solid systems (a notable exception being water based systems) and as a consequence the curing process does not lead to a loss of solvent to the atmosphere. For this reason the technology has been classed as a ‘green’ technology. Another important driver is the fact that these 100% solids systems are cured in a very short time thereby enabling fast line speeds to be achieved and facilitating carrying out mechanical post curing procedures in line, e.g., stacking, folding or cutting. The fast curing removes the necessity of having drying ovens (which occupy valuable space) and this in turn can lead to significant cost savings on energy. Of increasing importance is the quality of radiation cured coatings. The high gloss that is attainable is difficult to match by other methods and hence the technology is particularly useful for producing high quality coatings.

There are applications of radiation curing where there is not a comparable technology, e.g., the production of 3-D objects directly from a computer aided design (CAD) system (rapid prototyping). Radiation curing is particularly well suited for the manufacture of small devices as exemplified by microcircuits and nano-sized devices. Other benefits will become apparent in Section 6, where the many industrial applications of the technology are reviewed.

2 The Chemical Processes Used in Radiation Curing

The interaction of radiation with matter can be used to generate radicals, carbocations and bases, to bring about cycloaddition reactions and, in the case of microwaves, bring about thermal reactions.
2.1 Processes Involving Radicals

Neutral radicals and radical cations are electron deficient species and usually the extent of the deficit is one. Carbon centred radicals are the most commonly encountered in radiation curing with sulfur, phosphorus, silicon and halogen centred radicals being somewhat less frequently encountered.

Neutral radicals (typically alkyl or substituted alkyl radicals) are the reactive species in radical curing formulations, which currently account for 80–90% of the radiation curing market. Such species are used to produce surface coatings via polymerisation reactions which, in many cases, are of relatively low molecular species, e.g., acrylates, methacrylates, etc. In other applications, e.g., toughening of materials, radicals are generated in polymer backbones, e.g., polyethylene, which, when they undergo radical-radical combination reactions, produce crosslinks.

Reactions of great importance in a radical mediated polymerisation reaction are as follows:

2.1.1 Initiation

Radical reactions have to be initiated. This is done either by introducing a material which will interact with the radiation to generate suitable radicals, or the interaction of the radiation with the substrate leads to radical generation as is the case with electron beam (EB) or γ-radiation. Photoinitiators and photoinitiating systems are available which are sensitive to radiation spanning the range from the deep UV to the near IR. It is essential that the initiator-derived radicals react with the polymerisable substrate efficiently if fast cure speeds are to be attained. High energy radiation such as EB or γ-radiation interacts with matter with the result that ionisation occurs. In this way both radicals, radical cations and electrons are generated. Because of the high energy content of the radiation, ionisation is indiscriminate and consequently ionisation may occur at any position within the substrate molecule (Figure 1).

2.1.2 Propagation

Reaction of the initiator-derived radicals with the polymerisable species leads to generation of a substrate derived radical, e.g., Figure 2.

2.1.3 Termination

In theory the process of propagation should continue till all the polymerisable substrate is used up, with the final product being a macroradical. Such a process is called a ‘living polymerisation’ (a.6) and can occur under special circumstances. However, in the commonly encountered situations this does not occur due to the intervention of termination reactions. Some typical termination processes are outlined next.

![Figure 1](image1.png)

**Figure 1**

Initiation reactions

\[
\begin{align*}
RCH_2R & \rightarrow (RCH_2R)^+ + e^- \rightarrow RCH_2 + R + CH_2\dot{C}HCO_2R \\
\text{or} & \quad + R\dot{C}H + R
\end{align*}
\]

Propagating radical

\[
\begin{align*}
X\dot{C}H_2CHCO_2R + CH_2=CHCO_2R & \rightarrow XCH_2\dot{C}HCO_2R + CH_2=CHCO_2R \\
XCH_2\dot{C}HCO_2R + CH_2=CHCO_2R & \rightarrow XCH_2\dot{C}HCO_2R + CH_2=CHCO_2R \\
XCH_2CH(CO_2R)\dot{C}HCO_2R + CH_2=CHCO_2R & \rightarrow X(CH_2\dot{C}HCO_2R) + CH_2\dot{C}HCO_2R
\end{align*}
\]

**Figure 2**

Propagation reactions
2.1.3.1 Radical-Radical Combination Reactions

\[ \text{RCH}_2 \cdot + \text{RCH}_2 \cdot \rightarrow \text{RCH}_2\text{CH}_2\text{R} \]

This reaction consumes radicals and consequently terminates chain growth. The efficiency of this reaction is intrinsically very high since it is vastly exothermic (2 unstable species giving a stable product), but in a curing process its efficiency is regulated by viscosity and the size of the radical. For the reaction to occur the radicals have to diffuse together and hence the reaction is favoured by low viscosities. Diffusion rates are also related to molecular size and macroradicals diffuse less rapidly than small molecular species, hence at high viscosities radical-radical combination reactions of these species are retarded. Since in the polymerisation reactions there is an increase in molecular weight, the viscosity rises as the reaction proceeds and consequently radical-radical combination reactions are suppressed. This leads to an acceleration in the observed rate of reaction (this autoacceleration process is known as the Tromsdorff effect (a.7)).

2.1.3.2 Disproportionation Reactions

These reactions also deplete the radical population by yielding non-radical products, an example is given in Figure 3.

\[ \text{RCH}_2\text{CCO}_2\text{CH}_3 + \text{O}_2 \rightarrow \text{CH}_3\text{OO} \rightarrow \text{RCH}_2\text{CCO}_2\text{CH}_3 + \text{CH}_3 \]

This deleterious effect of oxygen upon the rate of cure is known as 'oxygen inhibition' and presents a serious problem to the UV curing industry. Ways of overcoming this problem are given later in the review.

2.2 Processes Involving Carbocations - Cationic Curing Systems

Carbocations, or carbonium ions as they used to be called, are carbon containing materials which possess a carbon atom that is electron deficient by two electrons and therefore carries a positive charge. As with the radical mediated reactions, the polymerisation process is made up of three distinct steps, i.e., initiation, propagation and termination.

2.2.1 Initiation

In light initiated systems a cationic photoinitiator has to be used. Such a material, after absorption of light, fragments to ultimately yield an acid, e.g., HPF6. The species which initiates reaction may be a Bronsted or Lewis acid. The commonly used cationic reactions fall into two classes.
• ring opening polymerisation reactions (e.g., of epoxides or oxetanes)

\[
\begin{align*}
\text{O} & + \text{HPF}_6 \rightarrow \text{OH PF}_6 \\
\end{align*}
\]

• vinyl polymerisations of electron rich alkenes (e.g., vinyl or propenyl ethers).

\[
\begin{align*}
\text{CH}_2=\text{CHOR} & + \text{HPF}_6 \rightarrow \text{CH}_3\text{CHOR PF}_6 \\
\end{align*}
\]

2.2.2 Propagation

In ring opening polymerisation, the protonated species suffers nucleophilic attack resulting in ring opening:

\[
\begin{align*}
\text{+ OH PF}_6 & \rightarrow \text{O(CH}_2\text{CH}_2\text{O})_n\text{H} \\
\end{align*}
\]

whereas the protonated olefin carries out electrophilic attack upon another molecule of the electron rich alkene:

\[
\begin{align*}
\text{+ CH}_2=\text{CHOR} + \text{CH}_2=\text{CHOR} & \rightarrow \text{CH}_3(\text{CHCH}_2)_n\text{CHOR PF}_6 \\
\end{align*}
\]

In both cases a living polymer is produced, but under the conditions used in radiation curing termination and chain transfer reactions intervene thereby destroying the possibility of obtaining such a species.

2.2.3 Termination Reactions

Unlike the radical-mediated reactions, these cationic curing reactions do not suffer from oxygen inhibition. However, they are dramatically affected by water which is a good nucleophile and therefore likely to intervene in the ring opening polymerisation reaction and react with growing macrocarbocations. Whilst these reactions terminate the growth of the growing chain, they do liberate a proton in the process thereby enabling cure to proceed. Such a process is known as chain transfer.

The product of the reaction with vinyl and propenyl ethers is unstable and breaks down to give an aldehyde, which may lead to odour problems in the cured coating. Alcohols react in an analogous manner to water and in the case of ring opening polymerisation reactions polyhydric alcohols may be used to introduce crosslinks.

Other nucleophiles which may be present in curing formulations are anions such as chloride, sulfate, sulfonic acid groups (such as are present in many organic pigments) and amines (present as surface treatments on many pigments and as substituent groups in many organic pigments).

The carbocations generated in the polymerisation of vinyl and propenyl ethers may also undergo chain transfer with unpolymerised alkene (Figure 5).

2.3 Processes Involving Carbanions - Anionic Curing Systems

This is a poorly developed area due to, in part, there having been very few suitable photoinitiators, and also many of the base-catalysed reactions require heat. The

\[
\begin{align*}
\text{CH}_3(\text{CHCH}_2)_n\text{CHOR PF}_6 & + \text{CH}_2=\text{CHOR} \\
\end{align*}
\]

Figure 5

Reaction of carbocations with unpolymerised alkene
most frequently used system is one in which the photoinitiator liberates an amine which is then used to polymerise a multifunctional epoxide (a.8). Other systems employed include the base-catalysed Michael addition reactions, such as the addition of malonate esters to acrylates (a.9). Liberation of primary and secondary amines can be used to initiate polyurethane formation (a.10). These base-catalysed reactions are examples of ‘living polymerisation’ systems but under the conditions used for radiation, curing impurities, e.g., acids, lead to premature termination.

3 Equipment

In this section the equipment used to apply radiation curable coatings and the equipment that delivers the radiation are considered.

3.1 Application of Curable Coatings

Many applications of radiation curing require the curable formulation to be applied to flat-stock. Details of the equipment used are given in some useful texts (a.1, a.11, a.12). For laboratory purposes, draw down bars are used. For commercial applications, the method of choice is determined by the rheology of the formulation, the thickness of the coating required and, in some cases, the end use of the cured formulation, e.g., in silk-screen printing. Spin coating is used to coat surfaces having relatively small dimensions. Roller coaters, curtain coaters, slot-die coaters, etc., are used for coating much larger areas. The coating of 3-dimensional objects is usually carried out by spray coating and here it is a real advantage if the ‘over-spray’ can be recirculated. Of ever increasing importance is the application of powders to surfaces, since UV curable powder coatings are now available. The powder is usually applied as a spray and subjected to triboelectric charging to facilitate adherence of the coating to the substrate prior to curing. More recently electromagnetic brush technology has been introduced for use with both non-ferromagnetic and ferromagnetic substrates alike (a.11, a.12).

The choice of equipment is very much determined by the type of radiation to be used.

3.2 Radiation Sources for UV Curing

Light sources for UV curing have been reviewed (a.1, a.13). The workhorse of the UV curing industry is the medium pressure lamp. Such lamps are available in a variety of sizes, configurations and power ratings. The control gear for such lamps is relatively simple and this helps to keep cost down. Doped mercury lamps (i.e., mercury lamps that contain additives which shift the emission spectrum of the lamp towards the visible end of the spectrum) are available. These are used when the emission profile of the standard lamps does not overlap to a sufficient extent with the absorption spectrum of the formulation.

Microwave powered lamps are available which have similar emission profiles to the mercury lamps. The downside of this type of lamp is that they are only available as linear lamps and their size is somewhat limited. Microwave powered lamps are available which deliver very high intensity radiation (a.14) and this can be particularly valuable for certain applications.

Excimer lamps are now available and these have the distinction of emitting radiation at a specific wavelength (not all the so-called excimer lamps are, however, truly monochromatic) (91, a.15). It is very important to match the emission of the lamp with the absorption properties of the initiator and to take into account the thickness of the film (a.14). In some cases the very high intensity of these light sources can lead to initiation of radical-mediated polymerisation without resorting to the use of photoinitiators (311, a.16-a.18).

Other types of lamps include high pressure mercury lamps, low pressure mercury lamps, xenon lamps, mercury-xenon lamps, black-light lamps, fluorescent lamps, etc. The lamps described so far all deliver continuous wave (CW) light, i.e., it is a constant beam of light as opposed to a discontinuous or pulsed source. In some cases these lamps can be operated in a pulsed mode, e.g., xenon lamps (64, 121, 337, a.5, a.19). Lasers can be obtained which operate both in the continuous and pulsed mode. CW lasers find application in the burgeoning technique of rapid prototyping (sometimes known as stereolithography) (301, 330), laser-addressable litho plates and silk-screen stencils (129).

Short wavelength excimer lasers (operating at 172 or 222 nm) can be used to modify polymer surfaces and make them more receptive to coating formulations. As the wavelength of the radiation is decreased so, increasingly is the radiation absorbed at the surface. If a high powered pulsed laser is used to deliver short wavelength light, the energy will be deposited in a very narrow layer (possibly monomolecular) at the surface of the substrate and this can lead to excessive heating.
Radiation Curing

and hence ablate the surface (a.20). Laser ablation has found application in etching silicon wafers.

A very important aspect of lamp technology is the design of the reflector system and the heat management system. In some applications small areas have to be irradiated and here point source lamps, spot cure systems or lasers are frequently used. With point source lamps it is necessary to have a light collimating system if maximum advantage is to be taken of the lamps’ output. A great advantage of a laser is that its output is coherent, which may mean that further optical manipulation of the beam is unnecessary. The design of reflector systems becomes most important when dealing with lamps used for irradiating large areas, e.g., lamp systems used on printing presses (325, a.13). The user has to decide whether to have the light focused at the surface of the coating or towards the centre. There seems to be no real consensus of opinion as to which reflector design is best for a particular application.

Given that most lamp systems emit an enormous amount of heat, it is essential to have an excellent extraction system which serves to pass cold air over the surface of the lamp to prevent overheating and to dissipate the heat in the irradiation chamber. In some cases the extraction system may not be able to keep the irradiated surface at a sufficiently low temperature and under these circumstances it may be advisable to use a dichroic reflector (282).

Reference has been made to the phenomenon of oxygen inhibition of radical-mediated curing systems. One way to overcome this problem is to cure under a blanket of nitrogen. Manufacturers of UV curing equipment are now making provision for nitrogen blanketing in a way that does not lead to an excessive consumption of nitrogen (a.21).

The curing of 3-dimensional objects presents special problems and these have successfully been addressed using a number of different reflector designs and configurations (a.22).

Electron beam (EB) curing is another well-established technique. EB curing requires that the space between the electron gun and the substrate be made inert with nitrogen. Initiation of radical-mediated polymerisation using EB radiation occurs at sites randomly placed within the coating, but overall relatively few sites are generated. Hence oxygen inhibition kills the cure and there is a need for inverting. Oxygen is also a good scavenger of electrons and will also reduce initiating efficiency in this way. The most frequently encountered EB curing units contain an electron gun which produces a curtain of electrons. Perforce the electrons are produced in vacuo and consequently the evacuated chamber has to have a window (usually made of titanium foil and water-cooled). In most units the electrons are accelerated at between 150 and 200 kV (a.3, a.13). More recently units have become commercially available which utilise an accelerating voltage of 125 kV (a.23). The lower accelerating voltage leads to more efficient interaction of the electrons with the coating, increases the lifetime of the titanium window, and leads to a reduction in the physical size of the equipment and cost! In addition to production units, smaller bench-top models are available to aid laboratory evaluation of samples (203).

The use of microwaves for curing formulations is of growing importance and in particular for the production of composites. Since the dielectric constant of the formulation changes as cure proceeds, it is necessary to use variable frequency microwave units (168). Provided the formulation contains materials having the appropriate dipolar characteristics, microwaves will be absorbed leading to heating which can be used to effect thermal reactions, e.g., production of polyimides from hydroxamic acids (128, a.24, a.25). Formulations based on a mixture of a cationic photoinitiator and a multifunctional epoxide can also be cured with microwaves (23). It is likely that the microwaves induce thermal decomposition of the initiator.

4 General Formulations

Formulations for UV curing generally contain:

(i) A photoinitiator

(ii) A polymerisable oligomer (also known as a prepolymer)

(iii) A reactive diluent

(iv) An amine synergist (this may be part of the initiator package) to ameliorate the effects of oxygen inhibition

(v) A pigment

(vi) Additives to improve adhesion of the coating to the substrate, improve slip properties, improve flow of the formulation, etc.

8
When considering formulations for EB curing, radical mediated curable formulations do not require the presence of a photoinitiator or amine synergist. EB curable cationic formulations do, however, require the presence of a photoinitiator.

4.1 Initiation of Cure by Photoinitiators

4.1.1 Radical Initiators

A photoinitiator is used to absorb the incident radiation and then undergo processes which lead to radical production. In general there are two types of initiator. Following excitation, Type I initiators undergo bond cleavage to give radicals (Figure 6).

In the example shown (α-cleavage has occurred. There is a wide range of commercially available Type I initiators and the chemistry and performance as initiators has been comprehensively summarised (a.26). Points which need to be borne in mind when choosing an initiator include wavelength response, efficiency of cleavage, solubility in the formulation, whether the by-products are odorous and/or enhance post-cure yellowing by heat or light of the cured film, toxicity, ease of handling, etc. The problem of odorous by-products has been overcome by the use of a polymeric photoinitiator (a.27).

Type II initiators are, for the main part, aromatic ketones. For these materials to be effective initiators it is necessary to use a synergist which usually is a tertiary amine. Following excitation the aromatic carbonyl compound attacks the synergist to give a synergist derived radical, e.g., (α-aminoalkyl radical, which is responsible for initiation of polymerisation. The materials which are commercially available have been detailed (a.26) and once again the selection is based on the criteria listed for the Type I initiators.

There are other types of initiators which are used to a far lesser extent than those already described. Of particular interest are those which respond to visible light, e.g., the fluorone initiators (254, a.28), n-butyltriphenylborate salts (a.29) of cyanine and other cationic dyes and hexaarylbisimidazoles (a.30).

4.1.1.1 Synergists

It is important to consider the synergists. Tertiary amines are the most popular of materials. Aliphatic amines have the dubious property of being odorous and give rise to migratable species in cured coatings. Use of these amines may not be permissible for some applications, e.g., in litho inks, where a water-washing step in the process would lead to loss of the amine from the formulation. To overcome these problems amino acrylates are now available. These materials are produced by adding a secondary aliphatic amine to a multifunctional acrylate in proportions such that the product (produced by Michael addition) still contains some acrylate group thereby making the amine ‘polymerisable’.

4.1.2 Cationic Initiators

There are far fewer cationic initiators available compared with their free radical counterparts. The commercially available initiators (a.26) are onium salts - iodonium and sulfonium. The reactivity of the salts is very dependent upon the counterion with the reactivity increasing in the series BF$_4^-$ < PF$_6^-$ < AsF$_6^-$ < SbF$_6^-$ . Other counterions find use in specialist areas, e.g., methanesulfonate anion

where h is Planck's constant and ν is frequency of the radiation

Figure 6
Type I initiation
in electronics. Most of the onium salts exhibit absorbance below 350 nm, which means they are excellent for clear films but light absorption problems may occur with pigmented systems. The spectral sensitivity of iodonium salts can be increased by the use of sensitisers, e.g., dyes which absorb in the visible region of the spectrum. Decomposition of iodonium salts can be enhanced by chemical sensitisation using Type I photoinitiators.

Selection of the initiator is based on spectral sensitivity, reactivity, solubility in the formulation and the nature of the decomposition products. Sulfonium salts release sulfides on decomposition which can be odorous and many of the iodonium and sulfonium salts also release benzene as a by-product. There is a commercially available iodonium salt which does not suffer from this drawback (131).

### 4.1.3 Anionic Photoinitiators

These have been reviewed (a.26). As yet there are no commercially available anionic photoinitiators. Some of the initiators which show promise are substituted carbamates (a.31) and phenacylammonium n-butyltriphenylborate salts (a.32). Decomposition of phenacylium salts has been used to generate some very strong bases (a.33), which were used to catalyse Michael addition reactions.

### 4.2 Prepolymers

Prepolymers are the materials in the formulation which have a profound influence on the physical properties of the cured coatings. Some of the most important types of prepolymer are listed in Table 1.

Other prepolymer materials in use include melamine acrylates, acrylic acrylates, acrylated unsaturated polyesters, acrylated polybutadienes, hyperbranched and dendritic acrylates.

The viscosity of a prepolymer is determined by its average molecular weight and whether or not it contains groups which can form hydrogen bonds, e.g., hydroxyl, thiol, primary and secondary amines, amides and urethanes. The groups listed will form hydrogen bonds with each other as well as with the oxygen atoms present in esters, amides, urethanes, ethers, etc.

### 4.3 Reactive Diluents

The reactive diluents that are sold in the greatest volume and for which there is the greatest choice are acrylates and methacrylates. These materials have replaced styrene (which is extremely volatile, odorous, flammable and slow to cure) and unsaturated polyesters. Vinyl ethers, which are not particularly susceptible to radical polymerisation, are used in conjunction with maleate and fumarate esters and maleimides.

What influences the choice between acrylates and methacrylates? Of the two types of compound, when like with like is compared, the acrylates are much faster curing. The slower curing methacrylates may therefore give rise to systems that are more susceptible to oxygen quenching. Methacrylates have the advantage over

<table>
<thead>
<tr>
<th>Prepolymer</th>
<th>Description of coating properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyether acrylates</td>
<td>Produce soft coatings of poor durability, are of low viscosity and can aid pigment wetting.</td>
</tr>
<tr>
<td>Aliphatic polyesters</td>
<td>Produce highly flexible coatings of moderate strength.</td>
</tr>
<tr>
<td>Epoxy acrylates</td>
<td>Give good strong coatings which often show good adhesion to metals. Exhibit yellowing in sunlight (particular those based on aromatics such as bisphenol A).</td>
</tr>
<tr>
<td>Aliphatic polyurethanes</td>
<td>Give very strong flexible coatings which show the best outdoor durability of all the acrylates.</td>
</tr>
<tr>
<td>Aromatic polyurethanes</td>
<td>Give very strong hard coatings but exhibit yellowing in sunlight.</td>
</tr>
<tr>
<td>Silicone acrylates</td>
<td>Give high gloss coatings with low surface energy and hence find application in the production of release coatings (see adhesives, Section 6.5). Sometimes used as slip additives.</td>
</tr>
</tbody>
</table>
Acrylates when it comes to toxicity and for this reason these materials are favoured for application in dentistry.

Choice is also made by referral to the function of the reactive diluent in the formulation. The main purpose of the diluent is to act as a 'diluent', i.e., a reducer of viscosity, for the prepolymer (oligomer) since these materials are often highly viscous and therefore cannot be applied to surfaces by the desired method. The diluent is used to adjust the viscosity so that the formulation can be applied using the coating method of choice. The diluents also have other important functions. Diluents possessing varying degrees of functionality can be obtained. As the functionality increases, i.e., as one progresses from mono to di, tri, tetra, penta and hexa, so the reactivity increases as does the crosslink density in the cured film. Thus the diluent can be used to modulate reactivity and to complement the properties (e.g., increase flexibility) of the cured film as determined by the prepolymer. Many of the diluents are excellent solvents and hence find a role in aiding the dissolution of additives (e.g., photoinitiators) and in wetting the surface of the substrate to be coated. When plastics are being coated it is useful to have a diluent which softens the surface thereby aiding adhesion of the cured film. Materials such as N-vinylpyrrolidone and N-vinyl caprolactam have proved useful for this purpose.

Use of high functionality diluents not only increases the rate of cure, but it can also lead to high levels of shrinkage and of uncured polymerisable groups in the cured film. When an acrylate formulation cures there is an increase in density due to the bonds formed bringing the component molecules closer together. This effect increases in magnitude as the functionality increases. Shrinkage can also occur because there is a difference in the rate of cure at bottom, centre and surface of the film. Shrinkage during cure can often have a disastrous effect upon the adhesion between the cured film and substrate and can lead to delamination. Another effect of increasing the functionality of the diluent is that the crosslink density increases and as a consequence the transformation from the liquid to the vitrefied state during the curing process occurs at an earlier stage. Once the coating has vitrefied the unreacted polymerisable groups are frozen in and cannot react via a diffusive process. Such groups often are slowly consumed when such films are exposed to daylight due to the intervention of oxidative processes.

Lists of commonly available monomers are available in several texts (a.1, a.34).

### 4.4 Pigments

There is a wide range of pigments used and selection is usually based on colour, the durability of the colour, the compatibility of the pigment with the formulation and, of course, cost. The most frequently used white pigment is titanium dioxide (with the rutile form predominating over the anatase form). Carbon black is a useful pigment but due to the presence of free radicals on its surface it can lead to the premature gelling of formulations. Iron oxide finds application in magnetic recording systems. To obtain the vast gamut of colours required by the graphic arts industry, organic pigments are used. For outstanding light fastness, phthalocyanine pigments are used. The successful use of pigments is determined by experience. Each pigment manufacturer has their own way of treating the surface of pigments to aid compatibility in formulations and therefore what is apparently the same pigment from two different manufacturers may behave very differently.

There has been a rapid growth of interest in the use of metallic aluminium and this has been triggered by the increased popularity of scratch cards. Use of metals (aluminium, copper, brass) can aid the production of films having wonderful colour effects (a.35). Other dramatic effects can be obtained by the use of pearlescent pigments (a.36).

In any formulation containing pigments there is the problem of getting cure over the whole depth of the film, to achieve this requires the careful selection of photoinitiators; usually a cocktail of initiators is used.

### 4.5 Additives

The formulator has at his disposal a wide range of materials which, although not polymerisable, are added to UV curable formulations to enhance one or more property.

A commonly encountered problem is the foaming of formulations during the coating process which can lead to pin-holes in the cured coating. A wide range of additives have been screened in an attempt to find materials to combat this problem (214) and some polyacrylates show promise (a.37). Fluoro compounds can be used to improve the water resistance properties of coatings as a result of lowering their surface energy (356). Silicones, in many cases polymerisable, are often used for a similar purpose (a.38). Scratch resistance can be improved by adding polytetrafluoroethylene.
Fillers find application in reducing the shrinkage which occurs upon cure; acrylated polycyrlates and aluminium trihydroxide (333) have also been found useful for this purpose (a.39). One of the valuable features of radiation cured coatings is their high gloss, but for some applications it is desirable to produce a matt finish and this can be done by adding silica (a.40). Some polyurethanes have also been found useful for this purpose (315). The addition of oxides, such as silica, which have been modified by incorporating acrylate groups, can also confer abrasion resistance upon coatings (160). Addition of fillers to formulations can lead to an increase in the viscosity of the formulation thereby requiring an increased use of reactive diluent.

5 Components of Cationically Cured Formulations Other than Photoinitiators

The two most widely used types of cationically curable materials are epoxides and vinyl ethers. There is a growing interest in using oxetanes (a.41, a.42), which, like epoxides, polymerise via a ring opening reaction.

5.1 Reactive Diluents

5.1.1 Epoxides

For years the standard workhorse material has been the cycloaliphatic epoxide:

O

There are other cycloaliphatic epoxides available, e.g., limonene di-epoxide and these are listed in several texts (a.1, a.34). There has been much interest in developing less costly materials and epoxidised dicyclopentadiene may fulfil this role (106). Another way to reduce cost is to use naturally occurring materials. Such a material is soybean oil whose main constituent is a triglyceride of an unsaturated acid which can be readily epoxidised (166). Castor oil has been converted into a glycidyl ether and shown to give good coatings on cationic cure (51). Terpenes such as nopol may also provide another source of low cost materials (142). The order of reactivity of epoxides is cycloaliphatic > acyclic > glycidyl.

5.1.2 Vinyl and Related Ethers

The range of vinyl ether diluents is far greater than that of epoxides and lists of the materials are to be found in standard texts (a.1, a.34). These materials cure extremely rapidly (130) far outpacing the cure of epoxides (355, a.43). Vinyl ethers exhibit shrinkage on cure (the extent being similar to that observed for acrylates when like with like is compared). When used in conjunction with epoxides shrinkage is reduced (thereby improving adhesion), a fast cure speed is attained and the properties of the cured film can be modulated by the choice of vinyl ether (220). The slow speed of cure of epoxidised soybean oil can be overcome if it is used with a vinyl ether diluent such as cyclohexane-1,4-dimethanol divinyl ether (184). Use of this vinyl ether enhances the hardness of the cured coating. The vinyl ethers of linear polyethers give flexible coatings, whereas use of cyclohexane-1,4-dimethanol divinyl ether gives hard brittle coatings exhibiting good stain resistance (353).

The excellent solvating properties of vinyl ethers have proved useful in the application of the prepolymer epoxidised polybutadiene which is poorly soluble in the epoxide diluent (Section 4.3) (184). One class of aromatic alkene ethers is the alkenyloxystyrenes, which can be used to produce coatings having an outstanding thermal resistance and high glass transition temperatures ($T_g$) (145). Such materials are of value in the assembly of electronic components.

5.2 Prepolymers

The range of epoxide containing prepolymers is severely limited (a.1, a.34). Epoxide novolaks which are glycidyl ethers of novolak resins, give good hard coatings as do their close relatives the glycidyl ethers of bisphenol A and related materials. Epoxidised polybutadiene and block copolymers containing epoxidised polyisoprene, polyethylene or polybutylene components are available. The latter materials are useful in adhesive formulations (a.44).

An area that has seen much work is the development of epoxy silcones (a.45). The epoxy groups may be present as either cycloaliphatic epoxides or as glycidyl ethers. A major use of these materials is in the
production of release coatings (179, 289, 291, 299, 307, 317). One of the reasons for generating the release coatings cationically is that the cure process does not suffer from oxygen inhibition, which is a particularly severe problem when acrylated silicones are used. Other uses of epoxysilicones include the production of pressure sensitive adhesives (83, 183) and in the coating of optical fibres (134).

A number of vinyl ether prepolymers are available including vinyl ether terminated esters, urethanes, ethers and siloxanes (a.1, a.34, a.46). The performance of many of these oligomers has been assessed both in pure vinyl ether formulations and when mixed with epoxides (220, a.47). These materials can be used to produce coatings having a range of properties varying from those which are hard having a high modulus; hard and high flexibility; and flexible showing a good abrasion resistance. Fluoroalkyl vinyl ethers have been used in conjunction with some of the prepolymers to give coatings having a low surface energy which is a valuable property for release coatings and for coatings possessing good stain resistance (194).

5.3 Combinations of Cationic- and Radical-Cured Materials

The foregoing sections illustrate some of the hybrid systems that have been used such as combining epoxides with vinyl ethers. In these systems, both components are cationically cured and therefore a single initiator is used. Cationically cured materials can also be used in conjunction with radically cured materials. Mixtures of epoxides and acrylates have been successfully cured. Castor oil is a triglyceride containing a hydroxylated unsaturated acid. Acrylation of the hydroxyls gives a material which can be used in conjunction with an epoxide (a.48, a.49). The formulation is cured using a mixture of a cationic initiator and benzophenone. The acrylated castor oil introduces some flexibility and decreases the hardness of the coating. It is claimed that other acrylate-epoxide combinations give coatings possessing properties that surpass those of the individual components (a.48, a.49).

Combinations of vinyl ethers and acrylates have also been found of value (a.50). Cure is effected by use of a mixture of cationic and radical initiators. The cure of the vinyl ether is extremely rapid and outstrips that of the acrylate, as a consequence the vinyl ether reduces the sensitivity of the acrylate cure to oxygen inhibition. If the vinyl ether and acrylate are correctly chosen interpenetrating networks can be formed (308). However, it should be noted that many acrylates contain small quantities of free acid and this can lead to the slow hydrolysis of the vinyl ether releasing the odorous acetaldehyde.

Vinyl ethers also find use in radical mediated reactions. Although vinyl ethers polymerise only slowly when inititated by radicals, they readily form 1:1 alternating copolymers with maleate esters and maleimides. It is the reaction with maleate esters (conveniently made from maleic anhydride and alkane diols) that has attracted the most attention.

6 Applications of Radiation Curing

The use of radiation curing has become accepted in a number of industries although in many it only represents a small percentage of the business. The advantages of radiation curing have to be weighed against important issues such as the higher cost of radiation curable materials, prejudice, i.e., the misplaced conception that it is dangerous (due to the use of the word ‘radiation’ - the term energy curable is being introduced to overcome this problem) and lack of familiarity with formulations (e.g., the uncertainty of formulators as to how to make changes to give the desired finish and yet maintain the correct rheological properties). Clearly education has an important part to play in advancing the use of this technology.

6.1 Wood Coating

This is a well-established industry in Europe (including Scandinavia), accounting for 50% of the radcure business in 1998 (a.51). Radiation curing is used to produce coatings for furniture, floor tiles (e.g., parquet) (211) and flooring in general, kitchen work tops, ceiling tiles, etc. As with other coating procedures the wood has to be filled and for high quality finishes more than one top coat may have to be applied (298). For flooring and worktops it is essential that the coating is abrasion resistant (264) and for good performance they have to be reasonably thick (e.g., > 50 (µm). The curing of fillers requires the curing of material within the pores of the wood and aluminium trihydroxide has been found to be beneficial in this respect (281). To obtain efficient, thorough cure careful attention has to be paid to the lamp system (297).

High line speeds are not usually required for wood coating since large pieces of stock have to be handled and thus low cost formulations based on unsaturated
esters in styrene have been popular. The odour and flammability of styrene have provided good reasons for change and acrylates have provided a viable alternative (298). Since wood coating covers coating of flat-stock and 3-D objects, a variety of coating methods are employed. This requires the use of formulations having widely different viscosities. Spray coating, curtain coaters, roller coaters (a.52) etc., are employed and suitable materials are available for use with these (either as UV or EB curable systems) (165).

An excellent way of achieving a good working viscosity is to use water as a diluent and waterborne coatings are attracting an increasing amount of attention (190, 224, 265, 272). The position of acrylate technology in this application is being challenged by the vinyl ether-maleate ester system. Vinyl ether-maleates have been used as diluents for acrylate prepolymers (181). Maleate esters derived from cellulose derivatives, when used with vinyl ethers, have been found to give excellent coatings (58).

The use of powder coating techniques is making inroads into the wood coating business. Radiation curing is particularly valuable in this respect since it allows formulations to be used that melt at temperatures which do not have a deleterious effect upon the wood (e.g., ~100 °C). Vinyl ether-maleate ester based powder coatings have been employed (283, 303, a.11). Titanium dioxide pigmented powder coatings have been successfully produced using this polymerisation system (a.53). Cationic curable systems have also been developed for powder coatings (78) as have acrylates (a.54). By judicious choice of photoinitiator and UV screens and stabilisers, waterborne formulations have been developed for coatings that are to be used in outdoor applications (a.55).

### 6.2 Graphic Arts

This is a well-established application of radiation curing occupying a major market position worldwide. Areas of application include the generation of the image to be reproduced onto the printing plate, silk-screen, etc. (a.56), use of radiation curable inks and production of overprint varnishes (104, 178, 249, 288). The different ways in which radiation curing can be used to generate images has been well reviewed (a.56). Many imaging processes rely on the exposure of materials to radiation to bring about a change in solubility in a solvent system (either organic or aqueous), thereby enabling exposed and unexposed areas to be differentiated. Differentiation between exposed and unexposed areas can also be effected if irradiation leads to selective delamination, softening, tackiness (which can affect the adherence of toner powders) or a change in refractive index (holography).

The imaging of flexographic, gravure and litho plates, and silk-screens is an application of resist chemistry (359), which has found widescale application for the production of printed circuit boards. A resist is a material that will resist solvent attack. Negative resists are materials which, on exposure to light, become less soluble (due to crosslinking, etc.) in a solvent that will dissolve the un-irradiated material. A positive resist is a material which becomes more soluble in a solvent system than the un-irradiated material (e.g., as would be caused by depolymerisation). Examples of negative working resists include the polymerisation of multifunctional methacrylates, decomposition of azido compounds and compounds that undergo [2+2] cycloaddition reactions.

Azido compounds undergo decomposition on UV irradiation to give highly reactive species called nitrenes which can add to double bonds, insert into C-H bonds and abstract hydrogen atoms from C-H bonds. Such processes (other than the hydrogen abstraction reaction) are not affected by the presence of oxygen, which is a particularly useful feature if thin films, such as those required for litho plate production, are to be cured. Use of difunctional azido compounds in a polyolefinic matrix (e.g., polyisoprene) leads, on irradiation, to crosslinking (a.57). Cycloaddition reactions are very different in character to the radical and cation mediated reactions. Many compounds which contain a double bond will dimerise on irradiation giving a product containing a cyclobutane ring, for example see Figure 7.

![Figure 7](image_url)

**Figure 7**

Formation of a cyclobutane ring
Formation of the cyclobutane ring is equivalent to a crosslink and these reactions are used to form crosslinks between polymer chains. Often the reactions take place in the semi-solid state and a requirement for these reactions to be efficient is that the double bonds of the participating molecules lie close to each other. One of the earliest systems to use this reaction contained polyvinyl alcohol esterified with cinnamic acid (a.58). A valuable feature of this reaction is that it can be sensitised and hence the spectral sensitivity can be extended out to 500 nm. A somewhat similar system is that based on stilbazolium salts and these are used for imaging screen stencils. The salts are attached as pendant groups to polyvinyl alcohol and undergo dimerisation when irradiated with light of up to 450 nm (357). The formation of the cyclobutane adducts reduces the solubility of the polyvinyl alcohol in water and hence irradiated and non-irradiated areas can be differentiated. An attractive feature of this system is that once the imaged screen has come to the end of its useful life, the polyvinyl alcohol and attached groups can be removed from the screen by treatment with periodate.

Another system that has attracted attention is that based on maleimides. Both direct irradiation and sensitised activation of maleimides leads to [2+2] cycloaddition (a.59-a.62). A goal for producers of litho plates and silk-screen is to produce imageable systems of sufficient speed to enable direct laser systems to be used (a.20). Some innovative formulations have been developed for the production of flexographic plates (93) and litho plates (138).

6.3 Printing Inks

There is much activity in the area of producing EB and UV curable inks and the market share of the various types of ink has been analysed (a.63). The major part of the market is taken by litho, letterpress and screen inks; in 1998 they accounted for 79% of the market. There is a real challenge to produce inks for flexography where the rheology of the inks and pigment wetting are of paramount importance (92, 213, a.64, a.65). For all types of ink, pigment wetting is of great importance and despite much work there are no simple rules to guide the formulator (177, a.66). Fluorescent dyes are used to create inks which, when printed, have a striking visual effect (135). To obtain effective cure requires the judicious choice of initiators. There is much interest in radiation curable inks for use with ink jet printing systems (an example of a non impact printing system) (a.67). Amongst the challenges to produce a good ink are: the requirement for low viscosity, selection of a dye or pigment that is stable in the formulation and which doesn’t block the jets, and a polymerisable system that will cure rapidly despite the presence of oxygen (226). Water is a good vehicle for such systems, but it is not suitable for cationic curing inks. Oxygen inhibition makes the use of radical mediated reactions difficult and therefore attention has been drawn to the use of cationic systems (125). Water based inks are of interest because they are easier to remove from rollers and presses than the purely organic solvent soluble inks, although there is still a problem of disposing of the washings in an environmentally friendly way!

In many cases a printed product has to suffer quite exacting physical demands such as scratch resistance (144) and in the case of printing on golf balls a severe hammering (61, 103)! Adhesion of the print to the substrate is very important (74) and this is particularly so in the field of security and label printing. Radiation curable inks have been printed onto plastic to produce bank notes (259), often with enhanced security features (a.68). Intaglio printed paper bank notes have been successfully produced using EB curable inks (a.69). Printing onto glass has also been accomplished and used for colour coding optical fibres (119). An acrylated silicone benzoate plus acrylated dyes were used for this purpose.

6.4 Packaging

The packaging industry is closely allied to the printing industry and the use of radiation curing in food packaging has been reviewed (246). The possibility that small molecular species can migrate through the packaging into the food has to be taken into account. Cationic curing is employed in can coating due to the excellent adhesion between the coating and the substrate (182, 294, 342). The cationic photoinitiators yield a number of by-products including aromatic sulfides (268) and benzene (a.70). If, after radiation curing, there is a sizeable thermal treatment, many of these small molecular species are removed from the coating due to volatilisation. The printing associated with packaging has to be of very high quality as the printed word and associated artwork is of paramount importance in attracting and informing potential customers. The printing has to be done on a variety of substrates including paper, plastics (polylefins, polycarbonates, polyvinyl chloride), metal, glass, etc. and ideally the printing has to be done at high speed. The label market represents a large sector in this business and radcure is used here (114), with the promise of greater usage if radcure flexographic inks come of age. Scratch resistance is a required property.
Radiation Curing

of printed articles and particularly so when the printing is on glass or metal. Very high quality and attractive printing (using screen inks) on glass has been attained (260). Acrylate formulations have been found useful for printing on metal packaging (136).

The cost of using UV curable inks for this purpose compares favourably with thermally dried inks (266, 267). The cost of EB curing in the packaging industry compares favourably with thermal and UV curing (225).

6.5 Adhesives

This is a rapidly expanding business for radiation curing due to the many advantages that the technology offers. The two main types of adhesives are laminating and pressure sensitive adhesives. An adjunct to pressure sensitive adhesives is the production of release coatings, which are used to protect the adhesive until it is to be used.

6.5.1 Laminating Adhesives

As the name implies these materials are used to bond materials together (206, 279, a.71). Bonding between many types of homopolymers has been achieved and examples include polyester, polycarbonate, polyethylene and cellulose acetate. There are many examples of glass laminates. Examples of heterolaminates include paper to polyester, paper to metalised polyester, acrylic to vinyl sheets, polyester to nylon, nylon to polycarbonate, glass to polyester and glass to polycarbonate.

Many of these examples utilise materials which are transparent to light and therefore UV curing may be employed (some materials may only transmit light at > 300 nm and therefore this may dictate the type of initiator that is used). When materials are used which are opaque to UV or visible light it may be possible to use EB radiation, e.g., high energy electrons may penetrate paper, foil and fabrics.

Other than waterborne formulations the UV curable adhesives are 100% solids and this is a particularly attractive feature. Many conventional adhesives are solutions of the adhesive in an organic solvent or are a dispersion of the adhesive in water. For the adhesive bond to develop, the solvent (water or organic) has to be evaporated off and this takes time and energy. Release of organic solvents into the atmosphere is the subject of severe legislation and therefore businesses operating on a large scale have to put in solvent recovery plants, which is an expensive exercise.

Hot melt adhesives are 100% solids systems and are applied in the molten state; the adhesive bond is created on cooling. There is, of necessity, a restricted temperature range over which such adhesives can be used. An alternative system is to use reactive adhesives, i.e., systems in which two species are brought together which react and so develop the adhesive bond. Such systems suffer from the disadvantage that the polymerisation process is relatively slow and the mixture has to be used straight after mixing.

Each of the three systems which have been outlined have their limitations and so how does radiation curing help? Firstly, there is no problem with solvent emission since UV curable adhesives are formulated as 100% solids. Secondly, the curing process is extremely rapid (a fraction of a second) compared with the time required to remove solvent or, in the case of the reactive adhesives, for the reaction to take place. Hot melt adhesives can be made into radiation curable systems, which offers the advantage that the radiation induced crosslinking enables the adhesives to be used at temperatures higher than the application temperature. Another feature of the radiation curable systems is that one can make the adhesive impervious to water or make it hydrophilic to aid its removal on demand. Whilst the requirement to be able to irradiate through one of the substrates may be seen as a negative aspect the problem is not insurmountable. If a cationically curable system based on epoxides is applied to one of the substrates and sufficient radiation applied to decompose the photoinitiator, then following the application of the second substrate cure will occur, i.e., this system employs the well-known post-cure effect that is frequently observed with epoxides.

Radiation curable laminating adhesives have found application in the fabrication of optical components. By matching the refractive index of the epoxy adhesive to that of the quartz filler excellent depth of cure could be achieved, with the cured composite exhibiting excellent strength and durability. The adhesive was used to position optical components with submicron accuracy. There have been other applications in the production of optical devices (227, 336) and in the field of optoelectronics where radiation curable adhesives have been used to assemble digital video discs (DVDs) (234).

The use of liquid crystal display devices is ubiquitous and here the adhesive which seals the plates which contain the liquid crystals has to be impervious to moisture. A radiation curable sealant has been used for
Radiation Curing

this purpose (88). Sealants also find application in other areas (96). Radiation curable adhesives have also been designed for aiding the assembly of electronic components (57, 86). UV curable bioadhesives have been developed and here water and tissue compatibility are of the utmost importance (240). Materials used for UV curable adhesives include both radical mediated (acrylate, methacrylate) and cationic systems. Vinyl ethers are reported to be of value because of their rapid rate of cure and the good adhesion of the cured films to substrates (195).

Choosing the right type of irradiation equipment is of the utmost importance (66). A case has been made for using visible light curing systems (118). It is important to choose the components of the formulation carefully and to control the light dose so that too much crosslinking does not occur otherwise delamination (loss of adhesive properties) will occur.

### 6.5.2 Pressure Sensitive Adhesives (PSAs)

The main property that distinguishes a PSA from other types of adhesives is that it possesses permanent, controlled tack. It is the tackiness that causes the adhesive to adhere instantly when it is pressed against a substrate. After it has adhered, the PSA should exhibit tack, peel and shear properties which are reproducible within narrow limits.

PSAs possessing a wide range of properties to suit an ever increasing number of applications have been described. They are most useful in the production of tapes and labels. Carton sealing tapes have to be produced at low cost, and be quick grabbing to paper board and resistant to moisture. Sealing tapes commonly used in the home must have quick tack and yet release cleanly and easily from the roll. Conventional PSAs are often composed of rubbers dissolved in a solvent or are dispersions of rubbers in water. In addition there are some hot melt systems. Use of radiation curable PSAs eliminates the release of organic solvents into the atmosphere, allows easy application of the formulation to the substrate, eliminates solvent entrapment in the cured adhesive and the cure gives rise to little shrinkage.

There is an excellent review available on radiation curable adhesives which describes the chemistry lying behind typical formulations as well as discussing the applications of radiation curable PSAs (a.72).

In designing formulations for radiation curable adhesives one has to bear in mind that to achieve tack the cured film must be only lightly crosslinked (53) and the T₆₅ kept low (140, 251, 256). Water based curable PSAs are available (197, 251, 256). Hot melt radiation curable adhesives are very popular. Radiation curing enables quite thick coatings (>250 µm) to be laid down with one application and cured by one pass under a lamp (68). Some of the advantages of radiation cured hot melt systems are the heat and moisture resistance and stability of the adhesive layer (67, 94, 201, 253). Hot melt systems based on acrylates (242, 247, 255), polyacrylates containing a covalently bound photoinitiator (247) and block copolymers of styrene-butadiene (210) have been described. Acrylated polyesters have been used to generate ‘warm’ melt adhesives (188). The nature of the molecular backbone of the acrylate has a profound effect upon the physical properties of the adhesive (148). Some epoxidised copolymers of butadiene and isoprene have been produced and used to produce PSAs (149, 150). Very high curing speeds were attained with thin films (up to 244 m/min). An innovative and extremely valuable use of radiation curing has been to develop PSAs which lose their tack upon irradiation and hence delaminate (due to crosslinking) (90, 155). These materials are finding increasing application in wound dressing materials.

As with laminating adhesives, the production of PSAs requires careful choice of equipment and operating conditions. Both UV (102, 176) and EB (262, 273, 274, 280) equipment has been employed.

### 6.5.3 Release Coatings

These materials are used to protect the PSA up to the point that the PSA is to be used. The release coating should peel away from the PSA without damage to the adhesive (291). Materials for release coatings must have a low surface energy and the materials of choice are silicones. Silicone acrylates are widely available and are used extensively (55). The cure of these materials is very susceptible to oxygen inhibition and consequently curing is usually carried out under a blanket of nitrogen. It may be for this reason that cationic systems are so popular. A number of epoxy silicones have been described (183, 293). Quite remarkably the cure of these materials can be brought about by EB radiation without the need to nitrogen inert (183). By using silicones which have terminal hydroxyl groups the physical properties of the coating can be altered, e.g., reducing the coefficient of friction and making release of the PSA easier. Vinyl ether terminated silicones are also used, both as straight cationic systems (a.46) and in conjunction with
acrylates (164). Use of the vinyl ether as a diluent removes the necessity for nitrogen inverting.

### 6.6 Optical Components and Optoelectronic Applications

One of the rapid growth areas in the last decade of the twentieth century and which is likely to continue to grow in the twenty first century, is that of the production of optical fibres for use in the communications industry (a.73, a.74). A cross-section of an optical fibre is shown in **Figure 8**.

![Cross-section of an optical fibre](image)

**Figure 8**

Cross-section of an optical fibre

The optical signal has to travel within the optical fibre (usually a doped silica glass) without any loss in signal (e.g., intensity). To keep losses to a minimum the fibre is coated with a material of lower refractive index than the fibre. To protect this layer, it is encased in a ‘buffer’ (which acts as a cushion), which in turn is encased in one or more protective layers. Both the primary and protective coatings can be applied using radiation curing. It is clear that the coatings have to be tough and yet flexible. Since the coated fibres will be used in locations where it is difficult to access them the coatings have to be highly durable. Aliphatic urethanes are popular materials but to obtain the required physical properties the urethanes are often modified by the inclusion of other polymer segments such as polyesters, polyether/polyolefin block copolymers and polycarbonates (122, 151, 318, 354). Epoxy and acrylated silicones admixed with polyurethanes have also been used (112, 134).

Polyurethanes carrying mercapto groups in the terminal positions have been used in conjunction with methacrylates in an attempt to reduce the number of migratable species (174). Vinyl ether terminated oligomers have been used in association with acrylates to prepare primary coatings (77) as have silicone acrylates (335). Careful selection of the substituents in the silicone acrylates enabled the refractive index to be controlled and adjusted to the desired value. Acrylated urethanes have been used to produce optical fibre ribbons, because of their strength and durability (100).

An alternative to using fibre optics is to use polymeric waveguides and some low-loss systems (based on polymethylmethacrylate) for 1320 and 1550 nm light have been successfully fabricated (105). The photocrosslinking of films produced from polyvinyl alcohol derivatised with cinnamic acid have been shown to have potential as channel waveguides (221).

Radiation curing also plays an important part in the production of compact discs and DVDs. In the production of compact discs both the replication and formation of the protective coat may be carried out using radiation curing (a.75). Methacrylates are commonly used and the shrinkage which occurs upon cure of these materials can lead to problems, but these have been surmounted (358, a.76). Such problems have to be overcome in using radiation curable adhesives for cementing the two discs required to make up a DVD (101, 234). In DVD production the light required to initiate reaction has to pass through one of the discs and consequently choice of an initiator having the right absorption properties and lamps with sufficient power are of great importance (192).

Adhesives play an important part in the assembling of optical components (163, 284) and need to exhibit adhesion to a variety of substrates such as glass and polycarbonates. Optical components such as lenses (for equipment and eye-wear) are also made using radiation curing (302, a.77). Radiation curing offers a very speedy way of making these. For eye-wear it is essential that no uncured monomers/prepolymers are present in the product and hence some curing is done under nitrogen to avoid oxygen inhibition (a.16). Methods are available for making lenses in multiple batches (124, 227). Methacrylated silicones have been used to produce biocompatible lenses having a predetermined refractive index (24, 25).

Being able to change the refractive index of a material by polymerisation is at the heart of producing holograms by radiation curing. Such holograms are useful for information storage. There is an excellent review on the subject which contains many useful references (a.78). Materials used for lens and waveguide production find use in this area (24, 25, 221).

Organic light emitting devices have been produced using radiation curing. It is suggested that photopolymerisation could reduce the cost of producing these devices to a considerable degree (132). Multilayer
devices were built up by repeatedly spin coating and curving. The system used was based on tetraphenylphenylenediamine as the hole-conductor, to make this material polymerisable, oxetane groups were appended.

A most elegant system is based on polymerised liquid crystals (133). These materials can be used to produce channel compounds (e.g., as found in zeolites) and such a material was produced doped with poly-p-phenylenevinylene. When stimulated, the organic polymer exhibited a blue fluorescence; in contrast, when it is randomly distributed in a solvent it emits further to the red and with diminished intensity.

Encapsulation in the polymerised liquid crystal leads to shorter oligo poly-p-phenylenevinylene chains and since the individual chains are well separated there is no concentration quenching. This product can be regarded as a composite.

6.7 Production of Composites

In the previous section an example was given of a polymerised matrix in which were embedded rods of poly-p-phenylenevinylene. In this case the material contains a collection of minute particles and represents a nanocomposite. Such materials will have very specialised applications whereas the normal bulk composites have, as engineering materials, a large range of applications.

The value of composites lies in their very favourable strength to weight ratio. Lightweight, high strength materials are invaluable in the aircraft, automotive, space, electronic and shipbuilding industries. Compared with traditional materials they are less susceptible to corrosion and fatigue. Current composites based on carbon and glass fibres have excellent strength and a weight equal to 20 to 25% of aluminium alloys. There are a variety of composites and these include particulate (e.g., as used in the radiation curing formulations utilised in the dental industry), laminar, discontinuous fibre-reinforced (the reinforcement has its length much greater than its cross-sectional dimension with the properties of the composite being determined by the length of the fibres) and continuous fibre-reinforced (similar to discontinuous but called continuous because there is no change in elastic modulus if the length of the fibres is further increased). The matrix is very important since it binds the fibres together, transfers the load to and between the fibres and protects them from the environment and from the effects of handling. The properties of the matrix will determine the temperature range over which the composite can be used and the environmental resistance of the composite.

What are the advantages of using radiation curing? Compared with thermal methods the cure rate is very rapid and much easier to control (e.g., to start and to stop). Cure only commences when the radiation hits the formulation which means that unirradiated material can be stored until the next time it is required. By way of contrast, thermal curing systems require the addition of catalysts and once this is done the mixture has a finite useful lifetime. However there are some disadvantages to using UV curable formulations, the main one being the difficulty of getting the irradiating light to penetrate thick sections which contain particles or fibres which may be opaque to light. EB radiation does not suffer this disadvantage and hence this has become a popular source of radiation. There is a goodly number of examples of where microwave radiation has been used and this has been helped by the availability of variable frequency microwave sources.

The use of silica as a filler has been extensively exploited in dental applications. Radiation curable dental formulations have been available since the early 1970s and have seen a growth in their use. The subject has been usefully reviewed (99, a.79).

Advantages of UV curable formulations for dental applications include: they are ready for use on demand, they offer an extended working time, absence of air bubbles, a high rate of polymerisation and good colour stability. The formulations do have to meet several stringent requirements. Use of light of <330 nm is unacceptable since it may cause tissue damage and requires both patient and operatives to use special protective wear, hence initiators working at longer wavelengths are used, e.g., camphorquinone (99). Methacrylates, despite their relatively slow rate of cure, are used rather than acrylates since their toxicological properties are more favourable and it is essential that minimal shrinkage occurs on cure (shrinkage leads to loss of adhesion between the filling and the tooth). Fillers such as silica are used to give strength to the cured material and also to reduce shrinkage. The material should also be polishable, opaque to X-rays, stable towards saliva, beverages, etc., and have the appropriate thermal and mechanical properties.

Silica has been used as a particulate filler to impart strength to the cured article and to impart abrasion resistance (228). Encapsulants for microelectronic devices have been formulated containing silica (up to 60%) and found to cure to give coatings which possess similar properties to those exhibited by thermally cured
formulations (175). Fibres used in composites include metal, glass, carbon and polyamide. Whilst UV curing has been used for some of these systems, electron beam and microwave curing appear to be more popular since in these cases it is easier to get the radiation to penetrate the full depth of the sample. Metal fibre composites have been produced in which there is efficient electrical contact between the fibres (276).

There are examples of glass and other fibres impregnated with resin being cured by UV light (290, a.80) in the production of coated filaments, and in the production of prepreg sheets for waterproofing buildings. In the latter system two photoinitiators were used, one of which responded to near infrared radiation and the other to UV/visible radiation (a bisacylphosphine oxide). The resin containing the fibres was first cured using long wavelength light (>500 nm) to create a prepreg that could be wound up and transported to the building site where it was required. When the prepreg was put in place it slowly cured in the daylight to give the finished product. Such an approach, i.e., a dual exposure system, could well prove useful in other applications and in fact is used in the technique of rapid prototyping (see later). Bisacylphosphine oxides have proved to be very useful initiators for curing glass reinforced composites (200) with the products exhibiting acceptable mechanical performance.

Perhaps somewhat surprisingly, carbon fibre containing resins have also been cured using UV light (245). It has been theorised that the UV curing of composites could have application in the fabrication of lightweight structures for exploring space (152). Some methacrylated hyperbranched polymers have also been found to be of value in producing lightweight structures for exploration (244).

Acrylate functionalised thermoset resins have been used to produce fibre filled composites using electron beam curing (62). Electron beam curing is a relatively cold cure and consequently vitrification occurs below the T_g; this has consequences for the mechanical properties. Ways of compensating for the lack of heat during cure were found. Glass fibre filled composites for production of cladding panels have been manufactured using EB radiation (258). This application illustrates the point that EB curing of composites is not restricted to the production of high added value products. The production of materials having good mechanical properties matching those produced by traditional thermal methods has been achieved and a growth in these applications is expected (169, 170). Graphite fibre reinforced composites with high T_g, of low stress and exhibiting little shrinkage on cure have been produced, which perform just as well as state-of-the-art toughened epoxies (169, 173). The costs of producing composites by EB curing have been assessed and ways of reducing them found (198, 233). Costs increase as the thickness of the composite to be cured increases. Therefore methods have been devised to utilise low energy electron beam curing systems, in which the curing is carried out during the deposition of the resin upon the fibres whilst they are on the mandrel (198, 233).

Most of the EB cured composites described so far have relied upon curing via radical reactions but cationic curing systems (a cationic photoinitiator has to be added) have a lot to offer (72, 250). Epoxy resins have been cured in this way (127, 296), with the products exhibiting excellent thermal and chemical resistance as well as excellent adhesion to metals and plastics. Such is the performance of the materials that they are finding application in the production of fighter aircraft and space shuttles (127). A real bonus of such systems is that they can be cured in air and this leads to worthwhile cost savings (296). A rather different curing system for producing composites having a fibrous reinforcement is based on bismaleimides and vinyl ether terminated diluents (244).

Microwave curing of composites has become much more attractive with the availability of variable frequency ovens. The theory of microwave curing and of its many applications has been reviewed (120). In the curing of some polyimide systems it was found that the microwave cured materials exhibited higher T_g's and thermal stabilities compared with the thermally cured materials (84, 128, 157, 171). Examples have, however, been found where the properties of microwave composites only approach those of the thermally cured materials (84). The cure of some resins can be accelerated by the addition of small amounts of microwave absorbers (84). To achieve the best results from microwave curing, the temperature of cure has to be controlled otherwise thermal degradation of the resin occurs (115). The heat liberated during cure in large polymer composites is sufficient to cause such degradation.

Since the dielectric constant of a material is related to its temperature and hence its degree of interaction with microwaves, controlling the temperature of the cure process is important if the polymerisation process is to be controlled. This approach was used in a study of the cure of rubber-modified epoxies (73). Temperature control of the cure of polymers applied to semiconductors has also been found to be important (167).
Composites of the types described so far can be characterised and much information gained about their structure using dynamic mechanical thermal analysis. The build-up of the properties of a UV cured composite can be monitored in real time if the sample is irradiated in situ (271).

An innovative composite has been produced for orthopaedic applications (146). The composites, based on methacrylated carboxylic anhydrides are used to repair a bone fracture. As the natural bones start to knit together the crosslinked polymer undergoes slow hydrolysis. By appropriate choice of materials the erosion of the UV cured material can be controlled so that its removal from the repair area coincides with the satisfactory joining of the two natural bones.

Some examples of interpenetrating networks fit the description of being composites because each component has a different function. For example, taking styrene-butadiene block copolymers and adding an acrylated oligomer, then polymerising the acrylate (158). The crosslinked acrylate imparts rigidity to the rubber making the material suitable for use in hot melt adhesives and flexible printing plates. Crosslinking of styrene-butadiene block copolymers can be carried out utilising the double bonds present in the polymer. If a polyfunctional thiol is added plus a photoinitiator, irradiation leads to a thiol-ene reaction which generates crosslinks. This reaction, which does not suffer from oxygen inhibition, is extremely rapid (111). The products of this type of reaction could find use in printing plates, protective coatings, adhesives, etc.

### 6.8 Rapid Prototyping

This is a technique which enables solid objects to be produced directly from a design produced on a computer. The computer is used to control an illumination system that builds up the object, usually, by a polymerisation process. An important part of the design is that the object is sectioned into many small slices so that the polymerisation process can be used to build up the object by adding slice upon slice (340, a.1, a.81). In the most frequently used process, a continuous wave laser is used to trace out and polymerise a resin in the shape of a slice and to fill in within this area as appropriate. When this process is complete the next slice is assembled on top of the previously produced slice. The object created by this process is then usually subjected to flood irradiation using a medium pressure mercury lamp to complete the polymerisation process. In other systems, the slices are generated by irradiating through a negative using a conventional lamp (e.g., medium pressure mercury lamp) and optics. Such a system requires a negative to be produced for each slice. An alternative system uses a carbon dioxide laser to fuse particles together to generate the slices. Commercial equipment is available for producing objects ranging from a small to quite a large scale. Variations on this theme are continually appearing (75, 230, 269, 328).

It is important that the 3-D models/objects created by the imaging process are produced with a high degree of tolerance if they are to be of value. Methacrylate resins have been used extensively since they offer a high speed of cure (63). However acrylate polymerisation leads to shrinkage and this has to be accommodated by careful choice of resin and diluent (63, 327, 331). Many polycrylates are brittle and hence the models/objects created from them do not always possess the desired mechanical properties. For this reason the polymerisation of epoxides has become popular (60). A case has also been made for using vinyl ethers (301).

If a laser is to be used to initiate polymerisation it is essential that the absorption properties of the initiator match the wavelength output of the laser. The most frequently used lasers are argon ion and helium-cadmium lasers. These lasers can be made to deliver UV light and it is in this mode that the lasers are most frequently operated for this particular application. The lifetime of the laser tubes is very much shorter when used to deliver UV rather than visible light, hence there is interest in using the lasers to deliver visible light where additionally the laser power is much greater (300). The advantage of using the UV lines of the lasers is that there is a much wider choice of initiators that may be used and manipulation of the polymerisable formulation does not require operating in safelight conditions. It is essential that the model created in the imaging process has sufficient mechanical strength (known in the trade as green strength) to withstand being moved from the bath of liquid resin to a chamber where it can be flood irradiated. It is at this final step that the properties of the fully cured resin are realised and for this process to be successful requires the careful control of irradiation conditions, etc.

The applications of rapid prototyping are many and some are quite eye-catching. In the medical world an x-ray picture of say, a foot, can be taken in 3-D and then converted into a 3-D polymer model. The design of objects such as bottles and computer mice can be carried out and life-size models made to aid the design features to be assessed. Clearly such a process has
significant reduced the time required to take a concept through to a prototype. Of even greater significance is the use of rapid prototyping to produce functional products such as moulds, which can then in turn be used to produce many replicas (54, 89). Composites can be used to create 3-D objects with enhanced strength (147). Fillers such as aluminium borate whiskers have been used (a.82). An area which may see further development is the use of liquid crystalline materials (229).

A relatively new development has been the use of rapid prototyping to generate microstructures such as would be useful in electronic and mechanical applications (a.82). Interestingly a pulsed laser (xenon fluoride, 351 nm) was used for this operation.

6.9 Nanotechnology and Microstructures

Construction of objects on the macro scale has been considered so far, but in this section we touch upon a new technology in which radiation curing is playing a part. Nanostructured or nanophase materials are so called because the size of their building blocks is of the order of nanometres. Nanostructures can show remarkable optical, magnetic and electrical properties. When nanosized particles of magnetic iron oxide are incorporated into a polymer, the particles are transparent and magnetic. Melting of such a polymer gives a magnetic fluid (a.83). Nanocomposites have been made by inserting single polymer chains between sheets of layered silicates, i.e., the polymers are intercalated and in these materials the polymers show enhanced thermal and oxidative stability.

Reference has already been made to the production of nanocomposites using liquid crystals (Section 6.6) (133). Another application of these materials is to produce immobilised catalysts. The freezing in of a particular structure exhibited by a liquid crystal is a valuable way of producing an ordered structure having pores of a known size and geometry. Chiral liquid crystals, which offer some marvellous opportunities for display devices, containing polymerisable groups have been synthesised (42), which show a strong tendency to adopt a chiral smectic phase. Such a structure may prove useful as an organic piezoelectric material. Nanocomposites containing magnetically and optically active cations have been produced (139). Europium (III) ions trapped in this way exhibit sharp emission bands when excited with 370 nm light. If palladium ions are trapped, palladium nanoparticles can be generated which exhibit excellent catalytic activity (82). Mesophases stabilised by hydrogen bonding have been crosslinked, and hence stabilised, by photopolymerisation (direct irradiation with 365 nm light) (a.84).

Nanofibres have been generated using a diblock copolymer carrying a crosslinkable group (a cinnamate ester) (286). The diblock was based on polystyrene and polymethyl methacrylate. This diblock is self-assembling forming cylinders. Crosslinking the cinnamate groups which are located within the cylinder stabilises the cylinders thereby generating fibres. A similar system has been used to prepare ‘tadpole molecules’ (243). Nanospheres have been generated from polymerisable micelles (205). A diblock copolymer carrying cinnamate was dispersed in water with the formation of micelles. A methacrylated oligomer was used as porogen. Following crosslinking of the micelles via the cinnamate groups, the porogen was removed to give porous nanospheres. It is speculated that such materials could be used for drug delivery. This type of material has been modified to produce functionalised nanospheres (e.g., generating vesicles containing a hydrophilic core) (137).

Fabrication of microstructures using excimer lasers has been mentioned earlier (a.20). Microstructures have been lithographically produced and by injection moulding (a.85). Polymer waveguides have been fabricated in this way. (Incidentally, macrosized injection moulded articles have been coated by using a radiation curable coating within the mould (a.86)). To return to micromed features, micrometre/nanometre dots have been generated utilising the phenomenon of localised field enhancement (LFE) (a.87). A conducting tip (e.g., as found in an atomic force microscope) having a terminal radius of ~ 50 nm was irradiated with a helium neon laser (543 nm radiation). Underneath and very close to the tip is placed a surface coated with a photopolymerisable formulation containing eosin (which absorbs in the 450-560 nm range). The intensity of the laser beam is such that it is too weak by itself to cause a significant amount of polymerisation, but in the vicinity of the tip the LFE polymerisation occurs. The eosin doped formulation has also been used to create small sized features using evanescent waves (218, a.88).

Nanosized particles of silica and titanium dioxide have been rendered polymerisable by attaching glycidyl groups and these have been used in reflective interference filters (a.89). Such materials could be particularly useful for making nanocomposites. Nanosized particles of silica functionalised with acrylate groups are now commercially available (a.90).
Such particles are transparent to UV light and their presence imparts increased abrasion resistance, surface hardness and chemical resistance to coatings.

### 6.10 Liquid Crystals

These materials, which a few years ago were a chemical curiosity, are now to be found in so many of the appliances we use today. Liquid crystal display devices are found in watches, electronic devices such as video recorders, lap-top computers and domestic microwave ovens. Simple thermometers are based on thermochromic liquid crystalline materials. Stationary phases for gas chromatography have been produced from liquid crystalline siloxanes. Some of the new high strength fibres are liquid crystalline, e.g., Kevlar (a rigid main chain liquid crystalline polymer made by condensing 4-phenylenediamine with terephthalic acid), and piezo elements. The property that the various types of liquid crystalline compounds have in common is that in particular temperature ranges they will form ordered structures which often lead to interesting and useful optical effects. Radiation curing has found use as offering a way of freezing in the ordered structures. Thus the ordered phase is created in the usual way, e.g., application of heat or an electrical potential, and then the phase is locked in either by polymerising a host medium which contains the liquid crystalline material (creating a polymer dispersed liquid crystal) or alternatively crosslinking the liquid crystal itself. In one recent example a liquid crystal was dispersed in a polymerisable mixture and when polymerisation took place phase separation of the liquid crystal occurred (43). Ferro electric liquid crystals have been dispersed in acrylates and the acrylate polymerised (180). The photopolymerisation rate was found to depend on which crystalline phase the liquid crystal was in. In a different system where the polymerisation reaction was a thiol-ene reaction, addition of liquid crystalline materials was found to decrease the rate of polymerisation (79).

An interesting way of obtaining aligned liquid crystalline materials is to use liquid crystalline materials that will photocrosslink and to carry out this reaction with linearly polarised light (97, 207). A number of liquid crystalline polyesters containing chalcone groups were found to crosslink on irradiation with linearly polarised light to give films which exhibited negative optical anisotropy (97). Other polyesters have been crosslinked using non polarised light following orientation (217). Other examples where the polymerising group is in the main chain include the use of cholesteric vinyl ethers (231), and materials for use with the thiol-ene reaction (a.91). Fibre forming liquid crystalline polyesters have been produced which exhibit excellent tensile strength (52).

Two excellent compilations of papers on liquid crystals (not all are photopolymerisable systems) are available (a.92, a.93).

### 6.11 Electronics

This is a major application area for radiation curing (a.51). Radiation curable resists are the backbone of the imaging process that is used to create the circuitry and also plays a major part in the encapsulation of electronic components. The imaging process has been outlined in Section 6.2 on Graphic Arts. Resists are classified as being sensitive to EB radiation, X-rays, deep UV (below 300 nm), UV and visible light. The choice of radiation is determined by the dimensions of the features to be produced and the cost and availability of equipment. The smallest size that an image can be produced is in part determined by the wavelength of the radiation used, with electron beam radiation being able to produce the smallest (a.94). Equipment for this purpose is available, but in the case of X-rays such esoteric sources as synchrotons have to be used. The use of deep UV has been advanced by the ready availability of lasers (continuous and pulsed) which operate to below 200 nm. Imaging with UV and visible light is well advanced, with such systems as the diazquinone system still being used having been available for many decades. A description of this and many other popular systems is readily available (a.57).

Matters of importance include the sensitivity of systems and the response in the development system. Sensitivity is gained by having amplification systems such as the polymerisation of methacrylates and initiation of electrophilic aromatic substitution. The choice of development systems has been influenced by the move to greener systems such as aqueous and dry etch development processes. In the development process it is important that removal of the resist does not lead to under-cutting, i.e., the imaged picture is fully and accurately realised when the relief pattern is produced. The development of resists exemplifies the great ingenuity of organic chemists. Some of the more recent developments have been reviewed (a.10). Cationic photoinitiators have been used to initiate the deblocking of acetics (348, 349, a.95), decomposition of tert-butyl ethers and esters (350, 351, 352), and to initiate generation of carbocations (a.10) that lead to
Radiation Curing

Features of sizes below 100 nm have been obtained by EB irradiating a dendrimer having peripheral t-butyl carbonate groups in the presence of a cationic initiator. The acid produced by the initiator hydrolyses the carbonate group releasing phenolic groups thereby aiding the dissolution of irradiated dendrimer by base (a.96). Other more unusual materials that have been used include polyaniline (347).

It is important that the resists for circuit boards show good adhesion to the copper and this is aided by the presence of free carboxyl groups in the resin (270). An important step in the production of the circuits is irradiation through a negative to generate the pattern. The imaging process has to be as accurate as possible and difficulties can arise due to the negative not being in direct contact with the resist. This matter has been addressed (346). Dry resists overcome this problem. In this process a dry resist supported by a polyethylene film is laminated to the copper-clad insulating support and the negative applied to the polyethylene film prior to illumination (a.97). Electron beam resists are very different materials to UV resists and the range of materials has been well reviewed (a.98). The standard workhorse is polymethyl methacrylate which undergoes chain scission on EB radiation, i.e., it is a positive resist. Many more sensitive systems have been devised and yet this material still remains very popular.

Resists are also used as solder masks. Following location of the electronic components on the circuit boards, connections between the components and the tracks have to be made. The resist (as a liquid or dry resist film) is applied over the whole surface and then polymerised leaving the contact pads exposed. Molten solder is flowed over the board and where it meets the contacts the interconnections are made. Clearly the resist formulations have to meet a number of stringent requirements, such as not undergoing thermal decomposition at the temperature of the molten solder, not containing ionic impurities that could subsequently lead to corrosion and good wetting of the copper tracks and board. Following soldering the resist may be left in place or removed. Peelable solder masks have been devised (313). Solder masks having the right thermal properties based on bisphenol A (a.99), polystyrenes (332), acrylated oligomers containing free carboxyl groups (323) and acrylated polyurethanes (a.100) have been produced.

The assembly of components requires the use of adhesives and the components themselves have to be protected (encapsulated) from the environment. Many radiation curable adhesives have already been referred to (see Section 5.5) and others designed for electronic applications have been described (275, 309, 319, 320, 345).

The encapsulation of components can be carried out using radiation curing. Use of light to initiate cure obviates heating components and in the case of very small components the light can easily be focused on the desired area (316). Epoxy resins appear to be the workhorse materials (153, 287, 310) with silica filled epoxies also being important (202). Silica filled (up to 60 wt.%) epoxy vinyl ester resins have been found to be very promising materials since their cure is fast and the coating produced has physical properties akin to those being currently used (175). Fluorinated organosiloxanes (80), acrylated siloxanes (252) and cyanates (321) have also been used.

Smart cards in the form of SIM cards are well known to mobile phone users. They possess chip modules and radiation curing has been shown to offer advantages in the encapsulation of these vital components (65). Polyimides used in chip circuitry have been cured by the use of variable frequency microwaves (123) and EB radiation (322). Interest is being shown in using re-workable epoxies (41, a.101). These materials should be removable under unique applied conditions so as to allow the removal of failed components and the attachment of replacements. Attainment of such a goal should aid in the recycling of valuable circuitry.

6.12 Powder Coatings

This is a technology which is forecast to see a much greater exploitation of radiation curing (223). The traditional powder coating business is associated with the production of durable coatings for metals, e.g., refrigerator casings. The coatings, as the name implies, are applied as a powder, and then melted at temperatures of around 180 °C whereupon curing takes place. Full cure may take up to 30 minutes. Advantages of this process include the fact that the coatings offer excellent adhesion for metals, and any powder which, during the spray, misses the target can be re-used. Disadvantages of the process are associated with the energy required to heat the substrates plus the rather long cure time.

The advantages of using radiation curing have been reviewed (70, 117, 191, 216, 257) and include such important attributes as being able to reduce the temperature required to melt the formulation and the time taken for full cure. Formulations for thermally cured coatings require a high melting temperature if
the formulation is to have a reasonable shelf life. This is not a requirement for radiation cured coatings since they are thermally stable. Curing with EB or UV radiation is usually very fast and certainly fast compared with the rate at which heavy stock can be moved through the curing unit. Whilst curing of powder coatings on metals is still the domain of thermostets, radiation curing can offer a number of technical advantages (e.g., shorter cool-down times for heavy objects (70)) as well as cost savings (223). Pre-assembled parts that may need coating, e.g., electric motors, may have components already coated with temperature sensitive coatings, such as varnishes, which preclude the use of thermostets, whereas UV curing can be carried out at an acceptable temperature.

Some metals/alloys when heated at temperatures required to melt and cure the thermostets start outgassing thereby spoiling the appearance of the coating, whereas the temperatures required for radiation curable powder coatings do not cause this undesirable effect and hence give products having a higher quality finish. Some metals/alloys, e.g., brass and bronze, can undergo undesirable colour changes when heated at high temperatures and this therefore is another area where radiation curing can lend a helping hand.

The lower temperatures required by radiation curable powder coatings means that they can be used with temperature sensitive substrates such as wood (see also Section 6.1), medium density fibre-board, paper, polyesters, etc. One of the great advantages for wood coating is that primers/sealers and fillers are not required (70, 257). With careful selection of photoinitiators, pigmented powder coatings can be cured (71), although some workers have suggested including thermal radical initiators into such formulations (76). A significant part of the cost savings comes from the ability to recycle over-sprayed material (241) and this requires careful selection of materials. Several polymerising systems are currently being used. Acrylate technology is well established (70) and such systems have been used to produce coatings suitable for outdoor applications (126). Weathering stability is achieved by careful selection of resins and the incorporation of UV stabilisers and radical inhibitors. The vinyl ether-maleate ester polymerisation system has been championed by one manufacturer (69, 187, 193, 239) and the curing of glycidyl ethers by another (a.102). Since the curing process is taking place within a highly viscous medium, the efficiency of the polymerisation process is very important. By use of a mixture of crystalline and amorphous materials, reduced melt viscosities can be achieved which enhance flow properties (196).

6.13 Radiation Cured Coatings for Outdoor Use

This is another potentially large market for radiation curable materials. In the early days difficulty was experienced in producing radiation curable coatings that would withstand the effects of the elements (light, moisture, dust particles, etc.). Degradation of UV cured films might have been anticipated on the grounds that the cured coatings would contain photo-active materials, e.g., unused initiators, initiator fragments and carbonyl groups present as polymer end groups. Perhaps somewhat surprisingly it transpired that EB cured coatings (derived from formulations not containing an initiator) displayed the same lack of durability. The main source of instability is the resin itself, with those resins containing polyether and aromatic groups being the worst performers. Aliphatic polyurethanes were found to be the most durable materials (261, 263). As with all polymers effective stabilisation could only be attained by incorporating UV screens and radical scavengers. Use of UV screens in UV curable formulations presents a potential problem, since the screen will filter out the light necessary to activate the initiator. This problem was overcome by the use of initiators such as bisacylphosphine oxides which not only absorb to the red of the UV screens, but also, on photolysis, yield products which absorb at shorter wavelengths (i.e., they are bleachable initiators) and as a consequence the UV screens prevent them exhibiting photochemical activity (186, a.103).

The design of a resin is clearly important if good durability is to be achieved (95) with minimal use of additives. Addition of silica to formulations not only improves abrasion resistance but also weathering properties (228, 292). There has been some debate as to whether it is best for additives to be made polymerisable or not and it would appear that this offers no advantage (219). An acrylated hydroxyphenyltriazole UV screen has been described in the patent literature (199).

A very interesting application of radiation curing is in the preparation of ‘bus wraps’ (a.104). Buses are being used as mobile billboards with much of the body work and windows being swathed in advertising. Panels presenting the message are silk-screen printed and then mounted on the vehicle. Powder coatings having good durability have also been produced (70, 113) with a polymerisable system based on a maleate/fumarate-vinyl ether polymerisable formulation, being stabilised by the addition of hydroxyphenyltriazines and a hindered amine (113). Outdoor wood coatings based on a radiation curable waterborne formulation have been described and perhaps somewhat surprisingly...
show good stability (a.55). Perhaps one of the toughest tests for outdoor coatings is in automotive applications (a.105). Highly resistant coatings based on acrylated urethanes have been formulated for such purposes (a.106, a.107). In a rather different approach, attempts have been made to graft a protective acrylic coat onto a melamine base coat (185). Polycarbonate headlamp lenses have been rendered more weather-resistant by coating with a UV cured acrylate (325).

### 7 Water-Based Formulations

In a number of the applications of radiation curing reference has been made to water-based formulations. Why should radiation curable water-based formulations be of interest when one of the major selling points of radiation curing is that it is a 100% solids system (161, 232)? Provided resins and other radiation curable components are water compatible, water offers many advantages as a diluent for radical-mediated polymerisation reactions. Water has a low viscosity, it is harmless and can be removed fairly easily once the formulation has been applied to a surface. Often this occurs in the curing process due to the heat liberated by the curing lamps. As a low viscosity diluent it is particularly valuable in formulating sprayable formulations (189, 295), which find application in the coating of 3-D articles such as furniture and car components. Use of water as the diluent removes the major potentially toxic material in the formulation, namely the reactive diluent.

Since water is a non-reactive component of the formulation and is removed before or during cure, the polymerisation process is brought about by the polymerisable groups present on the resin. Hence the coatings produced have a lower crosslink density than those produced from formulations containing acrylate based diluents. A consequence of the lower crosslink density is that less shrinkage occurs on cure and this can lead to better adhesion between coating and substrate (161). Replacement of an organic-based reactive diluent by water has the potential to reduce costs, but the savings made in this way may be offset by the increased cost and reduced choice of resins required for the job. Many of the water-based resins are polyurethanes and these are relatively high cost materials.

Other potential and perhaps less obvious benefits include the facility to clean equipment such as coaters with water rather than an organic solvent (but remember components are now on the cleaning rags and in the ‘wash’ water and these materials also require careful disposal). Another benefit to the printing industry is that when such formulations are used to print on paper, the water is absorbed into the pores of the paper thereby blocking them and hence the ink stays on the surface of the paper where it has the maximum effect. If water-based inks are to be used to print on plastic surfaces additives are required to make the ink wet the plastic. For some applications, e.g., wood coating, it may be necessary to remove the water from the coated surface prior to curing.

Water-based formulations are increasing in popularity but for many applications the mechanical strength and level of gloss that they give on cure are not as good as the conventional radiation curable formulations. Examples are known, however, of where water-based formulations give a superior performance (277). Resin performance can be tuned by careful selection of the precursors (107, 108), e.g., by ensuring a high enough level of crosslink density and elasticity or otherwise of the chains between the crosslinks. Another way of increasing crosslink density is to use a dual cure system where a thermal process can be used to create further crosslinks (162).

How is water compatibility built into resins? In the case of urethanes this can easily be done by reacting a diisocyanate, with a diol, 2-hydroxyethyl acrylate or similar species and 2-di(hydroxymethyl)propionic acid (116, 143, 232). Carboxyl groups can be introduced into acrylic fillers by using acrylic acid as a monomer. Other monomers that can be used to introduce comonomers include acrylated quaternary ammonium salts and acrylated sulfonic acids. Latexes containing water compatible groups have been synthesised (285) and used in such applications as adhesives and inks (314). In another route, water compatible polyesters have been made (189, 344), by such methods as opening up glycidyl polyethers with dicarboxylic acids and acrylic acid.

Water-based formulations have found use in wood and furniture coatings (81, 154, 224, 272, 326), adhesives (197, 251) and textile treatments (324). Water-soluble acrylate ionomers have been cured to give coatings possessing excellent physical properties such as hardness (33). It is believed that during cure phase separation occurs giving hard ionic domains and soft domains. These hard domains act as a reinforcing filler. Choosing a photoinitiator for such systems has been investigated and 2-hydroxy-2-methyl-1-[4-(2-hydroxyethoxy)phenyl]propan-1-one has been found to give the best performance (109).


8 Water Resistance, Permeability and Hydrogels

8.1 Water Resistance

In many applications it is essential that the radiation cured coating is impermeable to water. In the case of furniture having a UV cured lacquer, water penetration could lead to staining of the underlying printed pattern and cause delamination of the coating. It is also important that printed products are water impermeable since running of the ink could lead to illegibility and loss of vital information. Adhesives often need to be water impermeable to avoid delamination. Optical fibres have to be kept dry to maintain maximum performance and hence the UV cured coatings have to be totally impermeable.

8.2 Permeability

Membranes are produced having permeability towards particular molecular species such as water, oxygen, carbon dioxide and ions. Water permeability is determined by the molecular backbone of the resin, its water compatibility and the crosslink density. Aromatic polyesters and phosphazenes have been used as water and oxygen permeable membranes. The pore size of a porous polypropylene film has been tuned by applying a photopolymerised film of N-isopropylacrylamide. The polyacrylamide film is a temperature sensitive hydrogel and hence by controlling the temperature the swelling of the polymer is controlled and hence the pore size of the polypropylene.

Polyvinyl cinnamates have been used as sorption membranes for carbon dioxide. The degree of carbon dioxide sorption is determined by the extent of crosslinking and the presence of micro voids. Gas diffusion through a styrene-butadiene-styrene triblock copolymer has been modified by grafting N,N-dimethylaminoethyl methacrylate onto the surface. A membrane which is an interpenetrating polymer network composed of polyvinyl alcohol and polyacrylic acid and displaying ion transport has been produced. Ion transport is affected by pH and temperature.

Acryloyl-L-proline methyl ester has been polymerised by irradiating with gamma radiation to give a thermoresponsive membrane. Such a membrane, in which the pore size and shape can be adjusted could be useful for the separation of biological molecules. Polymerisation of mixtures of the alkali salts and acrylates of poly(alkylene glycol) dimethacrylates or trimethacrylates has been used to produce an ion conductive membrane having good mechanical properties, strong adhesive strength and ionic conductivity at room temperature.

8.3 Hydrogels

Production of hydrogels by radiation curing is attracting increasing attention. Hydrogels are capable of absorbing large amounts of water and in so doing swell. They act as permeable membranes for gases and salts. Poly(2-hydroxyethyl methacrylate) is probably the best known hydrogel since it is used for constructing contact lenses. Contact lenses have been produced using radiation curing.

Biodegradable hydrogels based on amino and hydroxy acids are of great interest due to their potential use in medical applications. Poly(aspartic acid) of an appropriate molecular weight distribution has been crosslinked by gamma irradiation to give hydrogels which swell in water to many times their original volume. The swelling is caused by ionic repulsion and needless to say occurs to a lesser degree when saline solutions or urine is used. The crosslinked polypeptide could be biodegraded by active sludge.

Poly(α-hydroxy acids), e.g., lactic acids, have been used to construct hydrogels. The poly(α-hydroxy acid) was first derivatised with polymerisable groups such as an acrylate group. The diacrylated polyacid was copolymerised with dextran acrylate. By varying the amounts of the two components, gels having a wide range of hydrophilicities and hydrophobicities were obtained. Acrylated poly(L-lactic acid-co-glycolic acid-co-L-serine) has been photopolymerised to give a material for use in tissue engineering. Copolymerisation with 2-hydroxyethyl methacrylate gave a hydrogel which possessed good swelling properties. Polyacrylic acid, crosslinked by gamma irradiation, has been examined for its possible use in gastrointestinal drug delivery systems. Heparin has been immobilised in a UV cured hydrogel which was itself attached to a polymer layer. UV crosslinking of polyoxyethylenes has been used to produce hydrogels which are stimuli responsive, e.g., to pH and temperature. Hydrogels based on polyphosphazenes have been produced and shown to give controlled release of dyes, which suggests that
they may be useful for producing devices for the controlled release of bioactive agents (278).

Hydrogels based on acrylamides (334), polyvinyl alcohol (338) and polyvinyl pyrrolidone (339) are better known and all have been prepared using radiation curing. A thermoresponsive hydrogel based on poly(N-isopropyl acrylamide-co-acrylic acid) has been produced in the form of string and net structures (204). A polyvinyl alcohol possessing pendant methacrylate and acrylamide groups has been synthesised and crosslinked to give a hydrogel having a potential use for contact lenses (212). Acrylated polyvinyl alcohol has been injected subcutaneously and successfully cured using UV radiation (a.109). This finding opens up the way for fabricating devices in vivo.

9 Vulcanisation

In many of the membranes/hydrogels described thus far, an important step has been the crosslinking of a polymer, e.g., by gamma radiation. The introduction of crosslinks gives strength to a polymer and is the basis of the well known process of vulcanisation. In the vulcanisation of rubber, polysulfide bonds are introduced as the crosslinks. The mechanical properties of many synthetic polymers have been improved by vulcanisation. If high energy radiation is used, e.g., gamma radiation or electron beam radiation, the crosslinks arise through radical-radical combination, with the radicals being generated via ionisation of the polymer. Crosslink formation in a polymer can be brought about by doping the polymer with aromatic ketones which generation radicals on excitation with visible light.

Examples are available of the use of microwave power for vulcanising natural and synthetic rubbers (110, 159, 222) and the economics of the process have been explored. The use of rubber in medical devices can give rise to allergic responses. These responses have been attributed to the proteins present in natural rubber and the breakdown of these proteins under gamma radiation can lead to further problems (236). Ways have been found to remove these materials from the latices (236). The accelerators and proteins present in vulcanised natural rubber can be removed by irradiating a mixture of the latex with water soluble polymers such as polyvinyl alcohol or polyethylene oxide (87). Use of gamma radiation to vulcanise natural rubber latex has been explored at pilot plant scale and compared to the normal vulcanisation procedure cost savings were achieved (238). Gamma radiation is also used to sterilise rubber products, and rubber vulcanised using sulfur is more stable to the high energy radiation than rubber Vulcanised by gamma radiation (237).

Polydimethylsiloxanes containing colloidal silica have been crosslinked by irradiating them with gamma rays (235).

10 Radiation Curing in the 21st Century

The use of radiation curing has become well established in many industries but to defend and enlarge upon these business areas is going to require innovation. The main drivers for change will be cost, health and safety requirements, legislation, improved performance and the discovery of new applications.

Normally radiation curing formulations are not an inexpensive option and therefore any other competing green technologies such as water-borne and powder coating, which aid the production of manufactured goods at as good or better standard and at lower cost, will erode the radcure business. Thus there is pressure to reduce the running costs of radcure units, and the cost of formulation components such as photoinitiators, resins and diluents.

There is pressure to remove photoinitiators from formulations since these represent a major contribution to the cost of formulations. They and their breakdown products contribute to the deterioration of cured films in sunlight and limit the use of radcure in some applications, e.g., for food contact products. Amine synergists present similar problems and their use is likely to decline as more users turn to nitrogen-inerted systems. The financial attraction of nitrogen inverting is increasing and may well soon become common practise on UV curing lines.

There are also health and safety issues relating to the toxicity of materials such as acrylates. If an alternative system comes along which yields cost and performance benefits then the use of these materials will decline. Reactive diluents are usually the materials in formulations which give rise to the greatest toxicity risk and for this reason replacements are being sought. A possible solution to the problem is to use hyperbranched polymers carrying an appropriate number of polymerisable groups. An adjunct to this approach is the use of functionalised monodisperse prepolymered, which have molecular weights that confer an acceptable working viscosity.
Undoubtedly one of the main drivers for developments must be the introduction of more user-friendly systems. Legislation is also likely to catalyse some of the new developments, e.g., the design of coating materials which will render recycling more easy. Increasing energy taxes may also change practices such as increasing the favourability of nitrogen-inerting which enables lamps to be run at much lower power.

A particularly exciting new area is the use of radiation curing in surgery, where fractured bones are joined using a radiation curable composition which undergoes a time-controlled erosion. Application of radiation curing in the medical and biotechnological areas is ripe for development. Radiation curing is proving its worth for the production of membranes having well-controlled physical properties and hence the use of such materials for the controlled release of drugs, bactericides and fungicides in vivo is likely to increase. Radiation curing has a place in the production of immobilised enzyme and antibody systems where it can be used to produce either macro or micro support systems. For such applications the development of functionalised polymers would be most useful.

Nanospheres have been prepared by radiation crosslinking of micelles. Thus a random copolymer carrying pendant cinnamoyl groups was dispersed in water to produce micelles and then crosslinked via the cinnamoyl groups (205). Aerosols are composed of tiny droplets of liquid and irradiation of appropriately substituted materials in this physical state has generated crosslinking to give spherical particles (a.110). In another application granules having a specified specific gravity have been produced. Such granules have been used to immobilise enzymes and microorganisms (a.111) and as aids to improve the flow of liquids (a.112).

With the increased use of optical information transmission and storage systems, optical properties such as control of the refractive index are becoming increasingly important. The manufacture of optical components such as lenses and waveguide switches using radiation curing is becoming increasingly attractive. Information storage systems such as compact discs and DVDs are now well established.

The development of UV curable adhesives which offer greater bonding strength over a wider range of temperature and humidity must surely be a major goal when one considers the versatility of the UV curing process, e.g., in patterning, joining heat sensitive materials, and bonding materials in inaccessible places via the use of light guides, either directly or remotely.

There is likely to be an increase in new adhesives which can be applied, cured and then the adhesive bond destroyed on demand, e.g., in the recovery of valuable components from electronic circuitry. The production of microcircuits is heavily reliant on radiation curing and with the continued drive for smaller and smaller, faster working components this demand is likely to increase.

Another area of development is likely to be use in security devices, e.g., in the production of holograms, smart chips, detection of tampering, scratch card systems, etc. The DIY (Do-It-Yourself) market is forever expanding and there is room for UV curable products in this area (probably with a large visible light component). Several patents describe UV curable putties which could be of great value to model makers and glaziers (a.113, a.114). Similarly the availability of solvent-free one-pack systems would be welcome. It should be possible to devise curing systems based on low-cost photographic flash lamps. Curable filler systems for hiding scratch marks on furniture, car bodies, etc., would also be useful.

The drive to improve performance of radiation cured coatings is of paramount importance. Developments will lead to coatings having a wider spectrum of finishes - both functional and aesthetic. The improved performance of coatings such as scratch resistance, impact resistance, heat resistance, and stability towards the combined effects of heat, light and moisture, is of the utmost importance if new markets are to develop. There is an increasing requirement for radiation curing to deliver engineering quality materials, e.g., coatings varying in thickness, with good tensile properties and the hardness and durability of their thermally cured counterparts. Such demands are also of importance to the increased use of radiation curing in the production of composites and functional three-dimensional objects produced by rapid prototyping. There is a requirement for the formulations for such applications to contain fillers either as particulates or as fibres. Development of new fillers that enable the coatings to meet the required performance levels is likely to occur.

The production of coatings having aesthetic appeal such as different levels of gloss and pearlescent effects is likely to increase with customer demand for more and more attractive finishes. Remarkable optical effects can be obtained from pigments coated with liquid crystals. There is a great future for polymerisable liquid crystals. Very few of the known structural phases adopted by liquid crystals have been investigated. An area not explored so far is the encapsulation of perfumes, deodorants and catalytic detoxifiers such as titanium
dioxide. Packaging of perfumes and deodorants in a controlled release format would be invaluable for advancing their use on apparel, soft furnishings, etc.

One can conclude with certainty that radiation curing has a bright future and one in which it will make a major contribution to our welfare in terms of health, protection of the environment and prosperity.
Additional References


a.82 W-J. Zhou and D.L. Gin, Polymer Preprints, 2000, 41, 2, 1330.


a.98 R.G. Jones and P.C. Miller-Tate *Advanced Materials for Optics and Electronics*, 1994, 4, 2,139.


References from the Rapra Abstracts Database

Item 1

*Macromolecular Theory & Simulations*
9, No.9, 29th Dec.2000, p.725-34

**ELECTRON-BEAM INITIATED POLYMERISATION OF ACRYLATE COMPOSITIONS, 2A. SIMULATIONS OF THERMAL EFFECTS IN THIN FILMS**
Defoort B; Defoort D; Coqueret X
Lille, Université des Sciences et Technologies

The thermal effects taking place during the electron beam-induced polymerisation of acrylate type formulations are numerically simulated on the basis of the general heat equation applied to a one-dimensional system. The nature, dimensions and environment of the polymerising medium are defined for representing the actual conditions of kinetic experiments performed with a 175 kV laboratory accelerator and FTIR monitoring. The modelled system is constituted of a polymerisable composition coated onto a NaCl plate, initially at 20 deg.C in gaseous nitrogen at the same constant temperature, with or without a PETP film covering the reactive layer. Polymerisation profiles describing the progress of the reaction as a function of dose are modelled on a phenomenological basis from actual data obtained by discontinuous FTIR monitoring of typical epoxy acrylate or polyurethane acrylate compositions. The influence of the reactive layer thickness, dose rate, maximum polymerisation on the temperature-time variations is examined for continuous irradiation. In spite of the relatively small thickness of the reactive layer, significant temperature rise is simulated when heat production is large and fast compared to energy dissipation at the reactive layer boundaries. 16 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE
Accession no.806051

Item 2

*European Coatings Journal*
Nos.1-2, 2001, p.26/58

**INITIAL PHOTOYELLOWING OF PHOTOCROSSLINKED COATINGS**
Studer K; Koeniger R

The results are reported of a study of the effects of several photoinitiators, which either undergo photoscission or react with hydrogen donors, curing conditions, binders, stabilisers and additives on the initial yellowing of coatings occurring immediately after exposure of the coatings to either UV or electron beam irradiation. The data for the various systems are compared and the roles of photoinitiator and binder in initial yellowing of the coatings are discussed. 30 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE
Accession no.806050

Item 3

*Sterling, Va., 2000, pp.4. 28 cms. 15/3/01*

**MINIATURE UV RADIOMETER, MICROCURE**

EIT Inc.

The MicroCure measurement system from EIT Inc. is comprised of two separate stand-alone items: the data collection radiometer which is placed in the UV environment to be measured, and a DataReader which reads and displays the measurement results from the radiometer. It is a microprocessor-based UV integrating radiometer which measures and accumulates the total UV energy that is applied to the measurement surface of the instrument. UV radiation strikes the radiometer in the same manner as it would strike an actual workpiece. Due to its small size and automatic operation, it is claimed to be very versatile. Examples are given of applications, which include small container curing, 3-D objects, and compact disk manufacture.

USA
Accession no.806051

Item 4

*Sterling, Va., 2000, pp.2. 28 cms. 15/3/01*

**LOW ENERGY, UV INTEGRATING RADIOMETER, UVIRAD**

EIT Inc.

UVIRAD is an integrating radiometer, designed to measure relatively low levels of ultraviolet energy. It features a rugged design, allowing it to be placed in the UV system as a normal workpiece. This results in very accurate measurement of the UV energy that is impinged on a workpiece during exposure under actual working conditions. Its design and construction, operating methods, and technical specifications are described.

USA
Accession no.806050

Item 5

*Progress in Organic Coatings*

**HIGHLY EFFICIENT PHOTONOINITIATOR FOR WATER-BORNE UV-CURABLE SYSTEMS**

Visconti M; Cattaneo M
Lamberti SpA

A ready-to-use oil-in-water emulsion of the oligomeric, polyfunctional alpha-hydroxyketone photoinitiator Esacure KIP 150 was developed. The emulsion was stable and was easily incorporated into water-borne formulations. It gave very good performance in curing experiments. The components of the emulsion did not adversely affect the performance of the photoinitiator itself. The photoinitiator incorporated into the emulsion
also had a very low volatility, it did not release volatile photodecomposition products and it had a very low tendency to migrate from the cured formulations. Formulations studied were based on acrylated polyester, polyurethane-acrylate or PU. 8 refs. (25th Athens Conference on Organic Coatings, Vouliagmeni, Greece, July 1999)  
EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE  
Accession no.805139

Item 6  
Progress in Organic Coatings  
40, Nos.1-4, Dec.2000, p.191-4  
LOW-TEMPERATURE POWDER COATINGS: A NEW UV-CURING REACTION AT MODERATE TEMPERATURES  
Tinnemans A; Roescher A  
Netherlands,Organisation for Scientific Research  
A new UV curing reaction was studied. Blocked isocyanates were prepared which showed reactivity towards epoxidised compounds upon UV irradiation. This deviated significantly from the reactivity towards polyhydroxy compounds after thermal deblocking of blocked isocyanates. The curing behaviour was strongly dependent on the functionality of the polyisocyanate and structure of the isocyanate-bearing group. The fastest UV-curing rate was observed for the case of resin provided with ketoxime-blocked isocyanate groups. Different epoxy compounds could be used as co-reactant, e.g. acrylic glycidyl methacrylate resins and triglycidyl isocyanurate. In the absence of steric hindrance, UV self-curing also occurred. The UV curing of epoxies with blocked isocyanate compounds was shown to offer a suitable method for use in coatings for application to heat-sensitive substrates. 1 ref. (25th Athens Conference on Organic Coatings, Vouliagmeni, Greece, July 1999)  
EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE  
Accession no.805134

Item 7  
Progress in Organic Coatings  
40, Nos.1-4, Dec.2000, p.93-7  
NEW UV CURING SYSTEMS FOR AUTOMOTIVE APPLICATIONS  
Maag K; Lenhard W; Loefles H  
Ciba Specialty Chemicals Inc.; DuPont Performance Coatings  
Recent developments in UV curable resins, which meet the high demands of automotive applications, e.g. weather resistance, and in lamp technology are described which offer extremely rapid drying of paints, giving complete curing in less than 2 min (in some cases even within seconds). This technology offers a significant time-saving advantage to the customer. The new technical standard is presented by a dual cure system due to the advantages of lower volume shrinkage and curing of shadow areas. The change of mar and chemical resistance depending on the amount of UV curable components in a one-pack automotive clearcoat is shown. The effect of both temp. and distance between lamp and painted object was investigated with reference to the decrease of UV curable double bonds in a given dual cure refinishing clearcoat. 4 refs. (25th Athens Conference on Organic Coatings, Vouliagmeni, Greece, July 1999)  
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; SWITZERLAND; WESTERN EUROPE  
Accession no.805124

Item 8  
Patent Number: US 6136382 A1 20001024 2000  
METHOD AND COMPOSITIONS FOR DECORATING VITREOUS ARTICLES WITH RADIATION CURABLE INKS HAVING IMPROVED ADHESION AND DURABILITY  
Kamen M E; Luo D; Hu M  
Deco Patents Inc.  
A primer composition for radiation curable inks comprises: 75-99.99% water, 0.01-20% of a silane coupling agent having a specified general formula and 0.001-20% of a nonionic surfactant which is a polyethylene glycol glyceryl fatty acid ester; a method for pre-treating a vitreous article prior to application of organic radiation curable decorative indicia with said primer composition; and a method for applying decorative indicia to the surface of a vitreous article comprising the steps of (a) applying to the surface of the article a primer composition containing a solvent and a coupling agent capable of forming a chemical bond between the surface of the vitreous article and an organic, radiation curable composition, (b) applying an organic radiation curable ink composition over the primer composition in a desired design, (c) curing the organic ink composition on the article by exposing it to the radiation by which it is curable, thereby causing the coupling agent to form a chemical bond between the surface of the vitreous article and the cured organic ink composition; and a method for pre-treating vitreous articles.  
USA  
Accession no.804649

Item 9  
Macromolecular Symposia  
Vol.159, Oct.2000, p.197-204  
RADIATION CURABLE MATERIALS - PRINCIPLES AND NEW PERSPECTIVES  
Jaworek T; Bankowsky H-H; Koniger R; Reich W; Schrof W; Schwalm R  
BASF AG  
Increasing environmental concerns and the ensuing legislation to cut emissions of volatile organic compounds
have been major driving forces behind the development of radiation cured coatings over the past 25 years. Today radiation cured coatings are known for their good overall performance and their excellent resistance against chemical and physical surface damages. Advanced photoinitiator systems allow the light stabilisation of UV-curable formulations and the outdoor application of the coating. The rapid curing, combined with the possibility of immediate processing of the coated objects, opens the way for radiation curing - in 100%, water based and dual cure systems as well as for radiation curable powder coatings - for a wide variety of applications.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.803516

Item 10
SYNTHESIS AND CHARACTERISATION OF EPOXYNORBORANE LINSEED OIL USING HYDROGEN PEROXIDE
Chen J; Soucek M D
North Dakota State University
(ACS,Div.of Polymeric Materials Science & Engng.)
UV curing of coatings offers the advantages of fast cure, high energy efficiency and low volatile organic contents (VOCs). The two principle types of UV coatings are based on free radical and cationic initiated mechanisms. Cationic initiated UV curing technology offers the advantages of insensitivity to oxygen and lower film shrinkage. Due to their excellent adhesion, low shrinkage and superior chemical resistance, multifunctional epoxides are of special interest for cationic initiated UV curing technology. The three major types of epoxides used are glycidyl ether, epoxidised seed oil (soybean or linseed oil) and cycloaliphatic. A norbornyl epoxidised linseed oil is synthesised in the hope that the epoxynorbornane group shows higher rates of polymerisation due to the higher ring strain. Many powerful methods for the epoxidation of double bonds have been developed. A very efficient phase transfer catalyst, ammonium tetrakis(diperoxotungsto)phosphate, has been reported. Epoxidation with hydrogen peroxide using this phase transfer catalyst is extremely attractive as it does not require the use of solvent, and no significant side reactions, especially ring opening reactions, are observed. The synthesis and characterisation of a novel norbornyl epoxidised linseed oil using hydrogen peroxide with this phase transfer catalyst are described. 8 refs.
USA
Accession no.802684

Item 11
PHOTOCURABLE POLYANHYDRIDES ENGINEERED FOR ORTHOPAEDIC APPLICATIONS
Burkoth A K; Anseth K S
Colorado,University
(ACS,Div.of Polymeric Materials Science & Engng.)
A class of methacrylate anhydride monomers is rationally designed for orthopaedic applications such that they photo-react in situ for safe and easy application for a surgeon in a clinical setting, react to form densely crosslinked networks for high-strength applications and degrade from the surface, to retain original mechanical properties with mass loss. The rate of surface erosion in the polyanhydride networks is controlled by the overall hydrophobicity of the backbone chemistry and is easily modified to span a wide range of degradation time scales. Furthermore, these polyanhydride networks have sufficient initial mechanical properties for trabecular bone applications and the networks maintain more than 90% of their initial mechanics at 40% mass loss. Preliminary studies in a model bone defect show no immediate inflammatory response to the photocrosslinking reaction and the degrading polymers. 7 refs.
USA
Accession no.802390

Item 12
RADIATION CURABLE PRODUCTS
Mitry M
Fuller H.B.,Co. (TAPPI)
This presentation concerns itself with UV curable pressure-sensitive adhesives. Their characteristics and environmental advantages are outlined, and performance data are included for warm melt PSAs, both free radical and cationic curing. Factors affecting the selection of tackifiers are examined, including the use of photodifferential scanning calorimetry to ensure compatibility. Optimisation of cure speed under high intensity lamps is examined, in order to achieve optimum adhesive performance. Both photodifferential scanning calorimetry and FTIR are recommended as tools for the study of the variables that contribute to cure speed and adhesive performance. A comparison is made of air and nitrogen curing.
USA
Accession no.801116
AN OVERVIEW OF ULTRAVIOLET LIGHT CURABLE PRESSURE SENSITIVE ADHESIVES, PSAS
Mitry M; Bushendorf P
Fuller H.B.,Co.
(TAPPI)
This overview of UV curable pressure-sensitive adhesives discusses the free radical and cationic photopolymerisations of pressure-sensitive adhesives. Variables such as cure speed, UV light intensity, and curing in inert atmosphere, are also examined. The impact of several commercially available tackifiers in free radical photopolymerisation is presented in some detail. 12 refs.
USA
Accession no.800578

UV-RADIATION CURING OF WATERBASED URETHANE-ACRYLATE COATINGS
Masson F; Decker C; Jaworek T; Schwalm R
Haute-Alsace,Universite; BASF AG
IR spectroscopy was used for a kinetic study of the drying and UV curing of a water-based urethane-acrylate formulation. The water release upon heating of the dispersion was shown to depend on the temp. and on the film thickness. The drying of a 30 micrometre thick coating was completed in less than 2 min. upon heating in an oven at 80C. The influence of a number of critical factors on the polymerisation kinetics was investigated, i.e. the type of photoinitiator, the sample temp., the chemical structure of the functionalised oligomer and its acid content. As expected, the latter factor had a marked effect on the properties of the UV-cured coatings, particularly their hardness and their hydrophilic character. The water uptake and the softening of coatings placed in a wet atmosphere was found to be directly related to the carboxylic content of the urethane-acrylate polymer. This phenomenon was fully reversible and did not affect the long-term properties of the UV-cured coatings. 14 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; GERMANY; WESTERN EUROPE
Accession no.800544

METHOD FOR CURING A LENS-FORMING FLUID
Su K C; White J C
Technology Resource International Corp.
A method for curing a lens-forming fluid, including exposing the lens-forming fluid to an ultra-violet light, wherein the exposure time is between twenty seconds and thirty minutes, which can completely cure the fluid. The exposure can occur by placing the lens-forming fluid intermediate a plurality of ultra-violet light sources, in
which the intensity of the ultra-violet light is at least 1.2 \times 10^{-2} \text{ watts per square centimeter at a wavelength of 350 nanometers. The lens-forming fluid preferably is a monomer. The prior art, in contrast, requires significantly longer exposure times to cure monomer or other lens-forming fluids.}

USA
Accession no.800401

**Item 18**

**Pitture e Vernici**
76, No.20, 1st.-31st Dec. 2000, p.17-24
Italian; English

**NEW DEVELOPMENTS IN RADIATION CURABLE POWDER COATINGS**
Udding-Louwrier S; Baijards R A; Feima N W
DSM Resins

The results are reported of a study carried out to determine the effects of various factors on the curing characteristics and properties of UV cured, unsaturated polyester clear and pigmented powder coatings. The coatings were applied to MDF and cured using UV lamps with different spectral outputs and various dose rates and UV peak irradiance. The effects of the various factors on the Tg and pendulum hardness of the clear coatings and coatings pigmented with titanium dioxide are discussed. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE
Accession no.800187

**Item 19**

**Journal of Coatings Technology**
72, No.911, Dec. 2000, p.51-60

**UV CURING OF AQUEOUS POLYURETHANE ACRYLATE DISPERSIONS. A COMPARATIVE STUDY BY REAL-TIME FTIR SPECTROSCOPY AND PILOT SCALE CURING**
Tauber A; Scherzer T; Mehner R
Institut fuer Oberflaechenmodifizierung

The UV curing of dried coating films obtained from aqueous polyurethane acrylate dispersions was investigated using real-time FTIR spectroscopy and a pilot plant for UV curing. The effects of various photoinitiators and photoinitiator concentration on the UV curing behaviour of the aqueous dispersions were examined as was the influence of technical parameters, such as cure speed and the number of required lamps, using single and multiple UV light flashes. A comparison was also made of UV curing performed under air and an inert nitrogen atmosphere. 25 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.800183

**Item 20**

New Orleans, La., August 1999, p.1273-4

**UV CURABLE ACRYLATED OLIGOMERS: MODEL CHARACTERISATION STUDIES**
Tortorello A J
DSM Desotech Inc.
(ACS, Div. of Polymer Chemistry)

Providing a higher molecular weight acrylic copolymer with a pendant or terminal acrylate functionality has not been widely practised because of the unique synthetic challenge it offers. The acrylate functionality in one part of the polymer molecule must be preserved during reaction of the identical functional group used to synthesise the polymer. Clearly, the acrylate functional groups cannot be part of the same monomer. Alternatively, a suitably functionalised polymer could be synthesised from acrylate monomers followed by conversion of the pendant functional groups through subsequent reaction with a suitably functionalised acrylate monomer. This sequence could be facilitated by polymerisation in solvent so as to prevent gelation from the Trommsdorf effect. However, the solvent would have to be substantially removed in order to have a desirable product for use in a UV curable application. A technique is developed to provide compositions which are solvent-free and contain acrylate functionality pendant to an acrylic copolymer backbone. The characterisation of the copolymer compositions and the model reaction studies used to assist in structural confirmation are summarised. 5 refs.

USA
Accession no.798337

**Item 21**

Patent Number: US 6100316 A1 20000808

**RADIATION-CURABLE COATING MATERIALS AND THEIR USE FOR THE PRODUCTION OF MATT COATING FILMS**
Lobert M
BASF Coatings AG

The invention relates to radiation-curable coating materials which comprise A a synthetic resin containing from 1.5 to 5 mol/kg, preferably from 3.6 to 4.5 mol/kg, of ethylenically unsaturated double bonds of which not more than 10% are vinyl groups, or a mixture of such synthetic resins, and B a compound of the general formula Ar-O-R_1-O-CO-\text{CR}_2=\text{CH}_2, where Ar is an optionally substituted aryl radical, R_1 is an alkylene radical having 1 to 6 carbon atoms and R_2 is a hydrogen atom or an alkyl radical having 1 to 3 carbon atoms, or a mixture of such compounds, from 10 to 70% by weight of the total quantity of A and B comprising component A and from 30 to 90% by weight of the total quantity of A and B comprising component B.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE
Accession no.797952
**Item 22**

Patent Number: US 6100313 A1 20000808

**UV-CURABLE ABRASION-RESISTANT COATING COMPOSITION**

Treadway G D
Walman Optical Co.

A coating composition for forming a transparent, abrasion-resistant coating upon eyeglass lenses or other transparent substrates, the composition comprising a binder component and a curing agent component and being substantially free of volatiles. The binder component comprises the hydrolysis product of an epoxy-functional alkoxysilane, a polyglycidyl ether, and an acrylic monomer having an acrylic functionality of not more than two. The curing agent component comprises a cationic photoinitiator and a free radical photoinitiator.

USA

**Accession no.797949**

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**Item 23**

New Orleans, La., August 1999, p.669-70

**USING FTIR TO DETERMINE THE EXTENT OF REACTION OF EPOXIES UNDER MICROWAVE ENERGY**

Stoffer J O; Zhang D; Crivello J V
Missouri-Rolla, University; Rensselaer Polytechnic Institute
(ACS, Div. of Polymer Chemistry)

The bisaliphatic epoxy resin, 3,4-epoxycyclohexylmethyl, 3,4-epoxycyclohexyloxycarboxylate (a) is very reactive, commercially available, and of a low order of toxicity. The epoxide polymerises rapidly under either thermally or under microwave irradiation in the presence of initiators of diaryliodonium or triarylsulphonium salts (b). Although the detailed mechanism of polymerisation is not fully understood, it seems very probable that the epoxide (a) polymerise via a cationic mechanism after thermolysis of the initiators under conditions of both microwave irradiation and conventional thermal activation. The extent of reaction cannot be determined using solubility methods, because the molecule of the epoxide (a) has two epoxy groups, which make the polymer crosslinked and insoluble. A new method using DSC and FTIR has been developed. The observation that an FTIR peak of the epoxide (a) changes as polymerisation progresses is reported. An FTIR internal standard method is developed to monitor the extent of reaction. One advantage of the FTIR method is that it is not related to the mass of samples. 3 refs.

USA

**Accession no.797534**

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**Item 24**

New Orleans, La., August 1999, p.271-2

**SILICONES FOR PHOTO-INDUCED REFRACTIVE INDEX MODULATION: DIVINYL ENDCAPPED SILOXANE MACROMER IN POLYDIMETHYLSILOXANE MATRIX**

Jethmalani J M; Kornfield J A; Grubbs R H; Schwartz D M
California, Institute of Technology; California, University (ACS, Div. of Polymer Chemistry)

Silicone compositions are formulated where selective photopolymerisation of a high refractive index low molecular weight macromer in a low refractive index high molecular weight matrix creates a refractive index contrast due to the divinyl crosslinking, diffusion and further crosslinking of the macromer. We have achieved a 0.15% change in the refractive index of the matrix after the first irradiation and have made the refractive index contrast permanent by a second irradiation of the entire matrix. 9 refs.

USA

**Accession no.797414**

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**Item 25**

New Orleans, La., August 1999, p.234-5

**PHOTO-INDUCED REFRACTIVE INDEX MODULATION OF BISMETHACRYLATE ENDCAPPED SILOXANE MACROMER IN POLYDIMETHYLSILOXANE (PDMS) MATRIX**

Jethmalani J M; Kornfield J A; Grubbs R H; Schwartz D M
California, Institute of Technology; California, University (ACS, Div. of Polymer Chemistry)

Motivated by the need for materials with photo-modifiable refractive index for ophthalmological applications, photosensitive polymers are developed based on biocompatible components. Potential applications in intraocular lenses (IOLs) require materials whose refractive index, n, can be increased or decreased up to 1% in a controlled part of the optical element (this range of tunability would be sufficient to correct post-operative refractive errors in 98% of cataract patients receiving IOLs). Silicone compositions are formulated in which selective photopolymerisation of a high n, low Mn, reactive macromer in a low n, high Mn matrix creates a refractive index contrast due to the bismethacrylate crosslinking, macromer diffusion and further crosslinking of the macromer to form an interpenetrating network. A % delta n of approximately 0.95% is achieved in the prism after three subsequent irradiations, sufficient to produce a 3 diopter change in IOL power. The effect of the ‘dark
interval’ between irradiations on the overall increase in n for a given irradiation time is studied. The results accord well with literature values of the diffusivity of silicones, consistent with a diffusion time of hours to cover a distance of approximately 1 mm. 12 refs.

USA
Accession no.797395

Item 26
New Orleans, La., August 1999, p.762-3
ULTRAVIOLET CURABLE COATINGS USING CAM
Subramanian R; Rachakonda S H; Smith O W; Thames S F
Southern Mississippi,University (ACS,Div.of Polymer Chemistry)

Cyloaliphatic epoxide derived coatings, when properly formulated, cure rapidly on exposure to UV light to give hard and tough films. A typical cationic UV cure composition of cyloaliphatic epoxides includes polyol as a ring opening reagent. Moreover, polyol offers good film formation and flexibility to the coating. However, the use of polyol increases water sensitivity. There are reports on the use of cationic and free radical dual cure systems using diacrylates or triacrylates in combination with epoxides showing increased cure rates and improved adhesion. The use of castor acrylated monomer (CAM) as a hydrophobic flexibilising monomer is described. It is confirmed that CAM, as a C18 hydrocarbon monomer, can introduce flexibility into the coating composition while avoiding an increase in water sensitivity. Earlier investigation of CAM as a reactive monomer in emulsion polymers confirms polymer flexibility, water resistance, flow and levelling as properties typical of CAM incorporation. 9 refs.

USA
Accession no.797248

Item 27
International Journal of Adhesion & Adhesives
20, No.6, 2000, p.489-95
EFFECTS OF MICROWAVE CURING CARBON DOPED EPOXY ADHESIVE-POLYCARBONATE JOINTS
Soesatyo B; Blicblau A S; Siores E
Swinburne,University of Technology (Paint Research Association)

The effects of various concentrations of carbon black (Vulcan 66 and Sterling) in two different epoxy resin adhesives on the bond strength of thin sheets of polycarbonate were investigated using an Instron universal testing machine. The fractured joints were analysed by means of SEM and residual stress in the adherends before and after microwave curing was evaluated using photo-stress methods and a polariscope. Changes in the surface characteristics of the joints resulting from microwave curing were examined by Raman spectroscopy. Higher bond strengths were achieved with Vulcan 66. 21 refs.

AUSTRALIA
Accession no.796640

Item 28
Patent Number: US 6096383 A1 20000801
CURING OF FLOOR COATINGS USING LONG AND SHORT WAVE ULTRAVIOLET RADIATION
Berg D W; Field B F; Gill N W; Keute J S; Johnson D E; Krueger E O F
Tennant Co.

A process for applying a coating to a floor surface and curing that coating after application involves first spreading a photochemically curable liquid coating in a thickness of from about 0.003 to 0.006 inches on a floor surface. After the coating has been applied, it is exposed to ultraviolet radiation at a power level of about 40 watts/in. of width of coating being cured and at two different sequentially applied wavelengths. This cures the liquid coating instantly to a durable solid coating. The first applied ultraviolet radiation may have a wavelength of about 365 nm and the second applied ultraviolet radiation may have a wavelength of about 254 nm. The ultraviolet radiation is provided by an array of UV lights on a mobile, self-powered vehicle, which moves over the floor coating at a speed of from 20 to 40 ft/minute.

USA
Accession no.795981

Item 29
Silicones in Coatings II. Conference proceedings.
Florida, USA, 24th-26th March 1998, paper 48
UV CURABLE TRANSPARENT HYBRID INORGANIC/ORGANIC COATING MATERIALS
Gilberts J; Tinnemans A H A
TNO Institute of Industrial Technology (Paint Research Association)

Hybrid inorganic-organic coating materials are prepared with a flexible approach of tailoring inorganic structures as well as organic polymeric structures, and so, the opportunity is created to achieve new multifunctional materials with properties such as anti-soiling properties, high abrasion resistance, anti-fogging properties and a high scratch resistance. Hybrid network materials range from organically modified ceramics (ORMOCERS) with a high inorganic content, to ceramic polymers (CERAMERS) with a high organic content. The inorganic structure of these hybrid materials can be prepared by hydrolysis and condensation of organoalkoxysilanes via the sol-gel process or can consist of nano-sized colloidal metal oxide particles. The organic structure is usually built by a thermal or irradiation induced polymerisation reaction of monomeric units, usually epoxy or acrylate groups. Sol-gel based
thermally cured coatings are highly transparent and exhibit excellent resistance to surface wear and chemicals. The application of these thermally cured coatings, however, is limited by processing conditions. UV curable coatings, preferably based on ceramer technology, offer processing advantages with respect to cure time and temperature. Nowadays they exhibit competing surface properties. The wide range of UV curable monomers and oligomers available allows many choices in the performance of these coatings. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE
Accession no.795811

EFFECT OF CROSSLINKING STRUCTURE ON SORPTION OF CARBON DIOXIDE IN PHOTOCROSSLINKED PVCA FILM
Matsuguchi M; Miura J; Sakai Y
Ehime,University
An investigation of the sorption behaviour of carbon dioxide gas in photocrosslinked poly(vinyl cinnamate) film under atmospheric pressure was carried out. The sorption isotherm was accurately described by the Langmuir equation, indicating that sorption of carbon dioxide is chiefly governed by adsorption in the microvoids. The degree of crosslinking significantly affected the amount of sorbed carbon. A lower degree of crosslinking enhanced the carbon dioxide sorption but it was decreased at a higher degree of crosslinking. The unexpected increase in the amount of adsorbed carbon dioxide correlated with the rise in the number of microvoids that occurred as a consequence of the crosslinking reaction. Further crosslinking led to a decrease in the mean size of the microvoids, however. The smaller microvoids, in comparison with carbon dioxide molecules, did not act as adsorption sites, so that the amount of sorbed carbon dioxide decreased. 27 refs.
JAPAN
Accession no.794912

SIMULTANEOUS MEASUREMENT OF POLYMERIZATION KINETICS AND STRESS DEVELOPMENT IN RADIATION-CURED COATINGS: A NEW EXPERIMENTAL APPROACH AND RELATIONSHIP BETWEEN THE DEGREE OF CONVERSION AND STRESS
Stolov A A; Tao Xie; Penelle J; Hsu S L
Massachusetts,University
An experimental technique which combined real time IR spectroscopy and a miniature cantilever was used to measure stress build-up and polymerisation kinetics in UV-cured multifunctional acrylic monomer coatings. Stress build-up occurred after a certain time interval after the onset of UV curing and this was attributable to the formation of crosslinks, leading to a gel state. The stress development could also be associated with the degree of chemical reaction. Using the experimental results, the accuracy of various published models for predicting the critical degree of conversion was evaluated. The authors developed a different approach involving the probability of finding a relative concentration of reacted or partially reacted monomers relating the stress and degree of conversion of vinyl groups. The predicted stress-conversion relationship based on percolation models did not agree well with the experimental results. 43 refs.
USA
Accession no.794386

NEW UV-CURABLE COATINGS FOR THE RESILIENT FLOORING INDUSTRY
Bontinck K; Idacavage M
UCB Chemicals Corp.; UCB Chemicals Inc. (American Plastics Council, Alliance for the Polyurethanes Industry)
Growing concerns for ecological issues have led to the development of technologies having a lesser chemical impact on occupational health and environment. Although the chemical industry has acted upon these concerns by allocating a growing amount of resources to projects with an ecological background, the change from existing to these new technologies is difficult and slow. Amongst the reasons why industries are somewhat reluctant to make this switch, surely a higher initial cost and a potential loss of performance can be regarded as the most important drawbacks. Emphasis is placed on UV curable PU dispersions used by the resilient flooring industry, their chemistry, performance and relative cost. During the last decade, solvents, hazardous crosslinkers, coalescents and free monomers have been questioned; the development of waterborne, UV curable coatings can offer a solution. The way these waterborne UV-systems can overcome cost and performance drawbacks is addressed, as well as how this chemistry could develop in the future. An insight is given into the present and future developments of high performance, yet environmentally and economically viable resilient flooring coating systems. These developments may vary geographically. Although the chemical industry is globalised to a high extent, it will have to find ways to meet local demands.
BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; USA; WESTERN EUROPE
Accession no.794285
WATER-SOLUBLE URETHANE ACRYLATE IONOMERS: EFFECT OF MOLECULAR STRUCTURE ON ULTRAVIOLET COATING PROPERTIES
Chan-Young Lee; Jin-Woong Kim; Kyung-Do Suh
Hanyang, University

Water-soluble urethane acrylate ionomers containing dimethylolpropionic acid were synthesised, the molecular components being varied, and their UV coating properties were studied. The UV coating properties were found to be very dependent on the molec.wt. of the soft segment, the type of diisocyanate and the level of neutralisation. The cured films generally exhibited much improved mechanical properties compared with conventional urethane acrylate film not containing ionic groups. The main reason for the improved properties appeared to be the presence of ionic groups in the network. In DMA, two distinct Tgs, corresponding to the ionic hard domains and soft domains, were detected at high content of ionic groups. This indicated that the urethane acrylate network was composed of two phases. The ionic hard domains formed by the phase separation from crosslinked network could thus act as reinforcing filler, which possibly explained the improved film properties of the urethane acrylate films. 35 refs.
KOREA
Accession no.793633

DEVELOPING A SYSTEM-LEVEL MONITORING INSTRUMENT FOR UV-CURING SYSTEMS
Dehkordi P H; Riner J L; Ingram D E
Applied Computing Technology Inc. (Adhesive & Sealant Council Inc.)

The use is described of the Spectralyze system-level monitoring instrument for monitoring UV curing systems. The challenges involved in the development of a spectrometer-based monitoring instrument and its associated software for the evaluation of the operation and maintenance of ultraviolet curing systems, are discussed. In addition, the customer benefits of the instrument are summarised in terms of calibrating and/or optimising the curing systems used, to show the correlation between the quality of the curing process and the diagnostic capability of the equipment.
USA
Accession no.792462
VARIABLE FREQUENCY MICROWAVE PROCESSING OF THERMOPLASTIC COMPOSITES

Ku H S; MacRobert M; Siores E; Ball J A R
Southern Queensland, University; Swinburne, University of Technology

The range of applications for variable frequency microwave (VFM) facilities (12-18 GHz) is extended to thermoplastic composites. Five thermoplastic polymer matrix composites are processed and discussed, including 33 wt.% random carbon fibre reinforced PS (PS-CF (33%)), and LDPE (LDPE-CF (33%)); 33 wt.% random glass fibre reinforced PS (PS-GF (33%)), LDPE (LDPE-GF (33%)) and nylon 66 (nylon 66-GF (33 %)). Bond strengths of lap joints are tested in shear and results compared with those obtained using fixed frequency (2.45 GHz) microwave processing. The primer or coupling agent used is a 5 min., two-part adhesive containing 100% liquid epoxy and 8% amine, which is more readily microwave reactive than the composites themselves. The VFM is operated under software control, which provides automatic data logging facilities. Results indicate that VFM can produce strong bonds for PS and LDPE. 21 refs.

SURFACE PATTERN FORMATION IN UV-CURABLE COATINGS

Lucinani A; Plummer C J G; Gensler R; Manson J E
Ecole Polytechnique Federale de Lausanne

The appearance of wrinkles in UV curable coatings is examined, and their control by means of a suitable choice of processing parameters, or by adaptation of formulation is investigated. The phenomenology of surface wrinkling is discussed in a maleate/vinyl ether system composed of an unsaturated polyester with a crystalline vinyl ether terminated polyurethane compound. The extent of wrinkling was determined to be strongly dependent on the levelling and irradiation procedures, and the conditions for sufficient wrinkling to give a matte coating are described. 14 refs.

UV CURED BIOCOMPATIBLE MEMBRANE FOR BIOSENSOR APPLICATION

Ng L T; Guthrie J T; Yuan Y J
Western Sydney, University; Leeds, University

As a natural product, chitosan has the inherent properties of being biocompatible, biodegradable and non-toxic. These properties make chitosan an ideal candidate for inclusion in matrices designed for use in enzyme immobilisation for clinical analysis. The feasibility of using chitosan in electrochemical biosensor fabrication is demonstrated. The enzyme, sulphite oxidase (SOD), is covalently immobilised onto the matrix of chitosan-polyhydroxyethyl methacrylate (chitosan-pHEMA), a natural/synthetic polymer hybrid material obtainable via a UV curing process. An electron transfer mediator, p-benzoquinone, is coupled onto the polymer network for the activation of chitosan-pHEMA copolymer, after completion of the photo-induced polymerisation reaction. Chitosan-pHEMA is characterised using Fourier transform infrared spectroscopy and differential scanning calorimetry techniques. The biological activity of the immobilised SOD and the electroactivity of the coupled p-benzoquinone are examined. 11 refs.

PROTEIN FREE RADIATION VULCANISED NATURAL RUBBER LATEX

Makuuchi K
Japan, Atomic Energy Research Institute (Nordic Council of Rubber Technology)

Protein-free NR products are developed by radiation Vulcanisation of NR latex. The process consists of three steps; namely, dilution of radiation Vulcanised NR latex, addition of water-soluble polymer and centrifugation. Low molecular weight water-soluble polymer does not induce a drastic viscosity increase of the RV NR latex. The extractable protein in the dried latex film is reduced less than 5g/g-rubber by leaching for 20-30 min. SDS-PAGE analysis confirms the reduction of extractable protein in the serum phase, and disappearance of protein bands in the extract of the latex film. Tackiness of the rubber film is decreased. Tensile strength and tear strength are comparable to the untreated radiation Vulcanised NR latex. 5 refs.

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ALTERING NETWORK ARCHITECTURE IN CURED THERMOSETS: THE DECOMPOSITION MECHANISM AND NETWORK BREAKDOWN OF REWORKABLE EPOXIES WITH TERTIARY ESTER LINKS
Chen J S; Ober C K; Poliks M D
Cornell University; IBM Corp.

An epoxy monomer was developed for use in a reworkable thermoset, designed to cleave under specific thermal conditions. The monomer was a cycloaliphatic epoxy derived from the esterification of cyclohexenoic acid with alpha-terpineol with subsequent epoxidation. The breakdown mechanism was studied by thermally treating the monomer at 230 C for different time periods, and monitoring the cleavage using differential scanning calorimetry, gel permeation chromatography, infrared spectroscopy, and nuclear magnetic resonance spectroscopy. The resin was found to cleave in a manner which enabled re-workability in fully cured thermoset networks, the break occurring at the tertiary ester bond. When part of a cured system, disconnection of the resin segments rendered the system soluble in common solvents. 7 refs.

USA
Accession no.784738

PHASE SEPARATION IN POLYMER DISPERSED LIQUID CRYSTALS
Hoyle C E; Whithead J B; Gill N L; Hladik M L; Kuang W
Southern Mississippi, University

Polymer dispersed liquid crystals were prepared using photocurable systems based upon either a mixture of N-substituted bismaleimide and divinyl ethers, or a mixture of a bismaleimide and a diacrylate, containing a blend of cyanomultiphenyls as the liquid crystal phase. The bismaleimide acting as both initiator and comonomer, the liquid crystal phase separating during polymerisation. The copolymerisation was monitored using real-time Fourier transform infrared spectroscopy, and the electrooptical properties of materials were determined. 11 refs.

USA
Accession no.784728

HIGH-SPEED PHOTOCROSSLINKING OF THERMOPLASTIC STYRENE-BUTADIENE ELASTOMERS
Decker C; Viet N T
Haute-Alsace, Universite

Photoinitiated thiol/ene polymerisation is used to crosslink a triblock styrene-butadiene-styrene (SBS) polymer of low vinyl content (8%). The crosslinking process is followed by IR spectroscopy (loss of unsaturation), insolubilisation, swelling and hardness measurements. The photogenerated thiyl radicals react with both the vinyl and the 2-butene double bonds of the copolymer. Concentrations of less than 1 wt.% in the trifunctional thiol crosslinker and in the acylphosphine oxide photoinitiator prove to be sufficient to create, within 0.5 s, a permanent chemical network in the elastomeric phase. This UV curing technology is successfully applied to crosslink rapidly commercial SBS-Kraton thermoplastic elastomers. It also proves effective in the case of the much less reactive triblock styrene-isoprene-styrene (SIS) polymer which contains no vinyl double bonds. The thiol/ene polymerisation is shown to be a much more efficient process to crosslink SBS and SIS thermoplastic elastomers than the copolymerisation of the rubber double bonds with a diacrylate monomer. 17 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE
Accession no.784192
UV CURING OF BLACK PIGMENTED COATING MATERIALS
Pietschmann N; Peter I; Stroh P
Institut fuer Lacke und Farben eV; Degussa-Huls AG

Black pigmented UV-curable coating materials intended for application on wood veneer and fibreboard are prepared and used to compare different compositions, e.g. varying pigments. Reactive oligomer/monomer combinations with high acrylate functionality and, thus an intense chain propagation reaction, a suitable and effective blend of long-wave and short-wave absorbing photoinitiators, and a careful pigment selection as well as a careful adjustment of pigment concentration, are necessary to make possible both opacity and through cure. In this context, the combination of the black pigment with certain extenders can be helpful. On wooden substrates good results are achieved with both a carbon black of larger particle size, and aniline black (at ten times the pigment content). In contrast, formulations containing a standard fluffy carbon black (which gives very good colour strength and jetness in conventional and waterborne coatings) fails with respect to curability. However, formulations with aniline black also show excellent jetness and brilliancy. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.783761

USING THE WRONG GLOVES MAY INCREASE RISK
Zwanenburg R
Talofina Elf

UV- and EB-curable acrylates are highly reactive substances - that is why they are used widely and preferably in radiation curing applications. Due to their reactivity these products may also cause skin irritation, in particular with persons who are working with acrylates regularly. In order to improve occupational safety, a study was sponsored by RadTech Europe and RadTech International North America aimed at permeation testing of five widely used acrylates with three different glove materials. The result was that thin (0.1 mm) disposable nitrile rubber gloves of good quality give adequate protection for up to 30 minutes for most low viscosity acrylates. For the medium thickness nitrile rubber gloves (0.45 mm), no permeation was seen for up to 4 hours, whereas for the thickest qualities tested (0.56 mm) no permeation was found after 8 hours. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE
Accession no.783505

METHOD FOR FABRICATING COMPOSITE STRUCTURES USING PULTRUSION PROCESSING
Farley G L
US National Aeronautics & Space Administration

A method for fabricating composite structures at a low-cost, moderate-to-high production rate. A first embodiment of the method includes employing a continuous press forming fabrication process. A second embodiment of the method includes employing a...
pultrusion process for obtaining composite structures. The methods include coating yarns with matrix material, weaving the yarn into fabric to produce a continuous fabric supply and feeding multiple layers of net-shaped fabrics having optimally oriented fibres into a debulking tool to form an undebuged preform. The continuous press forming fabrication process includes partially debulking the preform, cutting the partially debulked preform and debulking the partially debulked preform to form a net-shape. An electron-beam or similar technique then cures the structure. The pultrusion fabric process includes feeding the undebuged preform into a heated die and gradually debulking the undebuged preform. The undebuged preform in the heated die changes dimension until a desired cross-sectional dimension is achieved. This process further includes obtaining a net-shaped infiltrated uncured preform, cutting the uncured preform to a desired length and electron-beam curing (or similar technique) the uncured preform. These fabrication methods produce superior structures formed at higher production rates, resulting in lower cost and high structural performance.

**References and Abstracts**

**Item 50**

**Biomaterials**

21, No.17, 2000, p.1743-53

**PHOTOCURABLE epoxy-polyol matrices for use in dental composites. I.**

Tilbrook D A; Clarke R L; Howle N E; Braden M

London, University, Queen Mary & Westfield College

A range of epoxy-polyol formulations based on a commonly-used cycloaliphatic epoxy resin (UVR6110 from Union Carbide) was characterised and these materials were compared with ‘traditional’ methacrylate-based dental resins. Useful data were obtained for future studies into the development of lower shrinkage systems. The properties studied included reactivity, polymerisation shrinkage, Tg, water uptake at 37°C, hardness and flexural strength. The results indicated that the ratio of epoxy groups to polyol groups in the matrix should be selected to lie between the limits of 4 and 8 to ensure the matrix had a balance of acceptable properties. 33 refs.

**UNION CARBIDE**

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.781104

**Item 51**

**Journal of Applied Polymer Science**

77, No.1, 5th July 2000, p.8-13

**CATIONIC ultraviolet curable coatings from castor oil**

Thames S F; Yu H; Subramanian R

Southern Mississippi, University

Coatings formulated from castor oil glycidyl ether (COGE), cycloaliphatic epoxy resin UVR 6100 and photoinitiator UVI 6990 (mixed triaryl sulphonium hexafluorophosphate salts) were shown to produce smooth coatings with good gloss and good flexibility, adhesion, gloss retention and water resistance. Formulations containing up to 50% COGE exhibited promising coating performance. 13 refs.

USA

Accession no.780000

**Item 52**

**Polymer**

41, No.17, Aug.2000, p.6647-54

**MACRO-ORIENTED NETWORK OF LIQUID-CRYSTALLINE POLYESTERS: CROSSLINKING INDUCED BY GAMMA-IRRADIATION AND THERMALLY ACTIVATED REACTION**

Acierno D; Di Maio L; Iannelli P; Spadaro G; Valenza A

Naples, University; Salerno, University; Palermo, University; Messina, University

Thermotropic liquid crystal polymers were synthesised by interfacial polycondensation of 3,3'-dihydroxybiphenyl and chlorinated derivatives of 4,4'-dicarboxy-1-dihenoxy-alkanes, and fibres extruded from the anisotropic liquid phase. The fibres were crosslinked by thermal activation and/or exposure to gamma irradiation, freezing in the liquid crystalline state and the macroscopic anisotropy up to high temperatures. The irradiated fibres exhibited enhanced tensile strength compared with virgin fibres, from which it was concluded that the main effect of irradiation was crosslinking, without significant degradation. 21 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.778367

**Item 53**


Durango, Co., 13th-16th June 1999, p.115-30

**ESTABLISHING THE PROCESS WINDOW FOR UV CURABLE PRESSURE SENSITIVE ADHESIVES**

Fisher R

Fusion UV Systems Inc. (TAPPI)

UV curable pressure-sensitive adhesives (UVPSA) are unlike any other UV curable coatings. It is normally desirable to maximise the degree of crosslinking within a cured coating. This is not the case when curing a UVPSA. The surface of PSA is ‘softer’ than that of other ‘cured’ UV coatings. The soft surface results in a measure of cold flow that allows the adhesive to form a controlled intimate bond with the substrate during the end-use application. The balance of the adhesive and the cohesive strength within the cured coating is critical to the performance of
the UVPSA, and the UV energy must be delivered to the wet film in a controlled and efficient fashion.
USA
Accession no.778175

Item 54

Patent Number: US 6013714 A 20000111

RESIN COMPOSITION AND FIBROUS MATERIAL FORMING MOLD
Haruta Y; Takase H; Watanabe T; Ukachi T
DSM NV; JSR Corp.; Japan Fine Coatings Co.Ltd.

Process is disclosed for the manufacture of a mould for making products from fibrous materials by performing a combination of the steps of: (1) applying a thin layer of resin on a supporting stage; (2) selectively irradiating the thin layer of resin so as to cure a selected part of said resin; (3) applying a further thin layer of resin and repeating steps (2) and (3) so as to obtain a three-dimensional shape of a plurality of cured layers, optionally combined with either one of the steps of washing and post-curing the three-dimensional shape, so as to obtain the mould, wherein the resin composition is formulated from constituents comprising at least one photoreaction monomer, at least one photoinitiator and at least one filler.
EUROPEAN COMMUNITY; EUROPEAN UNION; JAPAN; NETHERLANDS; WESTERN EUROPE
Accession no.777654

Item 55

Patent Number: US 6013693 A 20000111

ULTRAVIOLET-CURABLE SILICONE-BASED RELEASING COMPOSITION
Takahashi M; Irifune S
Shin-Etsu Chemical Co.Ltd.

Provided by the invention is an ultraviolet-curable silicone-based releasing agent suitable for use as a coating agent on the back surface of a pressure-sensitive adhesive tape and releasable protective sheet on a pressure-sensitive adhesive label with an advantage that the coating layer thereof is curable by ultraviolet irradiation in an atmosphere which is not completely free from oxygen having an inhibiting effect on the curing reaction of the coating layer, contributing to cost reduction for the production of pressure-sensitive adhesive tapes and labels. The releasing composition comprises, in addition to a radical-polymerisable organopolysiloxane having (meth)acryloxyalkyl groups and a photopolymerisation initiator, a tertiary amine compound such as isoamyl 4-dimethylamino benzoate and 2-ethylhexyl 4-dimethylamino benzoate in a limited amount.
JAPAN
Accession no.777633

Item 56

Iranian Polymer Journal
8, No.4, Oct. 1999, p.263-70

SYNTHESIS OF ACRYLIC ACID HYDROGEL BY GAMMA-IRRADIATION CROSSLINKING OF POLYACRYLIC ACID IN AQUEOUS SOLUTION
Jabbari E; Nozari S
Tehran, Amir Kabir University

Polyacrylic acid (PAA) hydrogels are used extensively as a matrix in gastrointestinal drug delivery systems. Crosslinked PAA hydrogel is synthesised using a two step method. First, uncrosslinked PAA is synthesised by free radical precipitation polymerisation of acrylic acid in benzene. In the second step, PAA is dissolved in aqueous solution and crosslinked with gamma-irradiation. The swelling behaviour of the gels is studied in pH 4 and 7 to simulate gastric and enteric pH, respectively. In buffered pH 4 solution, degree of swelling ranges from 30 to 300 for irradiation doses of 5 to 25 kGy and swelling is Fickian. On the other hand, in buffered pH 7 solution, the degree of swelling ranges from 80 to 500 depending on the irradiation dose and swelling is non-Fickian. 42 refs.
IRAN
Accession no.776700

Item 57

Pittsburgh, Pa., 24th-27th Oct.1999, paper 29

SHADOW CURING OF UV ADHESIVES
Ritter G W
Edison Welding Institute
(Adhesive & Sealant Council Inc.)

UV cured adhesives offer tremendous advantages in cure speed and work very well on many substrates. Modern equipment allows cures in seconds. UV cured adhesives and underfills have the inherent drawback of needing direct exposure to the UV light source to effect a cure. Several approaches have been tried to circumvent this problem. Among them are secondary heat or moisture cures and the allowance for visible light cures. Secondary cures require a separate processing step. Visible light cures take advantage of the greater dispersion of longer wavelengths and the ability of visible light to diffuse into hidden areas. They carry the disadvantage of requiring complete protection of the adhesive from ambient light when used on the assembly line. Fillers are not used extensively in UV curable adhesives because they interfere with passage of UV light. An exception to this is alumina trihydrate, which is transparent to UV. ATH is frequently used to increase viscosity and gap filling while allowing UV light to pass through the adhesive sufficiently for cure. There is another potential use for
fillers in UV curable systems. Fillers that reflect UV light can be used to ‘bounce’ the UV energy through the resin. The simple inclusion of UV ‘mirrors’ should allow greater dispersion of UV light and potentially improve curing in shadowed regions. Several types of filler materials are examined for their ability to improve shadow cure of a trial UV resin.

USA

Item 58

Patent Number: US 5981738 A 19991109

UV CURABLE CELLULOSE ESTERS

Cook P M; Simm R A
Eastman Chemical Co.

The present invention relates to a modified cellulose ester containing unsaturated pendant groups which can be prepared by reacting a cellulose ester containing residual hydroxyl groups with, for example, maleic anhydride in acetic acid solvent with sodium acetate catalyst. The modified cellulose ester is not homopolymerisable but will copolymerise in the presence of vinyl crosslinking agents and a photoinitiator upon exposure to ultraviolet radiation. The modified cellulose ester is useful as a protective and/or decorative coating for wood, metal, plastics, paper, board, and other substrates, as well as an additive to printing inks and as a nail polish. In addition, because of the propensity for the pendant carboxyl groups to form hydrophilic salts with amines, the modified cellulose esters can be formulated to be water-dispersible.

USA

Item 59

Patent Number: US 5981618 A 19991109

MOLD CLAMPING AND PRECURE OF A POLYMERIZABLE HYDROGEL

Martin W A; Adams J P; Bjerre K; Christensen S; Kindt-Larsen T; Walker C W; Tsu-Fang Wang D; Widman M F; Pegram S C
Johnson & Johnson Vision Products Inc.

An apparatus and method for partially curing a polymerisable monomer or monomer mixture to form a soft contact lens includes a transport device for transporting a plurality of contact lens moulds to a precure station in a low oxygen environment, each contact lens mould including a first and a second mould half with a polymerisable monomer or monomer mixture therebetween. A clamping member having a plurality of mould engagement members clamps a first contact lens mould half against a second contact lens mould half for a predetermined pressure and time. While the mould halves of the contact lens mould are clamped, the polymerisable monomer or monomer mixture is exposed to a radiant energy source for polymerising the polymerisable monomer or monomer mixture contained in each contact lens mould.

USA

Accession no.774513

Item 60

Patent Number: US 5981616 A 19991109

PHOTO-CURABLE RESIN COMPOSITION USED FOR PHOTO FABRICATION OF THREE-DIMENSIONAL OBJECTS

Yamamura T; Watanabe T; Takeuchi A; Ukachi T
DSM NV; JSR Corp.; Japan Fine Coatings Co.Ltd.

A photocurable resin composition suitable for photofabrication is disclosed. The resin composition is capable of being promptly cured by photo-irradiation, thereby reducing fabricating time and providing cured products having excellent mechanical strength and minimal shrinkage during curing to ensure high dimensional accuracy. The composition includes (A) an oxetane compound, (B) an epoxy compound, and (C) a cationic photo-initiator.

EUROPEAN COMMUNITY; EUROPEAN UNION; JAPAN; NETHERLANDS; WESTERN EUROPE

Accession no.774511

Item 61

Patent Number: US 6013330 A 20000111

PROCESS OF FORMING A PRINT

Lutz M E
Acushnet Co.

Ultraviolet radiation curing of inks on game balls, golf balls and the like is disclosed. Production inks, logo inks and methods for forming production prints and logos on golf balls, game balls and like are disclosed. To form an ultraviolet radiation curable water-insoluble production ink, at least an adhesion promoting component is added to an ink base. The adhesion promoting component is selected from the group consisting of a carboxylic acid functional monomer, a carboxylic acid functional oligomer, an ester functional monomer, an ester functional oligomer and mixtures thereof, the adhesion promoting component having at least one adhesion promoting functional moiety comprising about 2 moles of a carbonyl functionality per mole of the adhesion promoting component and being sufficient to maintain adhesion of the production ink at least at least 75 % of the inked surface to the topcoat and to the surface of the game ball or the golf ball after ultraviolet radiation curing and after coating the production ink with the topcoat. To form an ultraviolet
radiation curable water-insoluble logo ink, at least a toughening agent is added to an ink base. The toughening agent is sufficient to maintain adhesion of the logo ink to the topcoat of at least 75 % of the inked surface after ultraviolet radiation curing.

USA
Accession no.774489

Item 62
Macromolecular Materials and Engineering
Vol.274, Jan.2000, p.20-4
ELECTRON-BEAM CURING OF THICK THERMOSET COMPOSITES: EFFECT OF TEMPERATURE AND FIBER
Glauser T; Johansson M; Hult A
Sweden, Royal Institute of Technology

The electron beam curing of thermoset resins used in fibre-reinforced composites was investigated. Two resins, a bisphenol-A acrylate and a bisphenol-A methacrylate, were used as model systems. The temp. was monitored during cure to follow the thermal history of the composite during cure. The thermomechanical properties were measured on the cured samples. It could be seen that all these values were influenced by the nature of fibre (glass or carbon) and fibre content (0 to 50 wt %). A linear correlation was found between the maximum temp. during cure and the Tg. It was shown to be possible to compensate for a lack of heat during cure in systems with too low exotherms. Some influence on the network homogeneity was also noticed when the thermal energy available during cure was too low. 17 refs.
EUROPEAN COMMUNITY; SCANDINAVIA; SWEDEN; WESTERN EUROPE
Accession no.774355

Item 63
Patent Number: US 6025114 A1 20000215
LIQUID PHOTOCURABLE COMPOSITIONS
Popat A H; Lawson J R
Zeneca Ltd.

These comprise a) 2 to 20 parts of a monomeric poly(meth)acrylate having a functionality of at least 3 and a molec.wt. of at least 650, b) 20 to 60 parts of a urethane (meth)acrylate having a functionality of 2 to 4 and a molec.wt. of 400 to 10,000, c) 20 to 80 parts of a monomeric or oligomeric di(meth)acrylate based on bisphenol A or bisphenol F and d) 0.1 to 10 parts of a photoinitiator. They are suitable for the stereolithographic production of three-dimensional articles, such as models of mechanical and body parts, and exhibit low curl & shrinkage coupled with a fast cure rate.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA; WESTERN EUROPE
Accession no.773950

Item 64
Patent Number: US 6022498 A1 20000208
METHODS FOR EYEGLASS LENS CURING USING ULTRAVIOLET LIGHT
Buazza O M; Luette S C; Powers G R
Q2100 Inc.

Method and apparatus for making and coating a plastic lens are disclosed. An oxygen barrier containing photoinitiator is used to cure incompletely cured lens portions. Radiation pulses are used to control the cure rate of the lens. The lens is post-cured while in a mould cavity using a conductive heat source. Alternating periods of ultraviolet light are applied to the lens forming composition. The composition is cured while controlling the rate of heat generation and/or dissipation via manipulation of the duration of the radiation or cooling in the curing chamber. The ultraviolet light is directed toward the lens forming composition, which is preferably disposed in a mould cavity formed by two mould members. The ultraviolet light may be directed in pulses or continuously.
USA
Accession no.773891

Item 65
European Design Engineer
April 2000, p.58-9
ENCAPSULATING UV-CURABLE CHIPS AT SECOND INTERVALS
Most R
Delo

UV curable chip sealing compounds for the smart card industry provide the manufacturer of chip modules with the possibility to apply UV reactive sealing compounds without additional instalment of metal frames. The newest generation of these Katiobonds are UV curing epoxies with greater than 7000 Mpa, an elastic modulus formerly reserved for heat curing epoxies. Additionally, the Tg can be increased to values between 120 and 150 degrees C, which prevents a high thermal expansion and softening of the encapsulation compound at high temperatures. During processing of these sealing compounds with the dam and fill technology, a high sealing geometry can be produced. Details are given of the dam and fill technology and the use of Katiobond compounds for sealing smart card modules.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.773052
A review is presented of developments in adhesives and equipment for light curing applications. Fast UV light and broader spectrum light curing resins are now available which offer expanded possibilities to reduce cost in many assembly operations. Criteria are examined for resin and lamp compatibility for particular applications, and details are given of spot lamps, flood lamps and focussed-beam lamps.

USA
Accession no.773045

Item 67
Adhesive Technology
17, No.2, April 2000, p.18-20
UV-ACRYLIC HOT MELTS
Schumacker K; Dussterwald U; Fink R
BASF AG

Among the raw materials for pressure-sensitive adhesives, hot melts are claimed to promise the strongest growth-rates for the future. UV acrylic hot melts will expand the possible applications of hot melts by combining the economic attractiveness of the hot melt coating technology with the benefits of acrylic chemistry, such as ageing, heat and moisture resistance. The principle of UV acrylic hot melts is described, and the ability to control the ratio of adhesion to cohesion by controlling the amount of radiant energy applied to the adhesive film after it has been coated, is discussed.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.773041

Item 68
Adhesive Technology
17, No.2, April 2000, p.14-6
UV-CURABLE HMPSA
Dobmann A
Collano Ebnothner AG

New raw materials are being used in radiation curable hot melt pressure sensitive adhesives (HMPSA) which expand their range of applications. They can be customised with designed-in properties including a combination of peel values and high cohesion properties; increased reactivity and consequently improved production conditions; coating thicknesses greater than 250 microns which can be totally cured. Latest developments in these areas are reviewed, with particular reference to acrylic polymers, modified styrene-block copolymers, and liquid rubbers, including applications in adhesive tapes, labels, insulation and medicine.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.773040

Item 69
Journal of Coatings Technology
72, No.904, May 2000, p.71-5
NEW DEVELOPMENTS IN RADIATION-CURABLE POWDER COATINGS
Udding-Louwrier S; Baijards R A; de Jong E S
DSM Resins BV

Two different maleate-vinyl ether based binders for UV curable powder coatings have been developed, which are claimed to provide a balance between flexibility and hardness of the coating by adjustment of the formulation. The coatings are cured by a combination of IR and UV radiation at temperatures as low as 120 degrees C. UV curable powder coatings for MDF, paper and metal substrates are discussed. The characteristics and coating performance of several UV powder coating formulations are described and a comparison is also provided between conventional coatings and UV powder coatings. 19 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE
Accession no.773036

Item 70
European Coatings Journal
May 2000, p.18/30
UV-CURABLE POWDER COATINGS
Zune C; Buysens K
UCB Chemicals

An overview is presented of the advantages and limitations of UV curable powder coatings with examples using coated metals and medium density fibreboard and the Uvecoat resin system. The main characteristics of powder coating systems and their technological advantages are described and UV curing methods are compared with traditional thermosetting systems. Characteristics such as weathering resistance, corrosion resistance, adhesion and film flexibility are examined. 11 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE
Accession no.773020
SELECTING PIGMENTS FOR COLOURED UV CURABLE POWDER COATINGS
Jahn R; Laver H; te Walvaart C
Ciba Specialty Chemicals
Factors governing the selection of pigments for the colouring of UV curable powder coatings are examined starting with the importance of the selection of the appropriate photoinitiator and its effects on curing performance. Results are discussed of tests carried out on two resin systems, Uracross for coating onto phosphated steel and the Uvecoat system for coating onto medium density fibreboard using inorganic and organic pigments at different concentrations. 4 refs.
SWITZERLAND; WESTERN EUROPE
Accession no.773019

ELECTRON BEAM CURING OF POLYMER COMPOSITES
Raghavan J; Baillie M R
Manitoba, University (SPE; National Research Council of Canada)
Electron beam (E-beam) curing, in the presence of a cationic photoinitiator, of an epoxy polymer matrix and its composite (reinforced with IM7 carbon fibres) is studied. Photoinitiator concentration, dose and process temperature are varied to understand their influence on E-beam curing. Optimal photoinitiator concentration is found to be 5 phr and the curing is due to a primary reaction, with a strong dependence on dose, and a secondary reaction, with a weak dependence on dose and a strong dependence on initiator concentration. The extent of cure increases rapidly with dose until 50 kGy and approaches a plateau value beyond 100 kGy. This plateau value corresponds to incomplete curing by 27% for resin and 22% for composite at a process temperature of 22 deg.C. The causes for incomplete cure appear to be due to the secondary reaction and diffusional limitation. Increase in process temperature results in higher extent of cure at a dose level. The material used is also found to be thermally curable and the reaction onset temperature (measured in a DSC ramp experiment) reduces from about 150 deg.C at 0 kGy to about 50 deg.C at 30 kGy. This indicates that simultaneous thermal curing during E-beam curing of resin and composite is possible. The Tg of the E-beam cured material increases threefold and the modulus decreases by 10% after thermal post-curing. The service temperature and the modulus of the 100% thermally cured material and the thermally post-cured (after E-beam irradiation) material are comparable. 15 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE
Accession no.771711

CURABLE INK COMPOSITION AND IMAGED RETROREFLECTIVE ARTICLE THEREFROM
Christian P D
3M Innovative Properties Co.
Radiation curable ink compositions and coating compositions contain an aliphatic (meth)acrylate functional macromonomer, a reactive acrylate monomer, and a photoinitiator. Ink compositions also contain an effective amount of colourant or pigment. These inks, when cured by exposure to actinic radiation, have excellent durability, weatherability and adhesion to acrylate substrates such as polymethylmethacrylate.
USA
Accession no.769735

SOLID IMAGING PROCESS USING COMPONENT HOMOGENIZATION
Lawton J A
Solid objects are formed in an imagewise layering process in which components of a dispersion are homogenised to form an alloy. Imagewise exposure of the layers to radiation to form an alloy permits separation of the exposed, homogenised regions from non-exposed, non-homogenised regions. As each layer is formed and imagewise homogenised, contiguous layer regions are
bonded together to form a homogenised, three-dimensional object which may be separated from surrounding dispersion.

USA
Accession no.769706

Item 76
Patent Number: US 6005017 A 19991221
DUAL THERMAL AND ULTRAVIOLET CURABLE POWDER COATINGS
Daly A T; Muthiah J; Haley R P; Kozlowski J J; Shah N B
Morton International Inc.

Opaquely pigmented or thick filmed powder coatings for heat sensitive substrates, such as wood, wood composites, for example, medium density fibre board, and plastics, that can be fully cured, especially near the substrate, through the incorporation of a dual cure system in the powder comprising a thermal initiator, such as a peroxide, along with a UV initiator. The UV initiator cures the surface, while the thermal initiator cures at the substrate. Surprisingly, virtually no pregelation occurs during the heated melt and flow out step prior to UV curing. Consequently, the hardened film finish formed on the surface exhibits exceptional adhesion to the substrate which cannot be achieved with traditional UV curable powders that have been pigmented. Although the dual cure system includes a thermal aspect, these powder coatings are especially suited for coating heat sensitive substrates. The dual thermal and UV curable powders still cure at significantly lower temperatures and significantly faster rates than traditional heat curable powders to make them safe for coating heat sensitive substrates.

USA
Accession no.767250

Item 77
Patent Number: US 5789039 A 19980804
RADIATION CURING OF POWDER COATINGS ON HEAT SENSITIVE SUBSTRATES: CHEMICAL COMPOSITIONS AND PROCESSES FOR OBTAINING COATED WORKPIECES
Biller K M; MacFadden B A
Herberts Powder Coatings Inc.

The present invention relates to powder coatings curable by exposure to radiation, typically ultraviolet radiation. Powder coatings based upon cationically catalysed resins (typically epoxy resins) are described including bisphenols, bisphenols modified by novolac, as well as aliphatic type epoxides including hydrogenated bisphenol-A, glycidyl methacrylate, glycidyl acrylates or related compounds and vinyl ethers including mixtures of the foregoing compounds. Photoinitiators of sulphonium type, ferrocenium type, iodonium type, triphenolic types and related compounds are also included. Opacifiers, flow agents and plasticisers are also included. Charge additives related to improved electrostatic deposition of the powder coating are also described. Degassing agents are also typically included in the formulation, both for degassing the powder coating during cure, and to assist in degassing those substrates (such as wood) which tend to form bubbles during cure. Flow agents are also typically included in the formulation. Solidification of photoinitiators prior to use, and the addition of hydroxyl polyesters are shown in the present invention to lead to improved curing and coating performance. Additives are also typically described which permit the powder coating to flow at temperatures below 100°C, thereby allowing powder coatings to be employed on heat-sensitive substrates such as wood.

USA
Accession no.766666
Item 79
Macromolecules
32, No.26, 28th Dec.1999, p.8982-8
STUDYING POLYMER-DISPERSED LIQUID-CRYSTAL FORMATION BY FTIR SPECTROSCOPY. I. MONITORING CURING REACTIONS
Bhargava R; Shi-Qing Wang; Koenig J L
Case Western Reserve University
Real-time FTIR was used to study the curing of a UV-curable prepolymer (NOA65) and its mixtures with liquid crystals. Curing reactions were examined as a function of film thickness, temperature, and liquid crystal content. While there was little dependence of the curing behaviour on the thickness of the film, the effect of temperature was strong. Curing rates exhibited a maximum around 325K, while conversions reached a plateau about 20K higher. Liquid-crystal addition depressed the conversion. However, compared with the neat matrix, the final conversion was significantly lower only for phase-separating concentrations. It is concluded that real-time FTIR is a useful tool for monitoring polymer-dispersed liquid crystal formation and optimising curing conditions. NOA65 (from Norland Products Inc.) is a thiolene-chemistry curable prepolymer mixture of trimethylolpropane diallyl ether, trimethylolpropane tris(thiol), isophorone disiocyanate ester, and a benzophenone photoinitiator. 34 refs.
USA
Accession no.765193

Item 80
Chemistry of Materials
12, No.1, Jan.2000, p.22-4
CATALYTIC PALLADIUM NANOPARTICLES SYNTHESISED USING A LYOTROPIC LIQUID CRYSTAL POLYMER TEMPLATE
Ding J H; Gin D L
California,University
Details are given of the synthesis of palladium nanoparticles with good stability and catalytic activity by using a crosslinked lyotropic liquid crystal as an organic template. Structures were confirmed using X-ray diffraction and TEM. 18 refs.
USA
Accession no.764745

Item 81
Adhesives Age
43, No.2, Feb.2000, p.11-2
NEW RESEARCH PRESENTED ON UV-CURABLE ADHESIVES
Bowtell M
Among the many topics discussed at Radtech Europe '99 were UV-curable acrylic pressure-sensitive adhesives, rubber-based radiation curable PSAs, UV acrylic hot melts, UV/EB epoxy silicones and radiation-curable UV acrylates.
WESTERN EUROPE-GENERAL
Accession no.764527

Item 82
Journal of Polymer Science: Polymer Chemistry Edition
37, No.24, 15th Dec.1999, p.4616-28
INVESTIGATION OF MICROWAVE ENERGY TO CURE CARBON FIBRE REINFORCED PHENYLETHYLNYL-TERMINATED POLYIMIDE COMPOSITES
Xiaomei Fang; Scola D A
Connecticut,University
The application of microwave energy to the processing of phenylethynyl-terminated polyimide (PETI-5) CFRP was investigated and evaluated with a variable-frequency microwave furnace. The thermal and physical properties of the composites were measured by DMTA, TGA, TMA,
density and composition (void, fibre and resin) tests. A comparison of the thermal and microwave processes was conducted to evaluate the advantage of the microwave process. It was concluded that microwave energy was used successfully to fabricate PETI-5/IM7 composites with higher Tg values (by 11-16C), and higher retention of flexural strength, flexural modulus, and shear strength at 177C than those fabricated by the thermal process. Furthermore, the microwave processes require only half the time required for the standard thermal process. Inspection by environmental scanning electron microscopy of the failure surface of composites tested at room temperature showed that more resin adhered to the fibre surface of the microwave-cured composite than to the fibre surface of the thermally cured composite. 22 refs.

USA

Accession no.764043

Item 85

Journal of Polymer Science: Polymer Chemistry Edition
37, No.24, 15th Dec.1999, p.4554-69

SYNTHESIS AND CHARACTERISATION OF BIODEGRADABLE NETWORK HYDROGELS HAVING BOTH HYDROPHOBIC AND HYDROPHILIC COMPONENTS WITH CONTROLLED SWELLING BEHAVIOUR

Yeli Zhang; Chee-Youb Won; Chih-Chang Chu
Cornell University

A new class of biodegradable hydrogels, consisting of hydrophobic poly(D,L)lactic acid and hydrophilic dextran segments with a polymer network structure was synthesised by UV photopolymerisation. Unsaturated vinyl groups were first introduced onto the poly(D,L)lactic acid and dextran polymer backbones. Diacrylate-terminated poly(D,L)lactic acid and dextran acrylate were then crosslinked. The chemical crosslinking forced the hydrophobic poly(D,L)lactic acid and hydrophilic dextran segments to mix in the network hydrogels. The effects of reaction time, temperature, and molar ratio of the reactants on the incorporation of acrylic onto the polymer backbone were examined. A series of hydrogels with different dextran/poly(D,L)lactic acid composition ratios was prepared, and their swelling behaviours were studied. These new bicomponent network hydrogels had a wide range of hydrophilicity to hydrophobicity that was difficult to achieve in totally hydrophilic hydrogels. A detailed summary on the use of hydrogels and biodegradable polymers in biomedical applications is included. 36 refs.

USA

Accession no.764036

Item 86

Adhasion Kleben & Dichten
43, No.10, 1999, p.16/20

GERMAN

REACTION ADHESIVES FOR ELECTRONICS

This report surveys the German market for adhesives to be used in the electronics industry. Names and addresses of fourteen manufacturers are given in a table, cross-referenced to curing methods including heat, UV, room temperature, moisture, anaerobic, condensation crosslinking, addition crosslinking, isotropic electrical conductivity, heat conductivity and electrical insulation. It includes areas where such adhesives are useful like chip adhesion, fixing flex or cord and components on printed circuit boards, protective coating for circuit boards, potting and encapsulation such as underfillers. It classifies adhesives as epoxide resins, polyurethanes, acrylates and silicones.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.763913

Item 87

Rubber Chemistry and Technology
72, No.2, May-June 1999, p.308-17

EFFECT OF WATER SOLUBLE POLYMERS ON RADIATION VULCANISED NATURAL RUBBER FILMS

Varghese S; Katsumura Y; Makuuchi K; Yoshi F
Tokyo,University; Japan Atomic Energy Research Institute

As an aid to reducing the allergical effects of articles produced from latex, radiation curing has been proposed. This produces a vulcanisate free of any accelerator residues, but the basic latex protein remains unaffected. A method of reducing latex proteins is proposed by blending the irradiated latex with water soluble polymers such as poly (vinyl alcohol) or poly (ethylene oxide). Radiation curing is shown to increase the protein content of the serum phase and reduce it in the rubber phase and in the presence of these water soluble polymers, it is shown that the proteins can then be leached out more quickly from the finished vulcanisate. Properties of the films prepared in this way, and containing traces of the water soluble polymer, are similar to normal radiation vulcanised films in both ageing and thermal degradation behaviour, but show an increased tear strength with a slight reduction in tensile strength. Film transparency can be increased with a reduction in tackiness. 29 refs.

JAPAN

Accession no.763826
PRODUCTION PROCESS OF LIQUID CRYSTAL DISPLAY PANEL, SEAL MATERIAL FOR LIQUID CRYSTAL CELL AND LIQUID CRYSTAL DISPLAY

Yamada S; Matsukawa H
Matsushita Electric Industrial Co.Ltd.

A liquid crystal display apparatus is produced by sealing a liquid crystal between two substrates having electrodes and an alignment film with a seal material containing a radically polymerisable curing resin, which is temporarily hardened using UV irradiation and then hardened by heating. The seal material is moisture resistant.

JAPAN
Accession no.763595

METHOD FOR PRODUCING LAMINATED OBJECT

Otsuka Y; Ozaki M
Toyota Jidoshia KK

A depositing step and an irradiating step are repeated alternately so as to pile solid layers to produce a laminated mould for casting an alloy melt. In the depositing step there is formed a deposited layer of sand coated with a thermosetting resin capable of forming a solid layer upon being irradiated with a laser beam. In the irradiating step, the deposited layer is irradiated with a laser beam to form a hardened solid layer. The irradiating step includes the operations of: distinguishing an outer skin portion from an inner portion of the deposited layer, and emitting a thick laser beam having a large diameter to harden the inner portion of the deposited layer, and emitting a thin laser beam having a diameter smaller than the thick laser beam to harden the skin portion of the deposited layer.

JAPAN
Accession no.763535

INVESTIGATIONS INTO THE MECHANISM OF ADHESION OF A NOVEL LIGHT DEACTIVATABLE PRESSURE-SENSITIVE ADHESIVE

Chivers R A; Webster I
Smith & Nephew Group Research Centre (IOM Communications Ltd.)

A pressure-sensitive adhesive based on specially modified acrylic copolymers was developed for use on wound dressings designed for easy removal from the skin. A photoinitiator was incorporated in the adhesive to initiate a free radical crosslinking process on exposure to visible light, resulting in a harder material with greatly reduced adhesion. Test results showed significant reductions in peel strength after light exposure. The dynamic mechanical properties of the adhesive were measured under a variety of conditions, and attempts were made to use the results to predict the range of peel performance using existing theories. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE
Accession no.761620

ENERGY EFFICIENT LASER CURING TREATMENTS ARE NOT AFFECTED BY PIGMENT ABSORPTION

Schweiger
Zeller & Gmelin GmbH

There has been a tremendous growth in UV technology in the last two decades and this technique is now adopted by many different printing processes. One of the concerns with UV curing systems is the poor energy efficiency of a UV lamp. Photoinitiators are only receptive to narrow UV bands that depend on their chemical structures. This article discusses the effects of UV absorption by pigments and the development of the Excimer system that provides energy in a single, narrow band.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.761591

POLYESTERS IMPROVE PIGMENT WETTING OF FLEXOGRAPHIC INKS

De Micheli P
UCB Chemicals

The key to achieving high-quality UV flexographic inks lies in pigment wetting, ink rheology and the reactivity of the formulated system. Rheological behaviour is directly related to pigment wetting and accounts for many of the required properties of the formulated ink. Other important criteria are adhesion and odour after cure of the formulated ink.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE
Accession no.761590
A compressible printing plate is prepared by casting liquid photopolymerisable resin directly onto a compressible material having open cells on its surface. The photopolymerisable resin is incompletely cured by exposure to actinic radiation, preferably in the absence of a coverfilm covering the photopolymerisable resin. A further layer of photopolymerisable resin is then cast onto the incompletely cured resin, and the whole exposed to actinic radiation through an image-bearing transparency. A release composition may be placed between the image-bearing transparency and the photopolymerisable resin to provide for decreased adhesion therebetween. After development, an image-bearing laminate suitable as a printing plate for flexographic printing is obtained. The printing plate achieves excellent short and long term adhesion between the compressible layer and the photopolymer plate, without the necessity of a tie layer or adhesive therebetween.
alignment direction from parallel to perpendicular was observed for 1b, depending on the irradiation doses. 26 refs.

JAPAN

Accession no. 759258

Item 98
Patent Number: US 5958997 A 19990928
COMPOSITION FOR AND A METHOD FOR PRODUCING A POLYMERIC ION CONDUCTIVE MEMBRANE
Eunkyoung K; Seobong L; Heejung K
Korea, Research Institute of Chemical Technology
The present invention provides a composition for a polymeric ion conductive membrane. Said composition comprises an alkaline salt, an acrylate and/or methacrylate of poly(ethylene glycol) alkyl ether with an unsaturated reactive radical, a poly(alkylene glycol) dimethacrylate or a poly(alkylene glycol) trimethacrylate, a vinylic monomer and a UV radiation curing initiator. The present invention further provides a method for producing said polymeric ion conductive membrane with the composition. The polymeric ion conductive membrane so produced according to the present invention has an excellent mechanical feature, strong adhesive strength and ionic conductivity at room temperature.

KOREA
Accession no. 759129

Item 99
Revista de Plásticos Modernos
78, No.519, Sept.1999, p.287-96
Spanish
PHOTOPOLYMERISABLE DENTAL COATINGS
Davidenko N; Diaz J M; Sastre R
La Habana, Universidad; Instituto de Ciencia y Tecnología de Polímeros
An examination is made of acrylic and methacrylic monomers used in coatings for dental applications, and of photocuring processes and photoinitiator systems applied to these materials. Factors influencing the degree of conversion and its effects on the properties of the coatings are discussed. Toxicological aspects of such coatings are reviewed, and applications of filled and unfilled coatings are described. 88 refs.

CUBA; EUROPEAN COMMUNITY; EUROPEAN UNION; SPAIN; WESTERN EUROPE
Accession no. 758786

Item 100
Patent Number: US 5881194 A 19990309
RADIATION-CURED MATRIX MATERIAL; OPTICAL FIBER RIBBONS CONTAINING SAME; AND PROCESS FOR PREPARING SAID OPTICAL FIBER RIBBONS
Duecker D C
An adhesion promoter, such as a carboxylic acid functional monomer or oligomer, ester functional monomer or oligomer or mixtures thereof, is added to an ink base to provide a production ink. The adhesion promoter has at
least one adhesion promoting functional moiety comprising at least about 2 moles of a carbonyl functionality per mole of the adhesion promoter and is sufficient to maintain adhesion of the ink of at least about 75% of the inked surface to the topcoat and to the surface of the game ball or golf ball after electron beam irradiation curing and after coating the ink with the topcoat. A logo ink is produced by adding a toughening agent to the ink base.

USA
Accession no.756451

Item 104
ENERGY CURING FOR FLEXIBLE PACKAGING
Bean A J
Sun Chemical Corp. (TAPPI)
The use of UV light and electron beam energy to cure inks, coatings and adhesives in the flexible packaging market has been both praised and panned for several years. The technology has been used for many years in folding carton food packaging, liquid packaging and other applications. The reasons for the technology and some of the problems, both real and imaginary, that are preventing broader acceptance, are reviewed.
USA
Accession no.756313

Item 105
Macromolecules
32, No.9, 4th May 1999, p.2903-9
LOW-LOSS PASSIVE OPTICAL WAVEGUIDES BASED ON PHOTOSENSITIVE POLY(PENTAFLUOROSTYRENE-CO-GLYCIDYL METHACRYLATE)
Pitois C; Vukmirovic S; Hult A; Wiesmann D; Robertsson M
Stockholm,Royal Institute of Technology; IBM Zurich Research Laboratory; Ericsson Components AB
Low loss optical waveguides were fabricated from fluorinated copolymers designed to incorporate photochemical amplification based on acid catalysis. Core and cladding layers were made, for single-mode channel waveguides, from the poly(pentafluorostyrene-co-glycidyl methacrylate) copolymer series and, for multimode ridge waveguides, from poly(tert-butyl methacrylate-co-glycidyl methacrylate) as the cladding and poly(pentafluorostyrene-co-glycidyl methacrylate) as core layer. Reactivity ratios were obtained for the pentafluorostyrene and glycidyl methacrylate monomers in free radical copolymerisation. Variation of the copolymer composition allowed precise control over the refractive index measured at 589, 633 and 1550 nm. These amorphous copolymers were photocrosslinked by contact printing and developed by wet etching to produce high quality ridge waveguides with very smooth top surfaces. Low loss single-mode waveguides exhibit averaged losses over eight channel waveguides as low as 0.39 dB/cm at 1320 nm and 0.42 dB/cm at 1550 nm. Thermal properties (DSC Tg and TGA thermal stability) were examined and optical losses were measured after two different annealings at 200 and 250°C for 1 hour. 24 refs.
SCANDINAVIA; SWEDEN; SWITZERLAND; WESTERN EUROPE
Accession no.754752

Item 106
Journal of Polymer Science: Polymer Chemistry Edition
37, No.16, 15th Aug.1999, p.3427-40
SYNTHESIS AND CATIONIC PHOTOPOLYMERIZATION OF MONOMERS BASED ON DICYCLOPENTADIENE
Crivello J V; Song S
Rensselaer Polytechnic Institute
The photoinitiated cationic polymerisation of activated epoxy monomers based on dicyclopentadiene was studied. Pronounced acceleration of the polymerisation rate in the presence of diaryliodonium salt photoinitiators was observed, which was attributed to free radical chain-induced decomposition of the photoinitiator. One of the chain carriers in this reaction involved a monomer-derived free radical. A dicyclopentadiene monomer was also prepared, bearing polymerisable epoxide and 1-propenyl ether groups in the same molecule. The functional groups in this monomer appeared to undergo independent vinyl and epoxide ring opening polymerisation. 32 refs.
USA
Accession no.753425

Item 107
Chimica e l’Industria
81, No.5, June 1999, p.563-5
Italian
POLYMER FORMULATIONS FOR COATINGS
Bigogno A
BASF Coatings
Topics discussed at a conference on polymeric coatings held in November 1998 by Federchimica are reviewed. These included the functionalisation of polymers for use in water-based and powder coatings, structure-property relationships of UV curable polymers, rheological properties of coating formulations, degradation processes and stabilisers and antioxidants for polymer protection, and applications of coatings in the corrosion protection of metals.
FEDERCHIMICA; PISA,UNIVERSITY; TORINO,POLITECNICO; TORINO,UNIVERSITA; TRIESTE,UNIVERSITY; GENOVA,UNIVERSITA EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE
Accession no.752730
CROSSLINKING EFFECT ON MECHANICAL PROPERTIES OF UV CURABLE COATINGS
Schwalm R
BASF AG

It is recognised that radiation curable resins provide either hard and brittle or soft and flexible coatings and that the development is discussed of coatings that are both resistant to surface attack and yet are flexible enough to withstand mechanical distortion. It is claimed that waterborne coatings that achieve this balance can be made if the transitions which occur in photoinitiated polymerisation are considered. Factors mostly affecting the mechanical properties of coatings are the glass transition temperature, and the elastically effective chain length between the crosslinks. Tests were carried out on Laromer acrylates from BASF. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.749881

PHOTOINITIATOR EFFICIENCY IN WATER-BORNE UV CURABLE COATINGS
Pietschmann N
Institut fuer Lacke & Farben

Various photoinitiators were tested in clearcoat formulations based on two aqueous UV curable resin emulsions, including unsaturated polyester and polyester acrylate, and on two polyurethane acrylate dispersions. Pre-drying temperatures, initiator concentrations and incorporation methods were varied. Pendulum hardness tests on glass allowed a rapid estimation of the curing results. Crystalline 2-hydroxy-2-methyl-1-(4-(2-hydroxyethoxy)-phenyl) propan-1-one was shown to give superior curing response especially at lower photoinitiator levels. 26 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.751782

OPTIMIZATION OF THE PRODUCTION OF EPDM SPONGE RUBBER SEALS FOR THE AUTOMOTIVE INDUSTRY
Krusche A; Haberstroh E
IKV

A study was made of relationships between compound rheological properties, microwave vulcanisation parameters and accelerators on the quality of extruded EPDM foam seals for the automotive industry. The influence of these factors on cell size and structure, density and mechanical properties was investigated. Correlations were found between the chemical composition of the compound, variations in processing parameters and the quality of the finished product. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE
Accession no.749667

STUDY OF UV-CURABLE COATINGS FOR OPTICAL FIBERS
Gexing Shen; Xiouning Qu; Wanneng She; Xiaomeng Yu; Quzhen Sun; Hanning Chen
Hubei Research Institute of Chemistry

Three types of UV-curable prepolymer, urethane acrylate(UA), polysilicone acrylate(SA) and epoxy acrylate(EA), were prepared. These prepolymer were mixed in different proportions to modify the properties of an optical fibre coating. The component-property and structure-property relationships of the mixed coatings were
studied. When the proportion of the SA:UA:EA mixture was 5:4:3, it was used for a single coating, while a ratio of 6:5:2 was used for a primary buffer coating. These mixture coatings were applied to optical fibres. 11 refs.

CHINA
Accession no.748396

Item 113

Journal of Coatings Technology
71, No.891, April 1999, p.37-44
WEATHER STABILIZATION AND PIGMENTATION OF UV-CURABLE POWDER COATINGS
Misev L; Schmid O; Udding-Louwrier S; de Jong E S; Bayards R
Ciba Specialty Chemicals Inc.; DSM Resins BV
A UV-curable powder coating based on an unsaturated polyester binder and a vinyl ether crosslinker was tested for weathering resistance. Accelerated and outdoor weathering demonstrated the combined protective action of a UV absorber and a hindered amine light stabiliser. Successful cure of coatings of various colours and shades containing organic and inorganic pigments was also reported. Curing performance mainly depended on pigment absorption and particle size. A combination of a bisacylphosphine oxide and an alpha-hydroxyacetophenone photoinitiator overcame limitations imposed by filtering of UV radiation by the pigments and provided balanced cure. 15 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; USA; WESTERN EUROPE
Accession no.748394

Item 114

TODAY'S PRESS DESIGNS AND UV CURING SYSTEMS
Zinnbauer F E
Fusion AETEK UV Systems Inc. (TAPPI)
Major changes in packaging over recent years include the growth of private labelling that has shifted market share, together with FDA demands for more information on the package that has caused graphics to be sacrificed to accommodate text. Shorter runs dictated by regional and promotional marketing are now the norm for producing beverage wrap, coupons, lottery and scratch-off as well as security printing, EDP, food, health and beauty pharmaceutical and in-mould labels. Greater competition on crowded shelves and at point of display has meant that marketers and printers have had to find new ways to create labels and packaging with impact and instant eye appeal. The package is the product's last salesman and is sold based on attractiveness to the consumer whether due to eye appeal or to some special offer being promoted by the manufacturer of a particular product.
USA
Accession no.747980

Item 115

Journal of Applied Polymer Science
73, No.12, 19th Sept.1999, p.2391-411
MICROWAVE IRRADIATION OF NADIC-EN-CAPPED POLYIMIDE RESIN (RP-46) AND GLASS GRAPHITE-RP-46 COMPOSITES; CURE AND PROCESS STUDIES
Liu Y; Xiao Y; Sun X; Scola D A
Connecticut,University
Microwave energy to cure nadic-end-capped polyimide precursors (RP-46 resin) is investigated using a Cober Electronics Model LBM 1.2A/7703 microwave oven at a frequency of 2.45 GHz. Both neat resin samples and glass cloth and hybrid glass cloth-graphite cloth-RP-46 resin composites are studied. For the resin studies, the effect of various parameters, such as power level, sample size, processing temperature, time, and graphite fibre absorber, are investigated. The variables investigated with the composite study are power level, mould material, vacuum and low pressure. The results show that microwave energy is effective in curing neat resin samples and composite specimens. The presence of a small quantity of absorber (chopped carbon fibre) accelerates the cure dramatically. Soapstone mould material is found to be an efficient absorber for glass and glass-graphite composite processing, causing an effective cure in less than 1 h. Glass and glass-graphite hybrid composites with flexural strengths of 372-588 MPa and moduli of 28.7-31.7 GPa are fabricated. This is equivalent to 50-80% of the properties of composites fabricated by conventional means. 11 refs.
USA
Accession no.748279

Item 116

Journal of Applied Polymer Science
73, No.14, 29th Sept.1999, p.2869-76
SYNTHESIS AND CHARACTERIZATION OF UV-CURABLE WATERBORNE POLYURETHANE-ACRYLATE IONOMERS FOR COATINGS
Zhiming Wang; Dongbo Gao; Jianwen Yang; Yongjie Chen
Zhongshan,University
A new type of UV-curable waterborne PU-acrylate ionomer, prepared from toluene diisocyanate, polyethylene glycol(PEG), dimethylpropionic acid(DMPA), triethylamine and 2-hydroxyethyl methacrylate, was synthesised by the modified prepolymer mixing process in which water served as a chain extender and dispersant. The effects of varying
molar ratios of DMPA to PEG 400 on the rheological
behaviour of the ionomer dispersions, as well as on the
thermal and physical properties of their corresponding
cured films, were investigated. 15 refs.
CHINA
Accession no.747394

Item 117
Polymers Paint Colour Journal
189, No.4420, Sept.1999, p.38/40
CRYSTAL BALL GAZING: WHAT FUTURE FOR
POWDER COATINGS?
Alfort H J; Blatter K; Zimmermann F
DuPont Deutschland
Ecologically compatible powder coatings have still not
achieved the big breakthrough. That will only be possible
when powder coatings technology also asserts its
superiority over other eco-friendly coating processes with
regard to consumption of resources and primary energy.
UV-curing and near-infrared curing powder coatings are
discussed. The properties of coatings using various
hardener systems are examined.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE
Accession no.747283

Item 118
Adhesive Technology
16, No.3, Sept.1999, p.14/6
STUCK BY LIGHTNING
Brown M
Inseto (UK) Ltd.
A range of visible-light-photoinitiated adhesives from
Delo provides high-speed cure of solvent-free, single-
component epoxy- or acrylic-based materials. Katiobond
are light-curing epoxy adhesives, while Photobond are
light-curing acrylic-based adhesives.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK;
WESTERN EUROPE
Accession no.747226

Item 119
Journal of Coatings Technology
71, No.894, July 1999, p.69-72
UV-CURABLE, SPECIAL CODING INKS FOR
OPTICAL FIBRES
Shen G; She W; Qu X; Yu X; Sun Q; Liu W; Ron G
Hubai, Research Institute of Chemistry
A UV curable, special coding ink for optical fibres consists
chiefly of UV curable prepolymer, colouring materials and
a photoinitiator. The UV curable prepolymer is
silicone epoxy benzoic acrylate and alicyclic hydrocarbon
epoxy acrylate. The colouring materials are disperse red
urethane acrylate, disperse blue urethane acrylate, acridine
yellow urethane acrylate or their mixtures. The relationships
of component-property of UV curable, special coding inks
are studied. The typical UV curable, special coding inks
are used to colour the optical fibres. 4 refs.
CHINA
Accession no.745663

Item 120
Composites Part A: Applied Science and
Manufacturing
30A, No.9, 1999, p.1055-71
MICROWAVE PROCESSING: FUNDAMENTALS
AND APPLICATIONS
Thostenson E T; Chou T W
Delaware, University
An overview is presented of the fundamentals of
microwaves, electromagnetic theory and microwave/
materials interactions. Some recent applications of
microwave heating to materials processing are also reviewed,
including ceramics and ceramic matrix composites and
polymers and polymer matrix composites. 94 refs.
USA
Accession no.744891

Item 121
Patent Number: US 5928575 A 19990727
METHODS FOR EYEGLASS LENS CURING
USING ULTRAVIOLET LIGHT
Buazza O M
Q2100 Inc.
An oxygen barrier containing a photoinitiator is used to
cure incompletely cured lens portions. The cure rate of
the lens is controlled using radiation pulses and the lens
is post-cured while in a mould cavity using a conductive
heat source.
USA
Accession no.744726

Item 122
Patent Number: US 5907023 A 19990525
RADIATION-CURABLE COATING
COMPOSITIONS AND OPTICAL FIBER
COATINGS
Chawla C P
DSM NV
The invention provides a radiation-curable coating
composition comprising: (A) 30-90 wt % of a urethane
oligomer having three types of moieties: (I) a polyether/
polyol block copolymeric backbone, (II) an aromatic
group having one or more alkyl substituents, and (III)
reactive termini, the three types of moieties being
connected via urethane and/or urea linkages, the aromatic
group being connected to a urethane and/or urea linkage
via the one or more alkyl substituents.
EUROPEAN COMMUNITY; EUROPEAN UNION;
NETHERLANDS; WESTERN EUROPE
Accession no.743443
VFM PROCESSING: RAPID CURE TECHNIQUES FOR THE ELECTRONIC PACKAGING INDUSTRY
Lambda Technologies Inc.

The principles of variable frequency microwave (VFM) energy are outlined and a description given of applications for the processing technique in the electronic packaging industry. The procedure can be used for rapid and selective curing of encapsulants, adhesives and polyimides, as well as for bonding electronic components onto flexible or rigid circuit boards without compromising functionality. Advantages of the method include heating uniformity and elimination of arcing problems. Typical uses include curing of underfill, glob-top liquid encapsulant, and cavity dam and fill encapsulant. VFM can also be used to accelerate the post-mould curing necessary to enhance the glass transition of polymer compounds and is useful in structural bonding applications and in the curing of polyimide coatings on silicon wafers. Brief details are given of the MicroCure 5100 and MicroCure 2100 VFM systems available from Lambda Technologies.

USA
Accession no.743210

PLANAR MICROLENS ARRAY AND METHOD OF MANUFACTURING SAME
Hamanaka K; Morio K
Micro Optics Co.Ltd.

This includes an array of convex microlenses made of a UV-curable synthetic resin having a high refractive index and disposed on a surface of a base glass plate. A cover glass plate is bonded to the array of microlenses by an adhesive layer made of UV-curable synthetic resin having a low refractive index. A film made of UV-curable resin is applied to a surface of the base glass plate remote from the array of convex microlenses. The film prevents warping when the UV-curable resins are cured.

JAPAN
Accession no.742069

UV OR VISIBLE LIGHT INITIATED CATIONIC CURED INK FOR INK JET PRINTING
Roth J D
NCR Corp.

An ink composition for use in ink jet printing is provided which is curable by UV radiation or visible light. The ink composition forms chemically resistant and smear resistant printed images and comprises a cationically photoreactive monomer or oligomer selected from epoxy monomers, epoxy oligomers, vinyl ether monomers and/or vinyl ether oligomers, a cationic photoinitiator and a colouring agent. Also provided are ink jet printers, ink jet printing processes and imaged substrates which employ such an ink composition.

USA
Accession no.739891

BEAMING OUTLOOK FOR COMPOSITES PROCESSING
Hill S

Acsion Industries is developing composite materials processing technologies for the next generation of high speed passenger aeroplanes, new fighter aircraft and the replacement for the Space Shuttle. Electron beam curing is being touted as a replacement for autoclave curing of composites. A range of electron beam curable epoxy resins is now commercially available. Acsion recently signed an agreement with Air Canada for the production and repair of some of the composite components in its A320 Airbus planes using electron beam processing.

ACSION INDUSTRIES
CANADA
Accession no.739244

COMPARISON OF MICROWAVE AND THERMAL CURE OF THE PHENYLETHYLNYL-TERMINATED POLYIMIDE COMPOSITES
Fang X; Scola D A

(ACS,Div.of Polymeric Materials Science & Engng.)
Composites, consisting of phenylethynyl-terminated polyimide/graphite fibre, were cured under vacuum using microwave and thermal processes. The resulting materials were characterised using thermogravimetric analysis, dynamic mechanical thermal analysis, thermomechanical analysis, 3-point bend tests, short beam shear tests, and density measurements. Higher glass transition temperatures and thermal stabilities were observed in the microwave cured composites. The thermally cured composites showed incomplete cure and much lower glass transition temperatures. The microwave cured samples also displayed higher flexural and shear strengths, measured at 177°C. 11 refs.

USA
Accession no.738924

Item 129
Journal of Applied Polymer Science
73, No.4, 25th July 1999, p.815-20
STUDY ON THE LASER CURING OF ACRYLIC RESIN FOR THE APPLICATION IN SCREEN PRINTING
Jeong Soo Kim; Jae-Hwan Lee; Jeung-Ho Park; You-Hie Han
Chungnam, National University; Sam Yang Co.; Korea, Institute of Machinery & Materials
Photocuring of acrylic resin by an argon ion laser was studied with the aim of developing an economic, automated and computer-aided manufacturing process of screen for textile printing. A commercially-available polyurethane-acrylate resin was selected as a test resin for the study of laser curing behaviour. The photoreaction by laser was observed by IR spectroscopic analysis of vinyl group. With 1-W input power, the degree of curing increased linearly with exposure time but reached a plateau with exposure time of more than 4 microsec. The curing reaction could be characterised in an S-shaped curve due to the combined effect of oxygen inhibition at lower point and photon saturation at higher power. The viscosity of acrylic resin could be controlled by addition of water as diluent without any significant reduction in curing speed. 15 refs.
KOREA
Accession no.738091

Item 130
San Francisco, Ca., Spring 1997, p.701. 012
CATIONIC UV CURING OF VINYL ETHER-BASED COATINGS
Decker C; Morel F
URA CNRS
(ACS, Div. of Polymeric Materials Science & Engng.)
Growing concern in the coating industry for environmentally friendly technologies has led to the development of solvent-free formulations which can be cured at ambient temperature by a short exposure to UV light. One of the distinct advantages of UV curing, besides its very low VOC emission, is that the photoinitiated polymerisation proceeds within tenths of a second upon intense illumination, thus transforming quasi-instantly the liquid resin into a solid and highly crosslinked polymer. Most of the UV curable systems currently used in the coating industry are based on acrylic monomers and oligomers which are known for their high reactivity. However, these monomers usually exhibit a strong odour and can cause skin and eye irritation. In this respect, vinyl ether-based systems appear as a promising alternative, as these low odour and non-irritating monomers are known to undergo fast cationic polymerisation in the presence of a photogenerated protonic acid. They are particularly suited to coating applications, as cationic polymerisation is not inhibited by atmospheric oxygen, in contrast to the radical polymerisation of acrylate monomers. The kinetics of the crosslinking polymerisation of multifunctional vinyl ether (VE) monomers, as well as the properties of the UV cured coatings, have been thoroughly investigated. An attempt is made to monitor in real time the high-speed photopolymerisation of divinyl ether formulations and to quantify the effect on the cure kinetics of some physical and chemical factors, such as the light intensity, the viscosity, the temperature, the chemical structure of the telechelic oligomer and that of the cationic photoinitiator. 13 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE
Accession no.737576

Item 131
Macromolecules
32, No.10, 18th May 1999, p.3209-15
CATIONIC PHOTOPOLYMERIZATION OF EPOXIDES BY DIRECT AND SENSITIZED PHOTOLYSIS OF ONIUM TETRAKIS(PENTAFLUOROPHENYL)BORATE INITIATORS
Toba Y; Saito M; Usui Y
Ibaraki, University
Cationic photopolymerisation of epoxides by the direct and sensitised photolysis of eight of the above onium borates as initiators was investigated. The relative reactivity of the onium borates in the photopolymerisation was studied by the measurement of spectral sensitivity and by real time FTIR spectroscopy. The kinetics of the photopolymerisation by the sensitised photolysis differed from those of the direct photolysis. Several onium borates were sensitised by the excited singlet state of the anthracenes (non-substituted anthracene and 9-methyl- and 9,10-methylanthracene) and the rates of polymerisation increased with decreasing free energy changes between the onium borates and the excited singlet state of 9-methylanthracene. The acid generated by the
photodecomposition of the onium borates produced non-acidic products by heating. 45 refs.
JAPAN
Accession no. 736537

Item 132
ORGANIC LEDs - PREPARATION OF MULTILAYER DEVICES BY SPIN-COATING OF CROSSLINKABLE MATERIALS
Braig T; Bayer M S; Nuyken O; Muller D C; Gross M; Meerholz K
Munchen, Technische Universitat; Munchen, Ludwig-Maximilians-Universitat
(ACS, Div. of Polymeric Materials Science & Engng.)
Spin-coating for the preparation of multilayer organic light-emitting devices is attractive because of its low-cost, but has the disadvantage that the existing layer can be affected by the solvent used in the next layer. To overcome this problem, layers were prepared by spin-coating from a solution of hole-transporting materials, based on triarylamines with crosslinkable oxetane moieties which contained two polymerisable groups, followed by photo-crosslinking in the bulk. The crosslinking films were insoluble in most commonly used solvents, and were therefore suitable for the next preparation step. 4 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no. 736506

Item 133
POLYMERIZABLE LIQUID CRYSTAL ASSEMBLIES AS A ROUTE TO FUNCTIONAL, NANOSTRUCTURED MATERIALS
Gin D L; Gray D H; Smith R C; Deng H; Kim E; Juang E; Baxter B C
California, University at Berkeley
(ACS, Div. of Polymeric Materials Science & Engng.)
The synthesis of lyotropic liquid crystal monomers which adopt the inverted hexagonal liquid crystal phase at room temperature and can be photo-crosslinked with retention of microstructure in a variety of hydrophilic solutions is discussed. The result is polymer networks with hexagonally-packed, extended hydrophilic channels approximately 2 nm in diameter, with an inter-channel spacing of 4 nm. Chemical reactions may take place inside the hexagonal phases to generate novel nanocomposites. 20 refs.
USA
Accession no. 736448

Item 134
Patent Number: US 5891930 A 19990406
HIGH TEMPERATURE COATING COMPOSITION FOR GLASS OPTICAL FIBERS, A METHOD OF MAKING A COATING COMPOSITION AND A COATED OPTICAL GLASS FIBER
Lapin S C; Murphy E J
DSM NV
Describes a radiation-curable optical glass fibre coating composition adapted to provide the combination of properties of: (i) enhanced resistance to thermal degradation when suitably cured; and (ii) a viscosity sufficient to provide a surface substantially free of pitting. The composition is formulated from components including: (A) at least one epoxy silicone monomer or oligomer which is crosslinkable via actinic radiation, or mixture thereof; (B) at least one thermoplastic resin which is substantially unreactive to actinic radiation and which is soluble or dispersible in component (A), said thermoplastic resin being present in an amount to provide said composition with a viscosity suitable for application to an optical glass fibre; and (C) a catalytically effective amount of a photoinitiator for catalysing the crosslinking reaction of component (A) and which is soluble or dispersible in component (A) or a mixture of said component (A) and said thermoplastic resin. Also provided is a method of making the radiation-curable coating composition and a coated optical glass fibre.
EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE
Accession no. 733823

Item 135
Patent Number: US 5866628 A 19990202
ULTRAVIOLET AND ELECTRON BEAM RADIATION CURABLE FLUORESCENT PRINTING INK CONCENTRATES AND PRINTING INKS
Likavec W R; Bradley C R
Day-Glo Color Corp.
Describes ultraviolet curable or electron beam curable fluorescent inks and ink concentrates. The synthesis of the fluorescent ink and ink concentrates does not involve the use of volatile organic solvents, so removal of solvents is not necessary during the manufacturing process. The fluorescent inks and ink concentrates display minimal, consistent colour shift when cured. The cured fluorescent inks and ink concentrates are solvent resistant, particularly to methyl ethyl ketone, methanol, nonane, and sec butyl alcohol. The fluorescent ink and ink concentrate is comprised of: from about 20-90 per cent, preferably 30-70 per cent, more preferably 30-60 per cent by weight of an oligomer, which is either a formaldehyde oligomer or a cyclic-aliphatic oligomer; 0.1-15 per cent, preferably 1-10 per cent, of fluorescent dye; and 10-80 per cent,
preferably 30-70 per cent, more preferably 35-60 per cent of a photopolymerisable vehicle.

USA

Accession no.732066

Item 136

Paint & Ink International
12, No.2, March/April 1999, p.8-9

METAL DECORATING PERSPECTIVE ON UV CURLED INKS
Darge R
Valspar Ltd.

UV cured inks are well established in the graphic arts industry. They are applied by a number of printing techniques including lithography, serigraphy and flexography. This comprehensive article outlines lithographic printing in the metal packaging field, including a discussion of the formulatory techniques and a summary of the typical properties of the three major acrylate oligomer types used: epoxy, urethane and polyester. The article also addresses the problems specific to this field and future trends. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.730424

Item 138

Patent Number: US 5849462 A 19981215
NEGATIVE-ACTING NO-PROCESS PRINTING PLATES
Minyu Li; Gardner J P; Kluge J E; Mitra S B
Minnesota Mining & Mfg Co.

A photosensitive composition is prepared containing a polymer of the formula B(X)(Y) wherein B represents an organic backbone, each X independently is an acidic group or salt thereof and each Y independently is a photocurable group and a photoinitiating compound or compounds. Preferably, free-radically polymerisable multi-functional monomer and/or oligomer is added to the photosensitive composition. The photosensitive composition can be coated on a suitable substrate for planographic printing plate applications. Imagemewise irradiation causes the light struck regions to photocure, becoming insoluble in aqueous and organic mediums, while the non-light struck regions remain highly soluble/ dispersible. Printing plates of this construction do not require processing prior to being run on a press.

USA

Accession no.730188

Item 139


Boston, Ma., March 1999, p.475-6. 012

ASSEMBLING METAL IONS ON THE NAMOMETER SCALE USING POLYMERISABLE LYOTROPIC LIQUID CRYSTALS
Gray D H; Juang E; Deng H; Gin D L; Schwartz K B
California, University
(ACS, Div. of Polymer Chemistry)

Nanostructured and nanopatterned materials represent one of the frontiers in new materials research. One objective is the development of methods for constructing synthetic materials with the architectural sophistication of biological systems for enhanced performance. A second is the development of viable methods for assembling functional materials with greater small-scale resolution for improved miniaturisation and microelectronic device performance. Of particular interest are methods for
References and Abstracts

patterning and assembling metals on the nanometer regime. Metals serve as conducting elements in almost all electronic devices. In addition, many metal ions possess optical and paramagnetic properties, and can even serve as reaction sites. The ability to reproducibly organise metals and metal ions on the nanometer scale would have a tremendous impact in creating higher performance electronic devices as well as new functional materials. A number of methods for assembling or patterning metals on the nanometer-scale have recently been reported. Recent progress in using polymerisable amphiphilic liquid crystals as a method for assembling transition-metal and lanthanide ions into regular hexagonal arrays on the nanometer scale is reported. In addition, the small-scale architectural control afforded by this method can be extended to bulk aligned materials via appropriate processing techniques. 10 refs.

USA
Accession no.730118

Item 140

ACRYLATE OLIGOMERS IN ULTRAVIOLET CURE PSA'S GLASS TRANSITION, MOLECULAR WEIGHT VERSUS PEEL STRENGTH
Miller H C
Sartomer Co.
(Adhesive & Sealant Council)

Typically those not skilled in the field relate glass transition temperature to pressure-sensitive adhesives. A low Tg material is required to prepare good pressure-sensitive adhesives. A wide range of acrylate terminated oligomers in a standard formulation is described. Molecular weight and chemical structure variations are examined versus the glass transition of the oligomers and final peel strength. Each formulated adhesive requires unique oligomer properties to reach 100 newtons per 100 mm peel strength. Excellent peel strengths may be obtained with oligomer molecular weight ranging from 6,000 to 1,000 molecular weight and glass transition temperatures ranging from -74 up to 13 deg.C. 5 refs.

USA
Accession no.729094

Item 141
Macromolecules
32, No.6, 23rd March 1999, p.1853-8

SYNTHESIS AND CHARACTERIZATION OF PHOTO-CROSS-LINKED NETWORKS BASED ON L-LACTIDE/SERINE COPOLYMERS
John G; Morita M
Japan Small Business Corp.; Hokkaido Government Industrial Research Inst.

Lactide-based polydepsipeptide polymer networks and crosslinked beads were prepared by UV photopolymerisation of acrylated poly(L-lactic acid-co-glycolic acid-co-L-serine)(PLA-Glc-Ser). These materials were developed for use as polymer scaffolds in tissue engineering, cell encapsulation and injectable drug delivery, which had ligand-immobilisable and biodegradable characteristics. The acrylated PLA(Glc-Ser) crosslinked polymer networks obtained were glassy and transparent and the gel content was about 90%. The networks showed relatively low swelling in water, due to their crosslinked nature, but were easily swollen in chloroform and in DMSO. The acrylate polymers on copolymerisation with 2-hydroxyethyl methacrylate resulted in crosslinked networks, which swelled in water and in DMSO, showing the potential of the polymer in hydrogel applications. The modified PLA(Glc-Ser) beads prepared by UV-initiated suspension polymerisation were characterised by optical microscopy and FTIR. These degradable networks and beads should be useful as polymer scaffolds for biomaterial applications. 21 refs.

JAPAN
Accession no.728566

Item 142
Journal of Polymer Science : Polymer Chemistry Edition
37, No.8, 15th April 1999, p.1199-209

SYNTHESIS AND CATIONIC PHOTOPOLYMERIZATION OF MONOMERS BASED ON NOPOL
Crivello J V; Liu S S
Rensselaer Polytechnic Institute

A new hybrid monomer, a nopol ether epoxide containing both epoxy and a 1-propenyl ether groups, was prepared. Studies of the photoinitiated cationic polymerisation of this monomer showed that, in contrast to model compounds, the rate of ring-opening polymerisation of the epoxy group was accelerated, while the rate of polymerisation of 1-propenyl ether was depressed. Two different mechanisms which involved the free radical-induced decomposition of the diaryliodonium salt photoinitiator were proposed to explain the rate acceleration effects. 17 refs.

USA
Accession no.727137

Item 143
Coatings World
4, No.2, March 1999, p.33-7

WATER-BASED UV-CURABLE COATINGS
Moss M
Zeneca Resins BV

A discussion is presented of the application of water-based UV curing technology for coatings. Advantages of water-based systems over 100% solid UV systems are examined,
References and Abstracts

and formulation and production considerations are outlined. The development by Zeneca Resins of a range of water-based UV curable polymers based on both acrylated aliphatic and aromatic urethane chemistry, together with bimodal approaches, is described, and advantages of its novel technology with varying options on molecular weight, particle size and the possibility of blending with acrylic polymers, are discussed. 4 refs.

EUROPE-GENERAL

Accession no.726361

Item 144

Patent Number: US 5863966 A 19990126

RADIATION-CURING PRINTING INKS WITH ENHANCED SCRATCH RESISTANCE AND LUBRICITY

Ebbrecht T; Feldmann-Krane G; Lersch P; Silber S Goldschmidt AG

Describes radiation-curable printing inks which comprise organopolysiloxanes having C1-C8 alkyl radicals and polyether groups attached to the silicon atoms, in quantities of from 0.01 to 3 per cent by weight, based on the ink formulation. The cured coating has improved scratch resistance and lubricity.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.724924

Item 146


New Orleans, La., Spring 1996, p.385-6. 012

PHOTOPOLYMERISATION OF NOVEL DEGRADABLE NETWORKS FOR ORTHOPAEDIC APPLICATIONS

Anseth K S; Shastri V R; Laurencin C T; Langer R Massachusetts,Institute of Technology; Pennsylvania,Medical College; Hahnemann,University; Drexel,University

(ACS,Div.of Polymeric Materials Science & Engng.)

A new class of photopolymerisable, multifunctional anhydride monomers (and oligomers) is developed that react to form highly crosslinked polyanhydride networks. The high degree of crosslinking facilitates enhancement of mechanical properties (as compared to their linear counterparts) and also promotes a surface controlled degradation mechanism. In addition, the ability to photoinitiate the polymerisation can lead to a new generation of orthopaedic implants that would provide surgeons with tremendous ease of placement and greater flexibility in design of fracture fixation systems. 11 refs.

USA

Accession no.724758

Item 147

Patent Number: US 5854298 A 19981229

PHOTOCURABLE LOW OBSERVABLE AIRCRAFT MATERIALS

McNay S D; Martin D B; Marino T L; Neckers D C Lockheed Martin Corp.

Disclosed is a hybrid cure mechanism for polymerising highly filled/loaded, optically opaque, acrylate polymeric material compositions by radiant energy. When incorporated into a resinous composition, it can be used to repair surface coatings on high performance aircraft where an extended composition pot life or application life and rapid cure capability combined with an acceptable shelf life stability are required. In particular, an electrically conductive resinous paint or gap filler for a suitably

alkenyl oxystyrene monomers have good compatibility with cationic photoinitiators, polymerise rapidly under UV light and, following a thermal post-cure, provide crosslinked products with outstanding thermal resistance and high glass transition temperatures. In addition, these materials have low viscosity, show good adhesive properties and have been found useful for the assembly of a variety of electronic components. The synthesis, polymerisation and properties of photocured films derived from 4-allyloxystyrene and blends of this monomer with a divinyl ether are outlined. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; IRELAND; USA; WESTERN EUROPE

Accession no.724924

Item 146


New Orleans, La., Spring 1996, p.385-6. 012

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EUROPEAN COMMUNITY; EUROPEAN UNION; IRELAND; USA; WESTERN EUROPE

Accession no.724924

Item 146


New Orleans, La., Spring 1996, p.385-6. 012

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USA

Accession no.724758

Item 147

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Disclosed is a hybrid cure mechanism for polymerising highly filled/loaded, optically opaque, acrylate polymeric material compositions by radiant energy. When incorporated into a resinous composition, it can be used to repair surface coatings on high performance aircraft where an extended composition pot life or application life and rapid cure capability combined with an acceptable shelf life stability are required. In particular, an electrically conductive resinous paint or gap filler for a suitably
prepared composite or metallic surface is disclosed. The composition may also be used on the production line of high performance aircraft.

USA

Item 148
Tech XXI. Conference proceedings.
Orlando, FL, 6th-8th May, 1998, p.49-57. 6A7
RECENT DEVELOPMENTS IN MONOMERS AND OLIGOMERS FOR UV ADHESIVES
Glotfelter G A
Sartomer Co.
(Pressure Sensitive Tape Council)

A number of UV/electron beam curing monomers and oligomers used in pressure sensitive and laminating adhesives were cured and examined by FTIR, gel chromatography, DSC and other traditional measures of adhesive performance, peel strength and shear strength. The materials were a number of urethane acrylate oligomers, isobornyl acrylate, 2-ethoxyethoxyethyl acrylate (SR-205 from Sartomer Co.) ethoxylated nonylphenol acrylate and an experimental monofunctional acrylate. Data include Tg, breadth of Tg, radiation dose to reach a particular peel strength, and peak peel strengths. The results are explained in terms of the molecular structures, crosslinking and crystallinities of the polymers.

USA

Accession no.724124

Item 149
Tech XXI. Conference proceedings.
UV CURED PRESSURE SENSITIVE ADHESIVE COATING PRODUCED AT EXCELLENT MANUFACTURING RATES WITH CURRENT SLOT DIE TECHNOLOGY
Albrecht D E
May Coating Technologies
(Pressure Sensitive Tape Council)

Novel UV curable raw materials have been developed recently to offer the tape and label manufacturer new choices for high speed application of compliant adhesives. A high speed coating trial is described using a warm melt UV curable pressure sensitive adhesive formulation based on a novel reactive epoxidised and hydroxy-containing polymer (Kraton L-207 plus curing system dispersed in Kraton L-1203). Tackifier was Regalite 91. The various adhesives were heated in and metered from standard MCT Model 50-P melters. Coating was performed on a CLS-300 Coater/Laminator with a conventional MCT slot die. Curing of the adhesive film was accomplished with a Fusion Systems I600 lamp. Both the melting/pumping system and the slot die were maintained at 150F as was the coating roll. Coating speeds were from 100 to 800 feet/min. and coating thicknesses 1.3 to 5 mils. UV exposures varied from 1 to 425 mJ/sq.cm. Data includes thickness, speed, dose, gel content, tack, peel, shear and shear adhesion failure temperature. The process appeared to be robust with good reproducibility and low sensitivity to UV dosage. High speed operation up to 800 ft/min was possible, although 190 ft/min was the maximum for thicker coatings.

USA

Accession no.724121

Item 151
Patent Number: US 5847021 A 19981208
SOLVENT-FREE, RADIATION-CURABLE, OPTICAL GLASS FIBER COATING COMPOSITION AND SOLVENT-FREE METHOD FOR MAKING A SOLVENT-FREE, RADIATION-CURABLE, OPTICAL GLASS FIBER COATING COMPOSITION
Tortorello A J; Murphy E J
DSM NV

The invention relates to a solvent-free radiation curable, optical glass fibre coating composition containing: (a) a urethane oligomer having a functional group capable of polymerisation in the presence of actinic radiation, with an average functionality of at least about 1.2, having a vinyl addition polymer as backbone; (b) a urethane compound having a functional group capable of polymerisation in the presence of actinic radiation, with an average functionality of at least about 1, containing an organic moiety having about 5 or more carbon atoms as
backbone; (c) a reactive diluent. Furthermore, the invention relates to a solvent-free method for producing a solvent-free, radiation curable urethane oligomer composition.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.723585

**Item 152**

*High Performance Polymers*

11, No.1, March 1999, p.141-4

**PHOTOCURABLE MONOMERS AND OLIGOMERS FOR SPACE APPLICATIONS**

Crivello J V
Rensselaer Polytechnic Institute

The rationale and prospects for using photocurable monomers and oligomers for a variety of space applications are discussed, in particular the fabrication of lightweight composite structures for use in earth orbit as well as for planetary exploration using ambient solar radiation. Such structures could be transported either into space or to the surface of the Moon or planetary bodies in a collapsed condition, then deployed by inflation with a gas and allowed to become rigid as a result of polymerisation induced by light. 8 refs.

USA

Accession no.723076

**Item 153**

*Plaste und Kautschuk*

41, No.5, Sept.1994, p.216-20

German

**UV-CURING EPOXY RESINS AS COATING MATERIALS FOR MICROCHIPS**

Bittmann E; Ehrenstein G W
Friedrich-Alexander University

UV curing of resins can be characterised by a special DSC method called photocalorimetry where the heat evolved by the reacting material is registered during the UV irradiation. By varying the components of the resin mixture and the irradiation parameters, the photocalorimetric method was used to determine influencing factors on the curing of an epoxy resin system designed to serve as a coating material for microchips. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.721325

**Item 156**

*International Journal of Adhesion & Adhesives*

19, No.1, Feb.1999, p.29-34

**DEVELOPMENT OF A PRESSURE-SENSITIVE ADHESIVE FOR TRAUMA-FREE REMOVAL**

Webster I
Smith & Nephew Group Research Centre

In developing a medical grade pressure-sensitive adhesive that may be used on wound dressings and can be removed without trauma to the wearer, medical grade adhesives have been developed where their adhesion is ‘switched off’ on exposure to visible light. A methacrylate functional pressure-sensitive adhesive was synthesised which, when blended with a visible light photoinitiator, is rendered light sensitive and therefore capable of crosslinking through the vinyl groups to give reduced peel forces. Peeling studies from PE test plates using this adhesive demonstrated that reductions of up to 90% were achievable following irradiation and therefore also the possibility of trauma-free removal. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.720363
INVESTIGATION OF MICROWAVE ENERGY TO FABRICATE PHENYLETHYNYL TERMINATED POLYIMIDE/IM7 GRAPHITE COMPOSITES

Fang X; Scola D A; DiFrancia C
Connecticut,University (ACS,Div.of Polymeric Materials Science & Engng.)

Processing of thick-section fibre-reinforced polyimide parts by conventional thermal techniques requires very low thermal ramp rates resulting in very long processing times. High Speed Civil Transport (SCT) requires high performance materials for service at 160 deg.C for 60,000 hrs. One material selected as the matrix for advanced composite application in this vehicle is the phenylethynyl end-capped imide oligomer, called LaRC PETI-5. In addition to the strong technical issues which this material must address, the ability to manufacture composites more economically than can be accomplished is a primary factor in making the HSCT a commercially cost effective vehicle. Presently, cure of LaRC PETI-5 composite materials requires temperature up to 371 deg.C and over a period of 3 hrs for high temperature curing. A microwave cure process that would lower the cure temperature and decrease process times would contribute to reducing initial vehicle and operating costs. A model compound, 3,4'-bis((4-phenylethynyl) phalimido)diphenyl ether, PEPA-3,4'-ODA, and LaRC PETI-5, are selected. The basic parameters to the thermally and microwave cure and postcure of the imide model compound and resin materials are investigated, the basic process knowledge to the fabrication of resin specimens and graphite cloth/polyimide and glass cloth/polyimide composites is translated, and the resin materials and composites fabricated by the microwave process are characterised. The results of a preliminary investigation of the microwave cure of unidirectional PETI-5/IM7 graphite prepreg are presented. 11 refs.
particularly where low viscosity required for application cannot be formulated with conventional reactive thinners, e.g. on absorbent substrates. Moreover, they exhibit better adhesion on various substrates because of lower polymerisation shrinkage. Besides describing the systems used, a new method for monitoring curing, confocal Raman microscopy, is presented. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.706177

**Item 162**

**Patent Number:** US 5780117 A 19980714

**DUAL-CURE LATEX COMPOSITIONS**

Swartz A J; Wood K A
Rohm & Haas Co.

Radiation-curable latex compositions having a secondary curing mechanism are disclosed. An anionically stabilised, water-borne dispersion of one or more radiation-curable resins is combined with a low molec.wt. compound having at least two reactive functional groups, one of which comprises an epoxy and the other comprises either an epoxy or a functionality capable of self-condensation after film formation. A coating of this composition can be applied to a substrate and the coated substrate exposed to actinic radiation to effect curing. Unexposed or under-exposed portions of the coated substrate are allowed to cure at room temperature or greater.

USA
Accession no.704572

**Item 163**

*Journal of Applied Polymer Science*
70, No.11, 12th Dec.1998, p.2269-82

**INTERPENETRATING POLYMER NETWORKS. II. SUNLIGHT-INDUCED POLYMERIZATION OF MULTIFUNCTIONAL ACRYLATES**

Decker C; Bendaikha T
Ecole Nationale Superieure de Chimie de Mulhouse; Haute-Alsace,Universite

Protective coatings and glass laminates were obtained by sunlight-curing of acrylate monomers dispersed in a PMMA matrix or in a SBR, in the presence of an acylphosphine oxide photoinitiator. The polymerisation reaction was followed by IR spectroscopy and by gel fraction measurements and was shown to proceed extensively within minutes. As expected, the inhibitory effect of atmospheric oxygen on such radical-initiated reactions was less pronounced than in liquid samples. The monomer, photoinitiator and plasticiser concentrations were found to have a strong effect on the polymerisation rate, final degree of conversion and hardness of the sun-cured polymer. The adhesion of the cured coating on glass was significantly improved by the addition of an acrylate-grafted organosol silica. In order to produce strongly adhesive glass laminates, a photocurable acrylate resin was poured between two coated glass plates and exposed to sunlight for a few seconds. The same formulation could serve as a light-sensitive quick setting adhesive to bond glass to a variety of materials, such as polycarbonates, PVC, aluminium and steel. 22 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE
Accession no.702790

**Item 164**

*Polymers Paint Colour Journal*

**VINYLEthers IN UV-CURABLE RELEASE COATINGS**

Dougherty J A; McKittrick; Mathur A M
International Specialty Products

The utility is examined of vinylethers in UV curable release coatings. Vinylether monomers are shown to offer more properties in terms of being efficient reactive diluents, and their ability to undergo both cationic homopolymerisation and free-radical copolymerisation is discussed. The ability of vinylethers to lower viscosity and contribute to release properties in cationic formulations based on epoxy silicones is presented and formulations based primarily on vinylethers with epoxy silicones as additives are addressed. Free-radical formulations based on silicone acrylates and vinylethers are discussed, and hybrid systems that offer unique advantages in terms of providing rapid cure without nitrogen inerting, are also described. In addition, silicone-free UV curable release coating formulations based entirely on vinylethers, which impart controlled or ‘tight’ release behaviour are also discussed. 10 refs.

USA
Accession no.701626

**Item 165**

*Polymers Paint Colour Journal*

**APPLICATIONS OF ULTRAVIOLET AND ELECTRON BEAM CURING**

Decaux M
UCB Chemicals

The development of low viscosity oligomers has opened up new possibilities for radiation curing, it is claimed. They enable low viscosity mixtures to be achieved, allowing formulators to use application equipment requiring lower viscosity such as curtain coaters, spray coaters, flexo machinery, and roller coaters, etc. A discussion is presented of the main applications, advantages and disadvantages of these modern systems, in particular, in the graphic arts, paper upgrading, wood, and plastics coatings applications. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE
Accession no.701521
CATIONIC UV CURED COATINGS USING EPOXIDISED SOYBEAN OIL
Raghavachar R; Sarnecki G; Baghdachi J; Massingill J
Eastern Michigan, University

Cycloaliphatic epoxy resins are used in coatings and inks because of their exceptionally low viscosity and reactivity with a variety of co-reactants, thus permitting high solids and even zero VOC coatings. The low viscosity of epoxidised soybean oil, its reactivity and relatively low cost make it an inexpensive candidate co-resin for cationic radiation cured coatings and inks using blocked acid catalysts. Formulations with up to 40% ESBO in the epoxy resin blend are investigated. UV de-blocked cationic catalysts give UV cured coating systems. Hardness, adhesion and solvent resistance of UV coatings are affected by the initiator used as well as the amount of epoxidised soybean oil in the formulation. Better UV coatings are obtained with combinations of photoinitiators instead of single initiators. Using a combination of triaryl sulphonium hexafluoroantimonate salt and hexafluoro phosphate salt of an aromatic sulphonium coproduct improves adhesion while giving improved pencil hardness. The hardness of coatings with epoxidised soybean oil is adjustable by changing the epoxy/polyol ratio, using harder polyols and using harder epoxy resins.

EXPANDING ADHESIVE & SEALANT APPLICATIONS WITH VARIABLE FREQUENCY MICROWAVE TECHNOLOGY
Porter G
Nordson Corp.
(Adhesive & Sealant Council)

Variable frequency microwave (VFM) technology expands the use of microwave technology in industrial production operations and opens up new applications for adhesives and sealants. Regular microwave technology operating at fixed frequencies are acceptable for consumer and some industrial applications. VFM expands the use of microwave technology by preferentially and evenly heating an adhesive or sealant without heating the substrate. Variable frequency microwave technology is very effective in producing selective, controlled and uniform energy distribution over a desired area. There are many advantages of and applications for variable frequency microwave technology in industrial applications.

EFFICIENT COMPOSITE FABRICATION USING ELECTRON BEAM RAPIDLY CURED POLYMERS ENGINEERED FOR SEVERAL MANUFACTURING PROCESSES
Walton T C; Crivello J V
Aeroplas Corp.International; Rensselaer Polytechnic Institute
(Canadian Association for Composite Structures & Materials)

Low cost, efficiently processed ultra high specific strength and stiffness graphite fibre reinforced polymeric composite materials are of great interest to commercial transportation, construction and aerospace industries for use in various components with enhanced degrees of weight reduction, corrosion/erosion resistance and fatigue resistance. 10 MeV electron beam cure processing has been found to increase the cure rate by an order of magnitude over thermally cured systems, yet provide less
moulded-in stresses and high Tgs. However, a limited range of resins are available which are easily processed with low shrinkage and with performance properties equal or exceeding those of state-of-the-art toughened epoxies and BMIs. The technology utilises a cost-effective, rapid curing polymeric composite processing technique which effectively reduces the need for expensive tooling and energy inefficient autoclave processing and can cure the laminate in seconds in ambient or sub-ambient conditions. The process is based on electron beam curing of a new series of specially formulated resins that have been shown to exhibit excellent mechanical and physical properties once cured. 1 ref.

USA
Accession no.698324

Item 170
AN EMERGING ALTERNATIVE TO THERMAL CURING: ELECTRON CURING OF FIBRE-REINFORCED COMPOSITES
Singh A; Saunders C B; Lopata V J; Kremer W; Chung M
AECL Whiteshell Laboratories
(Canadian Association for Composite Structures & Materials)
Electron curing of fibre-reinforced composites to produce materials with good mechanical properties is demonstrated. The attractions of this technology are the technical and processing advantages offered over thermal curing, and the projected cost benefits. Though the work so far has focused on the higher value composites for the aircraft and aerospace industries, the technology can also be used to produce composites for the higher volume industries, such as transportation and automotive. 21 refs.
CANADA
Accession no.698323

Item 171
MICROWAVE CURING OF COMPOSITES - A RAPID AND EFFICIENT METHOD
Bai S-L; Djafari V; Andreani M; Francois D
Peking,University; ECP
(Canadian Association for Composite Structures & Materials)
A unidirectional composite is cured by microwaves using double generators. The mechanical properties in tension and bending of such cured composites are proved to be better than that of traditional thermal cured composites.

This amelioration of mechanical properties arises probably from the matrix difference in composites, which is revealed by the different fractographic aspect of the matrix. 3 refs.
CHINA; EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE
Accession no.698322

Item 172
OXYGEN GAS PERMEABILITY IN WATER AND MECHANICAL PROPERTIES OF POLY(N-BUTYLAMINO)-(DI-ALLYLAMINO)PHOSPHAZENE MEMBRANES CURED WITH IRRADIATION
Kajiwara M; Kimura T
(Canadian Association for Composite Structures & Materials)
Poly(n-butylamino)(di-allylamino)phosphazenes are prepared by the reaction of (NPCl2)n with n-butylamine and di-allylamine. After the membranes are prepared by casting, they are irradiated by UV, EB and 60Co gamma-ray. It is found from FTIR data that the CH=CH2/N-H ratios of the irradiated membranes decrease with increasing doses. Also, the membrane does not dissolve in THF or other organic solvents. This supports the theory that the CH=CH2 bond is cleaved by the irradiation and the crosslinking occurs between the intermolecular. Oxygen gas permeability values (Dk) of the irradiated membrane are determined with oxygen permeation and mechanical properties are determined with Tensilon. Dk values decrease with increasing Young’s modulus in the case of low concentration of di-allylamine. 4 refs.
JAPAN
Accession no.698279

Item 173
EFFICIENT COMPOSITE FABRICATION USING ELECTRON BEAM RAPIDLY CURED POLYMERS ENGINEERED FOR SEVERAL MANUFACTURING PROCESSES
Walton T C; Crivello J V
Aeroplas Corp.; Rensselaer Polytechnic Institute (SAMPE)
Low cost, efficiently processed ultra-high specific strength and stiffness graphite fibre reinforced polymeric composite materials are of great interest to commercial transportation, construction and aerospace industries for use in various components with enhanced degrees of weight reduction, corrosion/erosion resistance and fatigue resistance. 10 MeV
electron beam cure processing has been found to increase the cure rate by an order of magnitude over thermally cured systems yet provide less moulded-in stresses and high Tgs. However, a limited range of resins are available which are easily processed with low shrinkage and with performance properties equal to or exceeding those of state-of-the-art toughened epoxies and BMIs. The technology utilises a cost-effective, rapid curing polymeric composite processing technique which effectively reduces the need for expensive tooling and energy inefficient autoclave processing and can cure the laminate in seconds in ambient or sub-ambient conditions. The process is based on electron beam curing of a new series of especially-formulated resins shown to exhibit excellent mechanical and physical properties once cured. Fabrication processes utilising these specially formulated and newly commercialised resins are engineered to cure with low shrinkage, provide excellent mechanical properties, be processed solventless and are inherently non-toxic.

USA
Accession no.698037

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<th>Item 174</th>
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<tr>
<td>Patent Number: US 5744514 A 19980428</td>
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<tr>
<td>COATED OPTICAL FIBERS HAVING A REDUCED CONTENT OF EXTRACTABLE AND VOLATILE MATERIAL</td>
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<td>Shustack P J</td>
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<td>Borden Chemical Inc.</td>
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Coated optical fibres with radiation-curable coatings which include mercaptofunctional oligomers are disclosed. Specifically, the coatings may comprise the cured reaction products of mercapto-terminated urethane oligomers of number average molecular weight as determined by gel permeation chromatography (GPC) of at least about 3,000 daltons, particularly in combination with one or more (meth)acrylate-terminated urethane oligomers, monomer diluents, and optical silane adhesion promoter, photoinitiator and stabilisers. The coatings, when cured, exhibit a percent extractables content, as obtained by Soxhlet extraction, of no more than about 15%, and preferably of no more than about 8%, and a volatiles content, as obtained by thermogravimetric analysis, of less than about 7%, and preferably less than about 3%. Processes for preparing such coated optical fibres and the coatings per se are also disclosed.

USA
Accession no.697081

<table>
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<th>Item 175</th>
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<td>RadTech '98. Conference proceedings.</td>
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<tr>
<td>Chicago, II., 19th-22nd April 1998, p.712-8. 895</td>
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<tr>
<td>PHOTOPOLYMERISABLE ENCAPSULANTS FOR MICROELECTRONIC DEVICES</td>
</tr>
<tr>
<td>Baikerikar K K; Rangarajan B; Godshall D; Scranton A B</td>
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<td>Michigan, State University (RadTech International)</td>
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Photopolymerisable encapsulants for microelectronic devices may offer important advantages over traditional transfer moulding resins, including improved yields and reduced wire sweep. An encapsulation process, based upon a low viscosity resin which cures rapidly upon exposure to UV light, is described. The cure time, coefficient of thermal expansion, thermal degradation temperature, flexural modulus and chemical resistance of photopolymerisable encapsulant formulations based upon epoxy vinyl ester resins are characterised. The results indicate that a photocurable encapsulant loaded with 60 wt.% fused silica is very promising since the material properties are similar to current commercial encapsulants. These formulations cure in less than three minutes for an initiating light intensity of 180 mW/sq.cm and exhibit appropriate values of the thermal expansion coefficient, degradation temperature, flexural modulus, dielectric constant and resistance to water (both acidic and basic). 16 refs.

USA
Accession no.696966

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<td>RadTech '98. Conference proceedings.</td>
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<tr>
<td>Chicago, II., 19th-22nd April 1998, p.651-62. 895</td>
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<td>ESSENTIAL PROCESS REQUIREMENTS FOR UV CURING OF PRESSURE SENSITIVE ADHESIVES</td>
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<td>Maitland J</td>
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<td>ACTSpectral (RadTech International)</td>
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UV curable, pressure-sensitive adhesives offer many advantages in material performance over that of conventional based chemistries. However, to ensure a consistent product with known performance for any given end application, the process variables need to be carefully controlled within acceptable limits. The factors influencing process control in relation to UV curing of the material are explored. Production line variables include application method, coating weight, temperature, substrate type and speed, UV lamp technology, heat management and UV monitoring of energy dose and irradiance levels. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE
Accession no.696958

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<td>RadTech '98. Conference proceedings.</td>
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<td>Chicago, II., 19th-22nd April 1998, p.646-50. 895</td>
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<td>OPTIMISING PIGMENT WETTING WITH OLIGOMER/MONOMER GRIND VEHICLES</td>
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<tr>
<td>McDevitt T</td>
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<td>Ciba Specialty Chemicals Corp. (RadTech International)</td>
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UV ink dispersions of coloured pigments utilising a three-roll mill must incorporate the pigment into the grind
vehicle with sufficient shear to develop its inherent strength, shade, transparency and gloss characteristics. Undispersed pigment particles on plate areas resemble ink piling, fill in and mottling which can result in spotted or speckled appearance of prints. The pigment type and resin selection in the formulas can affect the viscosity and wetting properties of the pre-grind concentrate. The ideal dispersion vehicle wets the surface of the pigment displacing air and adsorbed water with prepolymer resins and allows the achievement of sub-micron dispersion without excessive heat build-up or lengthy milling. The grind vehicles’ inability to wet the surface of the pigment will ultimately cause incomplete dispersion. 2 refs.

USA
Accession no.696957

Item 178
RadTech '98. Conference proceedings.
Chicago, IL, 19th-22nd April 1998, p.621-6. 895
UV/EB INKS - HIGH SPEED PRINTING
Gupta P
Flint Ink Corp. (RadTech International)

Many printers today are demanding UV/EB inks that run at high speeds. However, it is possible to encounter many different problems while printing at these high speeds. Some of the more common of these problems are excessive misting and incomplete curing. Additionally, it is more difficult to maintain proper lithographic quality at higher speeds. Experiments are conducted to overcome the aforementioned problems. Inkmakers are now using more highly structured UV/EB curing vehicles, more efficient fountain solutions, novel photoinitiator packages and special additives. Furthermore, for UV curing, the newer lamp systems are enabling the curing of even the most highly pigmented and darkest colours. The experimental work carried out in partnership with Flint Ink’s suppliers to formulate UV/EB inks to run at high speeds while maintaining very high print quality is described. 4 refs.

USA
Accession no.696954

Item 179
RadTech '98. Conference proceedings.
Chicago, IL, 19th-22nd April 1998, p.610-20. 895
EB-ACTIVATED CATIONIC CURING OF EPOXY-SILICONE RELEASE COATINGS
Kerr S R
Rhodia SA (RadTech International)

Electron beam (EB) processing in the presence of certain onium salts is providing a highly efficient alternative to UV light for curing cationic silicone release coatings. EB curing provides the potential for stable ‘premium’ and ‘differential’ release at faster line speeds and lower costs than UV processing. Excellent cures are achieved with EB doses as little as 1-2 Mrads, irrespective of line speed and, unlike free radical initiating EB systems, nitrogen inerting of the cure chamber is not required. Both EB and UV processing are compared and contrasted according to cure response and release performance. 16 refs.

USA
Accession no.696953
LOW VISCOUS MALEATE/VINYL ETHER RESINS AS REACTIVE DILUENTS IN CONVENTIONAL ACRYLATE BASED WOOD COATING FORMULATIONS FOR UV CURING
Meij E; Dias A A; de Coq L
DSM Resins BV
(RadTech International)

Maleate/vinyl ether (MA/VE) resins are tested as diluents for acrylate oligomers. Three acrylate oligomers based on different chemistries are diluted to a given viscosity with analogous MA/VE and acrylate-based reactive diluent. Application tests for wood coating are performed and show only small technical differences for using acrylate or MA/VE diluents. RT-FTIR measurements show comparable ultimate conversions for both types of diluents. Conversion per second is slower in the case where MA/VE resins are used as diluent, however, not adversely affecting the applicability for wood coating. It may be concluded that MA/VE can be considered a technically equal substitute for acrylate diluents, making their considerably lower irritancy a significant advantage.

10 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE
Accession no.696949

CATIONIC UV CURABLE INKS FOR RIGID PACKAGING
Braddock J K; Carter J W; Lamb K T
Union Carbide Chemicals & Plastics Co.Inc.
(RadTech International)

Cationic UV curable coatings and inks are uniquely suited to the rigid packaging market, possessing superior adhesion and processing capabilities and low VOC. These characteristics suggest that the availability of cationic UV curable chemistry in high viscosity (paste) inks for metal decorating would be desirable. Also, compatibility problems between non-cationic inks containing basic materials and cationic UV varnishes would be eliminated with the development of cationic inks for metal. The effects of rheological additives, dispersant type and formulating variables on high viscosity ink performance are evaluated. The rheological properties, with yield value and viscosity under varying shear rate, are evaluated. Other performance responses tested include tack and misting. The results of this testing are reported. 4 refs.
USA
Accession no.696944

MODIFICATION OF PHOTOCURED EPOXY SILICONES WITH CARBINOL-FUNCTIONAL POLYDIMETHYLSILOXANES
Eckberg R P; Krenceski M
GE Silicones
(RadTech International)

Linear dimethylsilicones end-capped with carbinol-functional trialkylsiloxanes are useful additives which react into epoxy-functional siloxane and silicone, organic and silicone/organic matrices on exposure to UV light in the presence of compatible photocatalysts. Coatings thus modified provide altered modulus, reduced coefficient of friction and easier release of PSAs than analogous unmodified photocured coatings. 26 refs.
USA
Accession no.696943

UV CURABLE EPOXIDISED OILS WITH VINYL ETHERS AS REACTIVE DILUENTS
Mathur A M; Narayanan V; Scranton A B
International Specialty Products; Michigan,State University
(RadTech International)

Epoxidised oils are low-cost ingredients for epoxy-based cationic formulations; however, most epoxidised oils are associated with slow cationic cure. Vinyl ethers undergo rapid cationic polymerisation and may be added to increase the cure speed. The polymerisation kinetics of epoxidised soybean oil (ESO) with cyclohexane-dimethanol divinylether (CHVE) as a reactive diluent are studied using photo differential scanning calorimetry. First, the polymerisation kinetics of ESO is investigated as a function of temperature. The final conversion of ESO is found to increase with temperature and the reaction rate is observed to be proportional to temperature. In the presence of CHVE the reaction rate for the ESO-CHVE systems is observed to increase dramatically with an increase in CHVE concentration. Preliminary FTIR studies for evaluating vinyl bond conversion reveal that the CHVE is completely consumed in all formulations investigated. The ultimate ESO conversion is found to decrease only marginally with an increase in CHVE concentration. Coatings formed by various ESO-CHVE formulations are evaluated for cure speed and hardness. 8 refs.
USA
Accession no.696941
UV GRAFTING OF ACRYLIC HARD COATS ON THERMALLY CURED AUTOMOTIVE BASE COATS
Blizzard J D; Popa P J; Schulte J C; Tonge J C
Dow Corning Corp.
(RadTech International)

On today's cars, the clear topcoat is designed to protect the anti-corrosion and colour coat from chemical and mechanical abuse. As vehicle manufacturers extend warranties, the demands on this topcoat are increasing. Attempts at grafting UV curing acrylic hard coats on typical automotive melamine base coats are reported. Application-based testing such as scrub, mar, chemical resistance and weathering are compared and contrasted with static and dynamic indentation measurements. 9 refs.

WEATHERFAST UV CURABLE CLEAR COATS
Valet A; Wostratzky D
Ciba Specialty Chemicals Inc.
(RadTech International)

In addition to other technologies, i.e. high solids, waterborne and powder coatings, UV curable coatings are certain to play an important role in the coating industry's future, especially as a means of overcoming solvent emission limitations and energy savings. In principle, UV curable coatings can be used in all applications, as long as the performance requirements are fulfilled. One of the most important requirements for a broad use of UV curable coatings in the coating industry is that coatings are stable against degradation caused by atmospheric influences. This weathering leads to a degradation of the polymeric binder. Today's state-of-the-art in oxidatively drying and thermoset coatings is the use of light stabilisers (UV absorber and/or HALS) in order to protect polymers against damage caused by the above influences. With novel photoinitiators based on bisacylphosphinoxides, it is possible to cure UV curable clearcoats containing a combined UV absorber/HALS light stabiliser package. These clearcoats show both a very good curing behaviour and an improved weatherability over a long period of time. 31 refs.

SWITZERLAND; USA; WESTERN EUROPE

THE USE OF ACRYLATE POLYMESTERS IN THE FORMULATION OF RADIATION CURABLE ADHESIVES
Kauffman T; Chappell J; Acevedo M
Fuller H.B.,Co.
(RadTech International)

The physical properties and performance characteristics of SolarCure acrylated polyesters are ideal for use as warm melt pressure-sensitive adhesives (PSAs). By applying the underlying principles of PSA design and the use of designed experiments and neural networks, the development of room temperature applied PSAs based on the acrylated polyesters can also be achieved. 12 refs.

USA

WATER-BASED RADIATION CURABLE SYSTEMS - NEWEST INVESTIGATIONS
Reich W; Enenkel P; Keil E; Lokai M; Menzel K; Schrof W
BASF AG
(RadTech International)

The use of aqueous binder emulsions for radiation curing coatings has increased within the last 20 years. A
technology that began with aqueous emulsions based on unsaturated polyesters, polyester or epoxy acrylates, has advanced into the 1990s with new, physically drying, radiation curable PU dispersion systems. Compared with radiation curing 100% systems, the water-based products enable a wide variety of application techniques to be employed. Even those requiring low viscosity, such as spraying, are possible without the use of monomers or organic solvents. Several investigations into migratable compounds are carried out in different aqueous systems, examining distribution of matting agents in the cured film. The results and other technical advantages of aqueous systems are presented. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.696917

Item 190
RadTech '98. Conference proceedings.
Chicago, II., 19th-22nd April 1998, p.235-40. 895

APPROACHES TO RADIATION CURABLE, TACK-FREE BEFORE CURE, SPRAYABLE WOOD COATINGS
Arcenaux J A; Bleus J-P; Corley A; Lindekens L; Moorehead T; Wang Z J
UCB Chemicals Corp. (RadTech International)

Tack free before cure, radiation curable wood coatings are of interest for two reasons: to eliminate waste from dust contamination of uncured, coated wood, and to allow the repair of coating imperfections before cure (sandable before cure). A diluent must be used in these systems in order to achieve sprayable viscosities. This diluent must be non-reactive and removable from the system in order to achieve a tack-free state before cure. This implies either aqueous or solvent-borne radiation curable wood coatings. Both types of diluents are evaluated, and the resultant properties of the wood coatings described. 6 refs.

USA
Accession no.696914

Item 191
RadTech '98. Conference proceedings.
Chicago, II., 19th-22nd April 1998, p.170-6. 895

UV POWDERS: ELDORADO OR INDUSTRIAL CURIOSITY?
Maetens D
UCB Chemicals Corp. (RadTech International)

Lower temperature curing is clearly advantageous for powder coaters as it means improved energy economics. Today’s powder coating technology allows for curing at temperatures as low as 120 deg.C, a reduction of approximately 50 deg.C compared with earlier methods. Coaters believe that processing economics will be further improved and that new markets will develop if curing temperatures are below 100 deg.C. This could, perhaps, arise through the replacement of solvent coatings, particularly for coating heat-sensitive materials, such as wood and plastics, which emit volatiles, or deform at current powder coating oven temperatures. Conventional powder technologies are unlikely to allow the production of powders that are heat curable at, or below, 100 deg.C because such inherently reactive powders would be unstable on storage. The dilemma can be solved by separating the two current thermo-energy functions. Melting can be carried out at around 100 deg.C. During the second stage, the curing can be achieved by UV or EB radiation. 11 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE
Accession no.696907

Item 192
RadTech '98. Conference proceedings.
Chicago, II., 19th-22nd April 1998, p.106-11. 895

CHARACTERISTICS AND PERFORMANCE OF RADIATION CURABLE POWDER COATINGS
Udding-Louwrier S; de Jon E S; Baijards R A
DSM Resins BV (RadTech International)

The reduction of volatile organic compounds is an important topic in the coating industry. As a result, new environmentally friendly coating systems have been developed, including new powder coatings. Application of traditional powder coatings is virtually limited to metal
substrates, because of the relatively high curing temperature. With the aim to extend the use of powder coatings to heat sensitive substrates like MDF, wood, paper, and plastics, DSM Resins is currently developing a new binder system for radiation curable powder coatings. The new binder system consists of an unsaturated polyester and a vinyl ether PU crosslinker. The curing process of this powder coating comprises two steps. Heating of the powder particles with infrared radiation leads to the formation of a smooth film, and subsequent exposure to UV radiation allows for the crosslinking reaction. This radiation curing technology will facilitate the finishing of heat sensitive substrates with powder coatings. 16 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.696897

Item 194
FLUOROALKYL VINYL EThERS AS MODIFIERS IN UV COATING SYSTEMS
Sitzmann E V; Nalewajek D; Bradley D E; Proszowski M J; Cruz J G; Anderson R F
AlliedSignal Inc. (RadTech International)
A new class of fluoroalkyl vinyl ethers (VEs) is introduced. These novel materials exhibit low viscosity, low volatility and high stability. The low refractive index fluoroalkyl VEs show good miscibility with photocurable resins and are effective wetting agents that do not foam. Examples are provided showing that these materials are non-fugitive in acrylate coatings as well as in vinyl ether coatings. The reactive fluoroalkyl VEs provide a very low surface free energy for the cured coating surface, which is necessary to obtain high release and high anti-blocking properties. 8 refs.
USA
Accession no.696894

Item 195
UV CURABLE ADHESIVES BASED ON VINYL EThERS
Dougherty J A; McKittrick J; Russell G S
International Specialty Products (RadTech International)
Vinyl ether-based polymers, prepared by conventional means, have been used as adhesives for many years. The introduction of new vinyl ether monomers, resins and photoinitiators allows this technology to be readily extended to UV curable systems. Vinyl ether-based formulations cure rapidly and provide excellent adhesive properties. Performance can be optimised by careful selection of monomers and resins. 10 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA; WESTERN EUROPE
Accession no.696893

Item 196
Journal of Coatings Technology
70, No.884, Sept. 1998, p.57-62
ON THE SYNTHESIS AND CHARACTERISATION OF NEW LOW TEMPERATURE CURING POWDER COATINGS CURED WITH RADIATION
Johansson M; Falken H; Irestedt A; Hult A
Royal Institute of Technology
The synthesis and characterisation of a new type of low temperature curing powder coating is described. The type of materials used were mixtures of an amorphous methacrylate-functional prepolymer and crystalline acrylate and methacrylate monomers. The introduction of a crystalline component in an amorphous resin mixture was shown to markedly reduce the melt viscosity and thus enhance the flow properties of the powder coating. Curing experiments showed the advantage of using photoinitiation compared to thermal initiation. The reaction was much faster and the problem with oxygen inhibition was avoided. 4 refs.
SCANDINAVIA; SWEDEN; WESTERN EUROPE
Accession no.696464

Item 197
Adhesive Technology
15, No.3, Sept.1998, p.22/4
UV-CURABLE PRESSURE SENSITIVE ADHESIVES
Skinner D
Fusion UV Systems Ltd.
This article examines the development, current uses and future potential of UV-curable pressure sensitive adhesives. At least one company has developed a waterborne UV-curable PSA. UV-curable hot melts are now widely used for applications such as laser printer or copying labels, and removable and repositionable labels. Radiation curable, 100% solids PSA systems are the latest developments in the field. 3 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE
Accession no.695107
Item 198

SAMPE Journal
34, No.2, March/April 1998, p.29-34

LAYER BY LAYER E-BEAM CURING OF FILAMENT WOUND COMPOSITE MATERIALS WITH LOW ENERGY ELECTRON BEAM ACCELERATORS
Guasti F; Matticari G; Rosi E
Laben Proel Tecnologie Div.

A new method for the electron beam curing of filament wound composites is described. The method uses a low energy electron beam to achieve the curing of the product during the phase of deposition, around the mandrel of the resin impregnated fibres. In this way the composite is polymerised and grown layer-after-layer until the desired thickness is achieved. The patented process, developed by Laben Proel Tecnologie Division is called ‘layer by layer E-beam curing.’ New proprietary resin formulations suitable for the cationic polymerisation mechanism have been prepared and characterised. Both the technical aspects relevant to the layer by layer polymerisation process with proprietary formulations, and the cost effectiveness advantages intrinsically associated with the new process, are addressed and discussed in detail. 23 refs.

SWITZERLAND; USA; WESTERN EUROPE
Accession no.693156

Item 199

Patent Number: US 5712324 A 19980127

UV CURABLE WEATHER RESISTANT COATINGS MADE BY A COLD-CAST PROCESS
Lilly K L
General Electric Co.

A radiation curable, organic coating for improving the weatherability of a thermoplastic resin substrate employs, as a polymerisable crosslinking monomer component, 2-hydroxy-5-acryloyloxyphenyl-2H-benzotriazole.

USA
Accession no.693645

Item 200

SAMPE Journal
34, No.4, July/Aug. 1998, p.40-4

PHOTOCURING OF GLASS-REINFORCED POLYESTER COMPOSITES
Koehler T J M; Wostratzky D
Ciba Specialty Chemicals

The limitations of conventional free radical curing methods initiated by free radicals generated from peroxides for unsaturated polyester/styrene resins are examined, and it is proposed that these can be overcome by the use of photocuring techniques, involving the generation of radicals by light from a photoinitiator. In a series of tests carried out by Ciba Specialty Chemicals, it was demonstrated that photocuring with a bisacylphosphine oxide initiator is an effective method for manufacturing glass fibre-reinforced composite laminates. The tests concluded that photocuring was faster than thermal curing methods and that the mechanical performance is sufficient for a broad range of applications, whilst also providing specific processing advantages. 11 refs.

SWITZERLAND; USA; WESTERN EUROPE
Accession no.694995

Item 201

Adhesives Age
41, No.7, July 1998, p.29-33

UV CURABLE PSA AS AUGMENT EXISTING ADHESIVE TECHNOLOGIES
Kauffman A; Chappell J; Acevedo M; Mitry M
UV/EB Curable Technology; Fuller H.B.,Co.

Solvent-based, water-based and hot-melt adhesives have a long history of success for pressure-sensitive adhesive (PSA) tape and label applications. These technologies are seemingly well entrenched with adequate performance and low cost. Several market trends, however, are opening up new opportunities for UV curable PSAs. In contrast to solvent-based adhesives, UV curable PSAs contain no fugitive solvent and are therefore VOC compliant. In contrast to hot melts, UV curable adhesives offer a crosslinked network upon cure and therefore are capable of higher heat resistance and plasticiser resistance. Finally, in contrast to water-based technologies, UV curable PSAs offer immediate cure and can be formulated to exhibit much better blistering resistance upon exposure to water. The lack of a need for drying capability is also a significant advantage of UV curable adhesives over water-based technology. 13 refs.

USA
Accession no.690129

Item 202

Atlanta, Ga., 26th-30th April 1998, p.1173-7. 012

DIELECTRIC CURE MONITORING OF UV CURING GLOBE TOP MATERIALS FOR CHIP-ON-BOARD TECHNOLOGY
Stampfer S; Ehrenstein G W
Erlangen-Nurnberg,University (SPE)

In chip-on-board technology, mostly silica-filled epoxy resins are used for encapsulation (globe top) of the bare microchip. By means of photoinitiators, UV curing of the globe top materials is possible. For some applications a
thermal postcure is necessary. For the investigations described, dielectric meter sensors are designed, which allow the real-time measurement of the advancing UV curing of globe top materials. The method can be used for controlling different process and material parameters such as UV intensity, and photoinitiator and silica content. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Item 203

Paint & Ink International
11, No.3, May/June 1998, p.8/10

POINTS OF INTEREST RAISED AT RADTECH '98 CONFERENCE
Davidson S

The papers presented at the recent RadTech 98 conference in Chicago are outlined. Radiation curing is forecast to expand its volume of business, and new market opportunities are opening up. Current users see a growth in the area of sprayable coatings and in flexographic printing. Sprayable water- and solvent-based formulations were described, and there is a clear need for a 100% solids system. Current users have also identified the equipment needs which include lamp systems with a variable power output and system which allow the performance of lamps and the cure of the coating to be monitored in real time. Electronic control of lamp power, which can be used to maintain irradiation conditions, is available. Monitoring the overall power output of the lamps is relatively commonplace, but systems are now available to monitor the spectral output and the intensity of each line.

USA

Accession no.6888170

Item 204

Macromolecules
31, No.13, 30th June 1998, p.4379-81

PHOTOLITHOGRAPHIC SYNTHESIS OF HYDROGELS
Chen G; Imanishi Y; Ito Y
NAIST; Japan Science & Technology Corp.

The photoreactive material azidophenyl-derivatised poly(N-isopropylacrylamide-co-acrylic acid) was prepared from the thermoresponsive copolymer poly(N-isopropylacrylamide-co-acrylic acid). The derivatised copolymer could be crosslinked by UV light to give thermoresponsive microgels. By selective crosslinking and washing away uncrosslinked material, it was possible to produce microgel strings and nets. Microgel strings swelled within 6s when the temperature was lowered to 10°C and contracted within 1s when the temperature was raised to 37°C. 28 refs.

JAPAN

Accession no.686982

Item 205

Macromolecules
31, No.13, 30th June 1998, p.4213-7

WATER-SOLUBLE POROUS NANOSPHERES
Henselwood F; Liu G
Calgary, University

Poly(2-cinnamoylethyl methacrylate)-random-(2-octanoylethyl methacrylate)-block-poly(acrylic acid) forms micelles in water with poly(2-cinnamoylethyl methacrylate)-random-(2-octanoylethyl methacrylate) as the core and polyacrylic acid as the shell. Poly(2-octanoylethyl methacrylate) is incorporated into the micelle cores. After UV crosslinking of the poly(cinnamoylethyl methacrylate), poly(2-octanoylethyl methacrylate) is extracted to produce water-soluble poly((2-cinnamoylethyl methacrylate)-random-(2-octanoylethyl methacrylate))-block-poly(acrylic acid) nanospheres. The porous nanospheres sorb significantly higher amounts of perylene from water/acetone/DMSO mixtures than the nonporous poly((2-cinnamoylethyl methacrylate)-random-(2-octanoylethyl methacrylate))-block-poly(acrylic acid) nanospheres. Relevance to controlled release materials with high drug loadings is suggested. 26 refs.

CANADA

Accession no.686960

Item 206

Patent Number: US 5709955 A 19980120

ADHESIVE COMPOSITION CURABLE UPON EXPOSURE TO RADIATION AND APPLICATIONS THEREFOR
Nohr R S; MacDonald J G
Kimberly-Clark Corp.

The adhesive composition comprises an admixture of unsaturated polymerisable material and a photoreactor, which comprises a wavelength-specific sensitizer, which has a molar extinction coefficient greater than about 5,000 litres per mole per cm at an absorption maximum, covalently bonded to a reactive species-generating photoinitiator. The photoreactors examples of which are given, have a quantum yield of greater than about 0.5 at an absorption maximum. Laminates, which include at least one layer of a cellulose or polyolefin non-woven web or film, are bonded therewith and cured by irradiation.

USA

Accession no.684758

Item 207

Journal of Polymer Science : Polymer Chemistry Edition
36, No.10, 30th July 1998, p.1521-6

OPTICAL ANISOTROPY OF A PHOTOREACTED SIDE-CHAIN LIQUID
CRYSTALLINE POLYMER INDUCED BY LINEARLY POLARISED LIGHT
Kawatsuki N; Takatsuka H; Yamamoto T; Sangen O Himeji, Institute of Technology

Linearly polarised photoreaction of a photocrosslinkable side chain liquid crystalline polymer (polymethacrylate) containing photoreactive cinnamoyl and biphenyl mesogenic groups was studied. The optical anisotropy of the polymer film was induced by the linearly polarised UV photoreaction and was investigated by temperature-controlled polarised UV absorption spectroscopy and polarised FTIR measurements. The reorientation of the nonreacted mesogenic groups along the electric vector direction of the incident linearly polarised UV light during the photoreaction occurred at the liquid crystalline temperature range of the polymer, and the induced birefringence was about 0.02. Because of the high density photocrosslinking, the linearly polarised UV photoreacted film showed orientational stability up to 160°C. 23 refs.

JAPAN
Accession no.684720

Item 208
Journal of Polymer Science : Polymer Chemistry Edition
36, No.10, 30th July 1998, p.1495-500

P-NITROPHENOL PERMEABILITY AND TEMPERATURE CHARACTERISTICS OF AN ACRYLOYL-L-PROLINE METHYL ESTER-BASED POROUS GEL MEMBRANE
Hiroki A; Yoshida M; Yamashita J; Asano M; Reber N; Spohr R; Kumakura M; Katakai R Gunma, University; Japan, Atomic Energy Research Institute; Teikyo, University of Science & Technology; Gesellschaft fuer Schwerionenforschung

Thermoresponsive porous gel membranes were synthesised by a simultaneously occurring process consisting of gamma-radiation-induced polymerisation and crosslinking in aqueous solutions at various concentrations of acryloyl-L-proline methyl ester without a crosslinker. Permeation of p-nitrophenol through a thermoresponsive porous gel membrane obtained at a monomer concentration of 80% (w/w) drastically reduced around 14°C, the lower critical solution temperature of linear poly(acryloyl-L-proline methyl ester) in water, from 0.0006 cm/min at 10°C to no permeation at 18°C, accompanied by changes in both size and shape of pores associated with gel shrinkage. Adjusting the size and shape of gel membrane pores, as well as manipulating gel porosity, which is greatly influenced by temperature, will lead to the development of selective biomolecule separation. Potential for selective biomolecule separation is suggested. 24 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; JAPAN; WESTERN EUROPE
Accession no.684063

Item 210
Pitture e Vernici
74, No.9, May 1998, p.37-44
Italian; English

NEW RADIATION CURABLE SOLVENTLESS PRESSURE-SENSITIVE ADHESIVES
Schreiber M; Braun H Novamelt Research GmbH

Novamelt’s range of UV curable hot melt pressure-sensitive adhesives is discussed. The limitations of conventional hot melt pressure sensitive adhesives are examined, and the concept of UV curable pressure sensitive hot melts is discussed and their ability to overcome such limitations. The paper concentrates on SBS radiation curable block copolymers and acrylic prepolymers, and factors are summarised which influence the curing rate and consequently the adhesive performance are described.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.682524
Item 211

**Pitture e Vernici**

74, No.9, May 1998, p.21-7

Italian; English

**FORMULATION AND TESTING OF RADIATION-CURING BINDERS FOR ABRASION-RESISTANT PARQUET VARNISHES**

Bankowsky H H; Enenkel P; Beck E; Keil E; Lokai M

BASF AG

Radiation cured wood coatings for use on parquet flooring are tested for abrasion resistance. The abrasion properties of the cured film can be controlled by the choice and combination of binder, reactive thinner and initiator, as well as fillers and additives. In this study three UV curable binders were compared with each formulation containing 4% of HMPP as the initiator. The binders were epoxy acrylate, polyester acrylate, and amine-modified polyether acrylate.

**Accession no.677497**

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Item 212

**Journal of Polymer Science : Polymer Chemistry**


**NEW WATER-SOLUBLE PHOTOCROSSLINKABLE POLYMERS BASED ON MODIFIED POLYVINYL ALCOHOL**

Muehlebach A; Mueller B; Pharisa C; Hofmann M; Seiferling B; Guerry D

Ciba Specialty Chemicals Inc.; Novartis; Ciba Vision GmbH

PVAl was partially modified by polymer analogous reaction with acrylic and methacrylic acid and with 2-vinyl-4,4-dimethyl-azlactone to give water-soluble polymers with pendant (meth)acrylate and acrylamide groups. Aqueous solutions of these polymers were crosslinked by UV irradiation within seconds to give transparent networks which were potentially of use for manufacture of contact lenses. The water contents and mechanical properties of the hydrogels were investigated. The formation kinetics and stability of aggregates, investigated by combined GPC/light scattering measurements of samples annealed and/or stored at different temps., provided insight into PVAl secondary structures. 12 refs.

**Accession no.677422**

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Item 213


**PRINTING WITH UV FLEXO INKS**

Pigden T

Sun Chemical Corp. (TAPPI)

The cure chemistry of UV curable flexographic printing inks based on acrylate modified polymers and epoxy resins is examined. The characteristics of these inks are compared with those of solvent- and water-based systems, and the effects of exposure time on properties and methods used to test curing are discussed.

**Accession no.676439**

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Item 215

**Macromolecular Symposia**

No.128, March 1998, p.165-82

**INTELLIGENT NETWORKS BASED ON POLYOXYETHYLENE**

Tsvetanov C B; Stamenova R; Dotcheva D; Dotytcheva M; Belcheva N; Smid J

Bulgarian Academy of Sciences; New York,State University

Films of polyoxyethylene and polyoxyethylene blends were efficiently crosslinked by exposure to UV radiation with high-pressure mercury lamp. Photochemical crosslinking proceeded in the presence of photoinitiator such as benzophenone or pentaerythritol triacrylate. Polyoxyethylene networks obtained by UV irradiation in the presence of potassium salts (thiocyanate, perchlorate and triflate) as templates showed enhanced binding ability for lithium and sodium cations. Cationic networks were prepared from crosslinked polyoxyethylene modified with ethyl methacrylate dimethyl dodecyl ammonium bromide. Stimuli-sensitive hydrogels (pH and temperature) were prepared from combinations of polyoxyethylene and poly-N-isopropyl acrylamide, polyvinyl methyl ether, polyvinyl acetate and poly-2-vinyl pyridine subjected to UV irradiation. 25 refs.

**Accession no.676439**
**Item 216**  
*Coatings World*  
3, No.2, March 1998, p.26/30  
**UV-CURABLE LOW TEMPERATURE POWDER COATINGS**  
Blatter K; MacFadden B; Strid M; Niggemann F  
Herberts Powder Coatings  

Powder coatings are the environmentally friendly, cost-effective alternative to liquid paint because of the very low emission and high application efficiency. Wherever possible, industries switch from solvent-borne liquid paint to powder. Although the development efforts of powder coatings producers, raw material suppliers and powder coatings application equipment manufacturers have improved the quality of powder coatings to very high standards, there are still significant limitations due to the high temperatures of 160-200 deg.C that are typically required to cure the standard thermosetting powder coatings. Even at these high temperatures, curing times of 10-30 minutes are quite common. There is a variety of substrates like engineering plastics, wood composites, natural wood or preassembled metal objects that contain seals, plastic parts, etc, that can not be coated with today’s powders because these substrates cannot withstand such high temperatures. Relatively long curing times at high temperatures also add significant cost to the powder process. This is especially a concern for large heavy metal parts or for areas where high line speed is essential, such as coil coating. The extension of powder coatings application into these areas creates a need for new, innovative powder coatings that can be cured at significantly lower temperatures, preferably below 100 deg.C and with shorter curing times.

USA  

**Accession no.676383**

**Item 217**  
*Macromolecules*  
31, No. 4, 24th Feb. 1998, p.1016-23  
**NEW POLYMER SYNTHESES. 95. PHOTOSETTING CHOLESTERIC POLYESTERS DERIVED FROM 4-HYDROXYCINNAMIC ACID AND ISOSORBIDE**  
Sapich B; Stumpe J; Krawinkel T; Kricheldorf H R  
Berlin,Humboldt University; Hamburg,University  

Two dicarboxylic acids were prepared by alkylation of 4-hydroxycinnamic acid with 1,6-dibromohexane or 1,12-dibromododecane. The dichlorides of these dicarboxylic acids were polycondensed with mixtures of isosorbide and methylhydroquinone. All copolymers then obtained showed nematic schlieren textures. Furthermore, three dicarboxylic acids were synthesised by alkylation of 4-hydroxycinnamic acid with the ditosylates of di-, tri-, and tetraethylene glycol. Numerous copolymers were prepared from the dicarboxylic acids and mixtures of isosorbide with methyl-, tert-butyl-, or phenylhydroquinone. Also 2,7-dihydroxynaphthalene was used as a comonomer. Almost all resulting copolymers were cholesteric, and nearly 50% of them were capable of forming a Grandjean texture. The photochemical behaviour of selected copolymers was studied in solution in spin-coated films and in films with Grandjean texture. Depending on the reaction conditions, photocrosslinking by 2+2 cycloadition competed more or less successfully with the photo-Fries rearrangement and with the photoisomerisation. UV irradiation (at 313 nm) of oriented films in the cholesteric melt caused disappearance of the Grandjean texture. However, irradiation below the Tg caused stabilisation of the Grandjean texture by photocrosslinking. Formula weight (range quarter million to 12 million). Tg (range -32C to +119C), isotropisation temperature and texture data are shown for 24 copolymers. 18 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE  

**Accession no.676066**

**Item 218**  
*Advanced Materials*  
10, No.5, 23rd March 1998, p.411-4  
**PHOTOPOLYMERIZATION BY EVANESCENT WAVES: A NEW METHOD TO OBTAIN NANOPARTS**  
Ecoffet C; Espanet A; Lougnot D J  
CNRS  

Photopolymerisation by evanescent waves(PEW) is described as a stereolithographic method for obtaining nanoparticles, the monomer used as an example being pentaerythritol triacrylate. The properties of evanescent waves are briefly reviewed and the experimental set-up developed for PEW and some typical applications are described. PEW is shown to be suitable for the fabrication of very thin parts, with an in-plane resolution of 1 micrometre and an out-of-plane resolution of 30 nm and is sufficiently versatile to be coupled with imaging, holographic recording, or pixel-by-pixel addressing set-ups. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE  

**Accession no.675983**

**Item 219**  
*Radtech Report*  
12, No.2, March/April 1998, p.51-3  
**AGING PROPERTIES OF UV CURABLE COATINGS CONTAINING VARIOUS ADDITIVES**  
Duecker D; Meyers T  
Borden Chemical Inc.  

In this study coefficient of friction and contact angle of aged and unaged films prepared from UV curable formulations containing various reactive and non-reactive...
silicone additives are compared. The change in coefficient of friction after ageing is small when compared with a control film containing no silicone additive. Furthermore, the surface energies of the films are low and generally unaffected by ageing. No advantages were found for reactive silicone additives. 5 refs.

USA
Accession no.675546

Item 220
Radtech Report
COMBINING VINYL ETHERS WITH EPOXIES FOR ENHANCED PERFORMANCE IN UV CURED COATINGS
Sitzmann E V; Anderson R F; Cruz J G; Proszowski M J; Patel A B; Bratslavsky S A; Bradley D E
AlliedSignal Inc.
The combination of fast-curing and flexible vinyl ethers with hard and low shrinkage epoxies is shown to lead to enhanced adhesion coating performance. Significant improvements are demonstrated in abrasion resistance, overall toughness, and good adhesion to glass or metal is found when using recently commercialised vinyl ether oligomers and monomers with epoxies. In addition, small amounts of epoxies in combination with antioxidants eliminate colour in cationically cured VE polymers. 18 refs.
USA
Accession no.675545

Item 221
Macromolecules
30, No.25, 15th Dec.1997, p.8088-90
PHOTO-OPTICAL CONTROL WITH LARGE REFRACTIVE INDEX CHANGES BY PHOTODIMERIZATION OF POLY(VINYL CINNAMATE) FILM
Murase S; Kinoshita K; Horie K; Morino S
Tokyo,University; Tokyo,Institute of Technology
The refractive indices of poly(vinyl cinnamate) film were measured before and after UV irradiation. Changes in refractive index after photodimerisation of poly(vinyl cinnamate) were as large as 0.037 (TE mode) at 633 nm after 80% photodimerisation. The results suggested the applicability of photodimerisation of poly(vinyl cinnamate) for channel waveguides. 25 refs.
JAPAN
Accession no.672105

Item 222
Revue Generale des Caoutchoucs et Plastiques
No.753, Oct.1996, p.74-6
French
VULCANISATION: ADVANCE OF MICROWAVES
Jacomino J M
Sairem
The principles of microwave vulcanisation and the components of microwave ovens used in the vulcanisation of extruded rubber profiles are described. The use of dielectrometry for assessing the behaviour of formulations in a microwave environment is discussed.
EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE
Accession no.670838

Item 223
Radtech Report
11, No.6, Nov./Dec.1997, p.16-9
UV POWDER COATINGS FOR METAL: OPENING NEW DOORS AND SOLVING OLD PROBLEMS
Mills P
Nutro Corp.
It is explained that two distinct classes of metal coating applications are emerging: one set comprised of parts that could not previously be powder coated, and a second set of applications where, because of newly-discovered benefits, UV powder may replace traditional powder coatings. This article discusses each of these scenarios, with examples of how the new powder coatings can solve paint problems.
USA
Accession no.670710

Item 224
Paint & Ink International
11, No.1, Jan/Feb.1998, p.6-9
UV CURABLE WATERBORNE DISPERSIONS FOR WOOD COATING
Peeters S; Bleus J P; Wang Z J; Arceneaux J A; Hall J
UCB Chemicals Corp.
The characterisation of aqueous dispersions of UV curable resins is described. The physical and rheological properties of these products and the performance of these dispersions in various formulations, especially for wood applications, has been studied. It was found possible to produce coatings having a good cure speed, good surface hardness and good solvent, chemical and water resistance. 5 refs.
BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; USA; WESTERN EUROPE
Accession no.670367
ELECTRON BEAM PROCESSING: IT'S COME A LONG WAY
Maguire E
Energy Sciences Inc.

Advantages of electron beam curing in the converting industry are discussed with reference to developments in the technology, and the costing of the process which is favourably compared with UV, solvent based and water based coatings in food packaging applications.

USA
Accession no.668753

INK COMPOSITIONS AND A METHOD FOR MAKING SAME
Figov M
Scitex Corp.Ltd.

UV curable ink-jet inks for continuous ink-jet printing and drop on demand (DOD) ink-jet printing are provided which are preferably applied to substrates capable of absorbing part of an ink droplet applied thereupon. The ink compositions of the present invention include a mixture of water which serves as a solvent, a water miscible polymerisable material capable of being cured upon the application of UV light, a photoinitiator, and a colourant which may be a dye or a colour pigment. The ink compositions may also include a bridging fluid.

ISRAEL
Accession no.667948

METHOD FOR MAKING LIGHT CURED OPHTHALMIC LENS BLOCKS
Cook M S; James M D; Strope T R
Coburn Optical Industries Inc.

A lens is placed at an input port to the machine by an operator. Data related to the lens is fed to or stored in the machine from either a keyboard or data base. The lens is then collected from the input port for processing and transported, preferably by means of pneumatics, to a block moulding point within the confines of the machine. A special adhesive is applied to the surface of a mould unit and the mould unit is then positioned to receive the lens. Pressure is applied to squeeze the lens against the adhesive and the mould. After moulding the adhesive onto the lens, the lens and mould are transported via a servo slide to a UV station where curing takes place from above the lens. After preliminary curing, the lens and mould unit are taken to a removal station and the lens, together with the adhesive cured to its front surface, is removed from the mould unit, again preferably by means of pneumatics. The separated blocked lens is then transported to a second curing station where it is cured by UV from the underside before being released to the operator. In the final stage of the cycle, a daubing unit is used to apply a release agent to the surface of the mould in preparation for the next cycle.

USA
Accession no.667710

PROCESS FOR PREPARING A UV-CURABLE COATING MATERIAL AND ANTI-ABRASION COATING COMPOSITION
Tamura M; Fukushima H
Mitsubishi Rayon Co.Ltd.

This process involves effecting a hydrolysis reaction of 40-90 pbw of colloidal silica and 60-10 pbw of a hydrolysate of an alkoxy silane compound containing not less than 50% by weight of a compound of given formula, replacing the dispersion medium of the colloidal silica with a nonpolar solvent when the amount of dehydration is in the range 50-90% of theoretical value, and effecting a further condensation reaction while maintaining in the state of 30-90% by weight of solid components in the presence of the nonpolar solvent. A coating composition containing the UV curable coating material can form an anti-abrasion coating film having excellent abrasion resistance, surface smoothness, thermal resistance, chemical resistance, durability, weather resistance and adhesion to the substrate.

JAPAN
Accession no.667328

PHOTOPOLYMERIZATION OF NEMATIC LIQUID CRYSTAL MONOMERS FOR STRUCTURAL APPLICATIONS: MOLECULAR ORDER AND ORIENTATION DYNAMICS
Schultz J W; Chartoff R P
Dayton,University

Dielectric techniques used to measure the molecular order and the reorientation dynamics in oriented diacrylate liquid crystal monomers were described. From these measurements, the calculated change in monomer orientation angle followed an exponential time dependence with two distinct time constants. The faster of the two time regimes was attributed to bulk reorientation and showed an Arrhenius type of temperature dependence. The slower time regime was
considered to result from inhibition caused by impurities and surface interaction with the electrodes. Dynamic mechanical analysis showed that the molecular anisotropy induced by the magnetic field was retained in the crosslinked polymer networks formed by photopolymerisation. 18 refs.

USA
Accession no.665921

Item 230
Patent Number: US 5650260 A 19970722
METHOD AND APPARATUS FOR FABRICATING THREE-DIMENSIONAL OBJECT
Onishi H
Teijin Seiki Co.Ltd.

A three-dimensional object is composed of successive solid layers, each formed by selectively exposing an unexposed layer of a photohardenable composition to actinic radiation. The unexposed layer is formed on a flexible sheet belt, which is brought into close and parallel relationship with a flat support surface of a base plate member facing downwardly, thereby laminating the unexposed layer of the photohardenable composition to the flat surface of the base plate member of the solid layer previously formed. A positioning plate member is positioned in such a manner that the positioning plate member faces the base plate member through the flexible sheet belt and is brought into contact with the flexible sheet belt so that the unexposed layer of the photohardenable composition is supported and positioned by the positioning plate member through the flexible sheet belt. The laminated unexposed layer of the photohardenable composition is selectively exposed to the actinic radiation through the positioning plate member and the flexible sheet belt to form a new solid layer and an unhardened layer of the photohardenable composition. After the positioning plate member is removed from the flexible sheet belt, the flexible sheet belt with the unhardened layer of the photohardenable composition is separated from the newly formed solid layer.

JAPAN
Accession no.663787

Item 231
Molecular Crystals & Liquid Crystals
SYNTHESIS AND PHOTOPOLYMERISATION OF CHOLESTERIC LIQUID CRYSTALLINE VINYL ETHERS
Lub J; Omenat A; Ruiz-Melo A; Artal C
Philips Research Laboratories

The synthesis of three cholesteric divinyl ethers is described. One of them is suitable for forming polymeric networks by isothermal cationic photopolymerisation. Such networks exhibit temperature-stable reflection bands. By mixing with nematic divinyl ethers before polymerisation, the reflection wavelength of such networks can be chosen by the relative amount of both types of divinyl ethers. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE
Accession no.662918

Item 232
Waterborne Coatings and Additives.
Cambridge, Royal Society of Chemistry, 1995, p.81-94. 6A3
DEVELOPMENT AND APPLICATION OF WATERBORNE RADIATION CURABLE COATINGS
Davies W D; Hutchinson I
Akcros Chemicals
Edited by: Karsa D R; Davies W D (Akcros Chemicals UK Ltd.)

Radiation curing systems made a big impact in the late 1970s as a solution to both energy conservation and environmental pollution in the ink and coating industries. Since the original systems were essentially 100% solids, it was not initially perceived advantageous to develop water-based systems. Recently, however, there has been a steady growth in the development and use of these systems. Some of the reasons for this growth are discussed, and some of the more important product types and methods of manufacture are reviewed. Particular attention is paid to PU-based systems. Some of the key application areas for this class of products are considered along with details of formulation and performance testing. 13 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE
Accession no.662601

Item 233
Composites Part A: Applied Science and Manufacturing
28A, No.11, 1997, p.965-9
LOW ENERGY ELECTRON BEAM CURING FOR THICK COMPOSITE PRODUCTION
Guasti F; Rosi E
Laben Proel

The need for high quality composite materials has led aerospace and defence companies to develop new curing processes using electron beam (EB) or X-rays. For industrial purposes, the maximum electron energy which can be used without inducing radioactive phenomena is 10 MeV; with such an energy it is possible to cure composite materials (density 1.6 x 10 3 kg/m 3) with
maximum thickness of 25-30 mm and curing times 1-2 orders of magnitude less than for autoclave processes. With X-rays, the maximum curable composite thickness is about 200 mm, but curing times become comparable to those of autoclave processes. These technologies, developed for specific aerospace composite items, require high investment costs for the electron accelerator and for the radiation shielding containing the whole process area. For the production of large composite items, investments strongly affect the cost of the product (i.e. a 10 MeV, 10 kW electron accelerator requires a concrete shield with a thickness of about 2-3 m). An alternative is to cure a composite item during the winding phase with a low energy electron accelerator (less than 500 keV). Proel Tecnologie (a division of Laben of the Finmeccanica Group) has developed a cost-effective process suitable for a wide range of applications. The process is described with its main advantages; some characteristics of composites obtained by such a process are presented. 16 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.662352

Item 234

Pigment & Resin Technology
26, No.5, 1997, p.312

CIBA SPECIALTY CHEMICALS - LEADING WAY IN UV CURING TECHNOLOGY

Capitalising on its considerable expertise and experience in the production of UV-curing adhesives, Ciba Specialty Chemicals has developed new formulations which are being used at the very cutting edge of the replication industry. Working closely with the Swedish company Toolex Alpha, which manufactures optical disc replication systems, Ciba is providing a bonding solution for the production of digital versatile discs (DVDs). A DVD is similar in appearance to a compact disc but, depending on the format, has between seven and 11 times the memory capacity (4.7-8.5 gigabytes on a DVD compared to a CD’s 0.7 gigabytes). Currently, the technology is predominantly being applied to the film industry and, in the USA and Japan, movies on DVD are already commercially available. The huge memory capacity allows the viewer to select soundtracks or subtitles in various languages or to view a certain scene from a choice of camera angles. Owing to its configuration and construction, the basic DVD-5 format requires a stiffening layer to make it more robust. A second polycarbonate layer is bonded to the aluminium-coated polycarbonate layer on which the information is moulded. Details are given.

CIBA SPECIALTY CHEMICALS (UK) LTD.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.662282

Item 235

152nd ACS Rubber Division Meeting, Fall 1997. Conference Preprints.

POLYDIMETHYLSILOXANE ELASTOMERS FROM AQUEOUS EMULSIONS. III. EFFECTS OF BLENDED SILICA FILLERS AND GAMMA-RADIATION INDUCED CROSSLINKING

McCarthy D W; Mark J E
Cincinnati,University
(ACS,Rubber Div.)

Polydimethylsiloxane (PDMS) elastomers prepared from aqueous emulsions in combination with alkoxysilane crosslinking agents were modified by the incorporation of separately prepared colloidal silica and by introduction of additional crosslinks by gamma-irradiation. Samples were characterised for soluble fractions, equilibrium swelling and mechanical properties. The morphologies of the reinforced PDMS depended greatly on how the silica phases were introduced. Blending colloidal silica into PDMS prior to film formation yielded an unusual morphology in which the continuous phase was silica and the dispersed phase was PDMS. This was opposite to the usual case in which silica is generated in-situ within the continuous elastomer phase. These differences were used to explain the different shapes of the stress-strain isotherms of samples in simple elongation. Radiation crosslinking was an effective technique for optimising properties. 19 refs.

USA

Accession no.659570

Item 236

IRC ’97. Conference proceedings.

PRODUCTION OF SOLUBLE PROTEIN FREE LATEX BY RADIATION PROCESS

Varghese S; Kastsumura Y; Yoshii F; Makuuchi K
Tokyo,University; Takasaki Radiation Chemistry Res.Establishment
(Rubber Research Institute of Malaysia)

Generally, for radiation vulcanisation, centrifuged latex is first irradiated and the prevulcanised latex thus obtained is used for making products. During irradiation, the latex proteins undergo disintegration which leaves highly soluble proteins in latex products. These latex proteins are said to cause widespread life threatening latex associated allergies. In order to follow up the radiation effects of NR proteins during irradiation, field latex is irradiated with gamma rays and the protein concentration in the rubber phase and serum phase are analysed. It is found that the water solubility of proteins in the latex increases with increasing dose. Based on the results, a
new process for the preparation of protein-free latex is developed. In the new process the radiation-prevulcanised centrifuged latex is subjected to dilution and then centrifuged. In the case of field latex, it is irradiated first and then centrifuged after dilution. The new process can result in prevulcanised latex almost free from insoluble proteins. Tensile strength of samples produced from the process is comparable with that of the conventional radiation process.

10 refs.

JAPAN

Accession no.658875

Item 237
IRC '97. Conference proceedings.
IRRADIATION EFFECT ON PHYSICOMECHANICAL PROPERTIES OF SURGICAL GLOVES VULCANISED BY RADIATION OR SULPHUR HEATING METHOD IN RADIATION STERILISATION
Binh D; Canh T T; Ngoc B D
Hochiminh City, Center for Nuclear Technologies; Hungarian-Vietnamese Joint Venture
(Rubber Research Institute of Malaysia)

The gamma irradiation of packed and sealed surgical gloves vulcanised by radiation or sulphur-heat is studied at multiple sterilisation doses of 0, 25, 50, 100 kGy. Changes of tensile strength (Tb), elongation at break (Eb), swelling ratio in benzene (SR) and visual colour observation are determined before and after sterilisation. It is shown that the radiation stability of sulphur-heat vulcanised surgical gloves (SHSG) is higher than that of radiation vulcanised surgical gloves (RVSG). The reduction in physicomechanical properties of RVSG could be due to oxidative degradation of the rubber molecular chain. The changeable effect of Tb, SR of the surgical gloves on storage time of 0, 6, 12, 18, 24 months is observed. There is no considerable influence on Tb of both surgical gloves at a regulated dose of 25 kGy. At a sterilisable dose of 100 kGy, the properties of radiation vulcanised surgical gloves appear to be subjected to remarkable changes. 3 refs.

VIETNAM

Accession no.658874

Item 238
IRC '97. Conference proceedings.
RADIATION VULCANISATED NATURAL RUBBER LATEX (RVNRL): PILOT SCALE PREPARATION, COST AND APPLICATION
Wan Manson W Zin
Malaysian Institute for Nuclear Technology Research
(Rubber Research Institute of Malaysia)

A pilot plant latex irradiator was commissioned in March 1996, designed for continuous irradiation of NR latex. The radiation vulcanisation dose received by the latex is adjusted by setting the latex flow rate, which is then automatically controlled by the computer system. It is the first of its kind in the world. The plant is designed to irradiate up to 6,000 m3 of latex per annum. The cost to prepare 1kg of RVNRL can be as low as RM 0.26. RVNRL has the required properties of prevulcanised NR latex. It can be processed into dipped products according to the standard techniques already available. Industrial scale production of gloves, balloons and baby teats using RVNRL have been successfully carried out and products of excellent quality are produced. 13 refs.

MALAYSIA

Accession no.658873

Item 239
Polymers Paint Colour Journal
187, No.4396, Sept.1997, p.18/20
RADIATION CURABLE POWDER COATINGS
Udding-Louwrier S; Witte F M; de Jong E S
DSM Resins NV

DSM Resins has developed a novel binder system for radiation curable powder coatings. The UV-curable powder coating allows finishing of temperature sensitive substrates, such as wood, MDF, plastics and paper. The binder system comprises of an unsaturated polyester and a vinyl ether polyurethane. The combination of environmentally friendly radiation curing and powder coating technologies accounts for a coating system which can be cured at lower temperatures than traditional powder coatings for metal substrates. In the radiation curable powder coating technology, the melt-flow and final cure are independent processes. With the aid of IR radiation, film formation can be achieved without exposing the substrate to high temperatures. Curing of the film with UV radiation results in high cure-rates and produces coatings with good properties. In addition, the radiation curable powder coating technology ensures maximum material utilisation and produces virtually no emissions during curing. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.657814

Item 240
Journal of Biomedical Materials Research
38, No.3, Fall 1997, p.191-6
UV CURABLE BIOADHESIVES: COPOLYMERS OF N-VINYL PYRROLIDONE
Kao F-J; Manivannan G; Sawan S P
Lowell, Massachusetts University

A series of UV curable bioadhesives is prepared from copolymers of N-vinyl pyrrolidone with four different comonomers: 2-acrylamido methyl 1-propane sulphonic acid, vinyl succinimide, glycicyld acrylate and 2-isocyanatoethyl methacrylate. The developed bioadhesives
demonstrate a fast UV-induced setting with a set time of about 3 min. Bond strength between the bioadhesive and porcine intestine specimen is determined by the peel test. These bioadhesives can provide improved adhesion values up to 4.6 N/m of 180 deg. peel strength compared to five different commercial bioadhesives (values ranging from 0.52 to 3.04 N/m). In addition, the fully hydrated UV curable bioadhesives show a high water uptake ranging from 25 to 350 wt.%. Because N-vinyl pyrrolidone is a monomer, all these copolymers are expected to retain good biocompatibility. Obtained promising results of peel strength and water uptake clearly suggest that the developed bioadhesives have a strong potential for many medical applications such as single-layered hydrogel wound dressings and tissue adhesives. 16 refs.

USA
Accession no.654424

Item 241
Radtech Report
11, No.4, 1997, p.22-3

RECLAIMING AND REUSING SPRAYED UV COATINGS
Grantham G
3D UV Solutions

Capturing and reusing UV overspray can be a relatively simple and profitable project. Some practical experience in this area is presented. Many types of UV material are being used in the market today. A urethane-acrylic blend, a single-component package, is described. Other types of coatings are also recoverable, including non-acrylate types. The key to designing a recovery system is the material supplier, who can say whether the material can be reused or if it can be modified to make it recoverable.

USA
Accession no.654384

Item 242
Adhesives & Sealants Industry
4, No.6, Aug.1997, p.40/4

UV CURABLE, ACRYLIC, HOT-MELT POLYMERS ADVANCE PSA TECHNOLOGY
Sanborn T; Barwich J
BASF Corp.; BASF AG

Advances in pressure-sensitive-adhesive raw materials and equipment occur regularly to meet or exceed demands of a growing market. Through continuous research and development efforts, suppliers of raw materials, such as polymers, tackifiers, rheology modifiers and wetting agents, are making important contributions to advancing the current state of PSA technology. From solventborne NR to solvent acrylics, hot melts, waterborne acrylics and SBR, the industry has seen developments designed to optimise a variety of polymer characteristics. They include PSA performance, compounding, coating, converting, cost and user- and environmental-friendliness. Recent efforts in the product development process have yielded a new range of adhesive raw materials: UV-curable, acrylic, hot-melt polymers. They are low-molar-mass polycrylates that can be applied by conventional hot-melt coaters and later crosslinked with UV radiation. BASF has developed UV-curable, acrylic, hot-melt technology through an understanding of the principles of polymer design, a review of the deficiencies of current technologies and a vision of an ideal raw material. Details are given.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE
Accession no.652424

Item 243
Macromolecules
30, No.8, 21st April 1997, p.2408-11

POLYSTYRENE-BLOCK-POLY(2-CINNAMOYLETHYL METHACRYLATE) TADPOLE MOLECULES
Jian Tao; Guojun Liu
Calgary, University

In THF/cyclopentane or THF/cyclohexane mixtures with sufficiently high cyclopentane or cyclohexane contents, polystyrene-block-poly(2-cinnamoylethyl methacrylate) forms micelles with poly(2-cinnamoylethyl methacrylate) as the core. Coexisting with the micelles are unimer chains. The unimers are expected to have the tadpole conformation with the PS block assuming the normal random-coil conformation and the poly(2-cinnamoylethyl methacrylate) block clustering together like a globule. Photocrosslinking the poly(2-cinnamoylethyl methacrylate) globule of the unimers enabled the first preparation of permanent tadpole molecules from diblock copolymers. The tadpole conformation was confirmed by GPC, light scattering and NMR. 16 refs.

CANADA
Accession no.651398

Item 244
Patent Number: US 5585417 A 19961217

PROCESS FOR THE HARDENING UNDER IONISING RADIATION OF A BIS-MALEIMIDE RESIN AND A COMPOSITE MATERIAL USING SAID RESIN
Beziers D; Camberlin Y; Chataignier E; Dourthe P
Aerospatiale Societe Nationale Industrielle

At least one reactive diluent consisting of a monomer having a copolymerisable vinyl termination is added to the basic resin, prior to use thereof, and the resulting mixture is subjected to ionising radiation. The total quantity of the diluent is such that the maleimide functions of the basic resin are consumed following the ionising radiation action and is in the range 10 to 50 pbw per 100 pbw of the basic resin. The resin is suitable for making
composites having fibrous reinforcement by filament winding.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

Accession no.651249

Item 245
Patent Number: US 5591784 A 19970107
CURING OF FIBRE-REINFORCED COMPOSITE STRUCTURES
Muranaka K
Three Bond Co.Ltd.

Curing of a carbon fibre-reinforced composite structure is performed efficiently by a simple procedure wherein a composite material is formed with a carbon fibre, a photocurable resin and a catalyst. The composite material is irradiation cured so that even the resin existing in its interior is cured.

JAPAN

Accession no.647336

Item 246
Radtech Report
11, No.3, May-June 1997, p.22-30
UV/EB AND FOOD PACKAGING: OVERCOMING MISCONCEPTIONS AND FEAR OF CONTACT WITH FOOD LAW
Hurd P J
Keller & Heckman LLP

Common questions presented to the RadTech association by members on food-contact applications for UV/electron beam cured coatings are presented, together with their solutions. A practical approach is taken, illustrating the potential for UV/electron beam curing technology in this field.

USA

Accession no.642039

Item 247
Pitture e Vernici
73, No.8, 1997, p.37-44
English; Italian

MECHANICAL PROPERTIES AND ADHESION PERFORMANCE OF UV CROSSLINKABLE ACRYLIC HOT MELT PRESSURE SENSITIVE ADHESIVES
Zosel A; Barwich J
BASF AG

Polyacrylates rank among the most important raw materials for pressure-sensitive adhesives (PSAs), which at present are mainly used as polymer emulsions or solutions. A novel method to produced acrylic PSAs is the crosslinking of solvent-free polyacrylate hot melts with UV light. These materials are copolymers of acrylic esters and a photoinitiator, i.e. a photo reactive comonomer leading to crosslinking upon UV irradiation. Due to their relatively low molecular weight, the polyacrylates can be processed without any solvents as polymer melts at temperatures between 120 and 140 deg.C. The performance behaviour of UV crosslinkable hot melt adhesives can be adjusted in a wide range by varying the intensity of the UV irradiation. A high UV dose results in more densely crosslinked, cohesive PSA films, whilst a low dose leads to predominantly adhesive, tacky products. The adhesives can be easily adapted to a wide range of applications. The investigations described are carried out in order to gain a better insight into correlations between molecular structure and adhesion performance of UV crosslinkable pressure-sensitive adhesives. The influence of important molecular and processing parameters such as UV dose, molecular mass, film thickness, etc. is studied. Besides adhesive performance tests, dynamic mechanical measurements are especially suited to characterise the behaviour of pressure sensitive adhesives and to establish structure-property relationships. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.642022

Item 248
Polymer
38, No.11, May 1997, p.2791-5
PREPARATION CONDITIONS AND PROPERTIES OF BIODEGRADABLE HYDROGELS PREPARED BY GAMMA-IRRADIATION OF POLY(ASPARTIC ACID)S SYNTHESISED BY THERMAL POLYCONDENSATION
Tomida M; Yabe M; Arakawa Y; Kunioka M
Mitsubishi Chemical Corp.; Japan,National Institute of Materials & Chemical Research

Poly(aspartic acid) crosslinked hydrogels were prepared by gamma-irradiation of poly(aspartic acid) produced by thermal polycondensation reactions with an acid catalyst. The conditions under which the hydrogels could be prepared were when the weight-average molecular weight of poly(aspartic acid) was 95 000, the pH of the solution was 7.5 or higher, the concentration of the solution was 5-10 wt/vol%, the dosage of gamma-irradiation was 32 kGy or more and the preparation of the poly(aspartic acid) solutions was done under nitrogen. Hydrogels could not be formed by gamma-irradiation from poly(aspartic acid) with a low molecular weight of 15 000. The swelling of poly(aspartic acid) hydrogels in deionised water was 3400 g-water/g-dry hydrogel and in artificial urine, it was 27.4 g-water/g-dry hydrogel. The biodegradability was about 50% for 28 days using activated sludge. 13 refs.

JAPAN

Accession no.638554
UV INK: A LANDMARK IN PRINTING
Chatterjee A D
Coates of India Ltd.
The advantages of UV curable inks are discussed, together with details of their features, applications, and environmental friendliness. Aspects discussed include their safety, handling, versatility and environmental matters.
INDIA
Accession no.638033

FABRICATION OF EPOXY MATRIX COMPOSITES BY ELECTRON BEAM INDUCED CATIONIC POLYMERISATION
Crivello J V; Walton T C; Malik R
Rensselaer Polytechnic Institute; Aeroplas Corp.International
The use of high-energy electron beam radiation to fabricate high-performance epoxy resin matrix composites was studied. By using catalytic amounts of diaryliodonium and triarylsulphonium salt photoinitiators, it was found that graphite fibre-reinforced composites based on epoxy monomers could be efficiently electron beam-cured at room temp. when exposed to electron beam irradiation. A mechanism involving the reduction of theonium salt initiators by electron beam-induced free radicals was proposed. Strong protonic acids generated during the course of this reaction initiated the cationic ring-opening polymerisation of the epoxy resins. This chemistry was used to fabricate high-performance carbon fibre-reinforced composites. The mechanical properties of the composites were measured and the effects of blends with other epoxy monomers and additional types of particulate fillers were evaluated using various testing methods. 36 refs.
JAPAN
Accession no.635919

UV CURABLE MONOMERS AND OLIGOMERS IN PSA APPLICATIONS
Gloftfelter C
Sartomer Co.
Solvent borne pressure sensitive adhesives formulations, traditionally based on modified rubber chemistry are being challenged by low VOC, fast curing systems such as ultra violet and electron beam cured pressure sensitive adhesives, (PSAs). This paper describes both water-based and 100% solids UV curable PSAs and their properties. Properties of shear, peel strength and tack are reported for systems with various oligomer and monomer contents. Findings show a correlation between crosslink density and shear performance, tackifier content and peel strength, and system Tg, with all properties. New acrylate monomers are discussed, which have been developed and which offer great utility in the formulation of water based PSAs. 4 refs.
USA
Accession no.636897

RADIATION-CURABLE COATING COMPOSITION USEFUL FOR PROTECTING ELECTRONIC CIRCUITRY AND METHOD OF CURING THE SAME
Mine K; Naito H
Dow Corning Toray Silicone Co.Ltd.
Acryl-functional siloxane polymers may be cured using a two-step procedure in which the coating composition is first irradiated with UV radiation and then heated to a temperature between about 100 and 300C. The cured coating compositions exhibit high hardness and adhesion to the kind of resins used to support electrical circuitry, such as epoxy resins.
JAPAN
Accession no.635919

UV CURABLE POLYACRYLATE HOT MELT POLYMERS FOR PSAS
Barwich J; Dusterwald Y; Mayer-Roscher B; Wuestefeld R
BASF AG
Solvent-based systems, mostly solutions of rubber/resin mixtures, still have a share of nearly half the pressure-sensitive adhesive market, and in tapes almost 70%. There are two main reasons for this dominance: the good cost/benefit ratio of rubber/resin mixtures and the investments in solvent recovery systems that have been made. Disadvantages of these solvent-based adhesives are the environmental hazards, high energy processing, lower coating speeds at high coat weights and poor ageing resistance. UV crosslinkable acrylic hot-melt polymers have been developed to address ageing concerns in pressure-sensitive adhesive applications. The design of these polymers and their properties, their advantages and disadvantages, and information on potential applications, is given.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.634268
ENHANCED CURE OF HIGHLY PIGMENTED WHITE COATINGS USING A FLUORONE VISIBLE LIGHT PHOTONITIATOR
Moore M J; Lungu V; Marino T
Spectra Group Ltd.

H-NU 470, a fluorone visible light photoinitiator, was developed to address the various needs of the UV curing industry. When combined with selected co-initiators and other typical UV photoinitiators, H-Nu 470 significantly enhances the UV curing of highly pigmented titanium dioxide coatings. The improved cure response of acrylate based coatings containing 40 wt.% of titanium dioxide was monitored by pencil hardness, MEK rub resistance and maximum curable thickness. Coating thickness, line speed and spectral light sources were varied. Addition of as little as 0.05 wt.% H-Nu 470 coupled with an amine coinitiator (or an amine acrylate) resulted in coatings with increased cure speed, chemical resistance and cure thickness. The incorporation of an iodonium salt to the system further improves cure response. 12 refs.

Item 255
Radtech Report
11, No.2, March/April 1997, p.19-21
POTENTIAL APPLICATIONS FOR UV CROSSLINKABLE ACRYLIC HOT-MELT PRESSURE-SENSITIVE ADHESIVES
Scheiber M; Braun H
Novamelt Research GmbH

Some new developments and applications of UV curable, hot-melt, pressure-sensitive adhesives are discussed. Development targets are to achieve coating temperatures lower than 130 deg.C, high heat stability in the molten stage, less volatiles and less odour. Applications in the area of labels, tapes, acoustic insulation products and abrasive papers in a variety of applications are considered.

Item 256
Adhesives Age
40, No.3, March 1997, p.50/5
UV CURABLE MONOMERS AND OLIGOMERS IN PSA APPLICATIONS
Glotfelter C
Sartomer Co.

A description is given of current water-based and 100% solid UV curable pressure-sensitive adhesives and their properties. Shear, peel strength and tack properties are reported for systems with various oligomer and monomer contents. The adhesives were prepared to minimise premature polymerisation and evaluated by three test methods: rolling ball tack, peel and shear. The article describes sample preparation, test methods and significant findings. These findings reveal a correlation between crosslink density and shear performance, tackifier content and peel strength, and system Tg. 3 refs.

Item 257
Radtech Report
11, No.1, Jan./Feb.1997, p.15-6
UV CURABLE POWDER COATINGS: NEW MARKET POSSIBILITIES
McFadden M
Herberts Powder Coatings

New markets for UV curable powder coatings are discussed. The lower temperature requirements of UV curable powder coatings will allow powder coatings to be used in markets unavailable to traditional thermal cure powder coatings. Markets considered include wood and wood products, industrial coatings, plastics, and automotive applications.

Item 258
Radtech Report
11, No.1, Jan./Feb.1997, p.12-4
BUILDING SUCCESS: EB COATINGS IMPROVE STENI’S CONSTRUCTION PANELS
Chaix C; Handegard N
PPG Industries (France) SA; Steni

The use by Steni of electron beam curing techniques to improve the performance of its cladding panels for use in building construction is described, and the partnership with PPG Industries which made the project successful is discussed. Steni wanted to upgrade its products to offer increased resistance to UV, chemicals and weathering, surface hardness, durability, and a quick colour change capability. The advantages of electron beam curing are examined, and the success of the Steni Colour range is reported.

Item 259
RADIATION CURING IN AUSTRALIA:
WORLD'S FIRST UV CURED POLYMER BANK
NOTE
Garnett J L; Bett S J; Viengkhou V; Ng L-T
New South Wales, University; New Age Technologies Pty.Ltd.
(RadTech International)

The Australian UV/electron beam curing is reviewed. The field is expanding at 10 to 12% per year with predominant growth in UV. The technology is being utilised in a very wide range of applications, mainly small to medium size in volume. The major areas of use are in overprint varnishes and printing with the flexographic process showing the most potential. Environmental issues are one of the major reasons for promoting the technology in the region, since the greenhouse effect is a major health concern in the community. Competition from water based formulations remains strong. Hybrid systems combining water based and UV processes are proving popular for economic reasons particularly the printing industry. Thus in lithographic printing, a typical hybrid system would be the application of a conventional ink, followed by water based sealer with a UV topcoat. A unique development of the UV technology in the country is the conversion of the Australian currency from a paper to a plastic base. Details are given. 7 refs.

AUSTRAlia
Accession no.628136

DIRECT GLASS BOTTLE PRINTING WITH UV CURABLE ORGANIC INKS
Kamen M E
Revlon Inc.
(RadTech International)

Revlon Consumer Products Corporation was given with the 1995 CONEG Innovation Award in recognition of the development of breakthrough patented glass decorating technology utilising radiation curable inks. Dr. Mel Kamen, for Revlon, has invented a breakthrough, patented glass decorating technology which eliminates the need for paper labels and decals, heavy metal based inks and glazes, volatile organic chemicals and energy-intensive decorating processes, and facilitates recovering of uncontaminated glass for recycling. In addition, the technology is cost-competitive with existing processes and produces a final product with superior graphics to traditional ceramic inks and superior durability to existing labelling. Key features offer a full range of opaque colours including cadmium-free fire reds and chromium free bright yellow, along with raised gold, silver and other brilliant metallics. Using standard high-speed screen printing machines, ink is applied in precise patterns to container. Gold, silver or coloured metallics can be heat applied over the printed area creating raised bright gleaming permanent designs. Details are given.

USA
Accession no.628133

WEATHERABILITY AND YELLOWING BEHAVIOUR OF UV/ELECTRON BEAM CURING SYSTEMS
Goss W K; Moorehead T E
UCB Chemicals Corp.
(RadTech International)

Characterisation of various UV/electron beam curable systems is studied using Florida exposure study and other techniques. The influence of formulation composition on yellowing behaviour is explored as a function of the oligomer system, initiator system, additive package(s), and processing condition(s). Colorimeter data (delta E), and gloss readings provide the basis for comparison between systems. 4 refs.

USA
Accession no.628118

ULTRA LOW VOLTAGE CURING OF ACRYLIC HOT MELT PRESSURE SENSITIVE ADHESIVE
Ramharack R; Chandran R; Foreman P; Shah S; Orloff J
National Starch & Chemical Co.
(RadTech International)

Recent dramatic advances in electron beam curing equipment design and in materials development have now made electron beam curing of pressure-sensitive adhesives (and other coatings) affordable, practical and possible. Electron beam for radiation processing can now be produced at much lower voltages. This significantly reduces the size and cost of the hardware making it much more attractive. Synthesis is briefly reviewed, as are curing results at ultra low voltage. 8 refs.

USA
Accession no.628108

WEATHER RESISTANT OLIGOMERS
Yang B

Item 260
895

Item 262

Item 263
A series of aliphatic urethane acrylate oligomers were UV cured and their accelerated weathering performance studied. Gloss retention, yellowing index, tensile strength, elongation at break, and tensile modulus were determined as a function of accelerated weathering length. Preliminary spectroscopic data are also presented. Several high performance oligomers passed 3000 hours of QUV testing with excellent retention of both physical appearance and mechanical properties. Possible degradation mechanisms in weathering are proposed and related to chemical structures of these oligomers. 10 refs.

USA
Accession no.628078

Item 264

STATIC AND DYNAMIC INDENTATION MEASUREMENTS ON UV CURING MULTI-COAT SYSTEMS
Tonge J S; Blizzard J D; Honaman L A; Gilles J S
Dow Corning Corp. (RadTech International)

The wood coating and plastic flooring industries commonly use a base coat (sealer) in conjunction with a topcoat (wear layer). In creating these systems it is necessary to consider the presence of two or more interfaces and the multiple UV dosing experienced by the base coat. Performance tests such as flex or abrasion resistance seldom give insight to the mode or loci of failure. These typical pass/fail tests do not provide enough information during early coating development for direction. Details are given of dynamic and static indentation studies on single and two coat systems on plastic substrates. These methods provide quantitative information which can be used to understand both chemical and processing dependent variables such as thickness, total incident radiation, adhesion and modulii effects. 1 ref.

USA
Accession no.628076

Item 265

UV CURABLE AQUEOUS DISPERSIONS FOR WOOD COATINGS
Wang Z J; Arceneaux J A; Hall J
UCB Chemicals Corp. (RadTech International)

Aqueous dispersions of UV curable resins are prepared and evaluated. The physical and rheological properties of these dispersions are determined and the performance of these dispersions in various wood coating systems studied. Coatings based on these dispersions have faster UV cure speed, better surface hardness, and better flexibility compared with coatings based on undispersed resins. These coatings also have excellent solvent and water resistance. Moreover, one of the sprayable waterborne wood coatings gives tack-free before cure properties. 4 refs.

USA
Accession no.628072

Item 266

COMPARISON OF LITHOGRAPHIC INKS CURLED THERMALLY AND BY UV FOR SHEET FED METAL PACKAGING
Battersby G C
Coates Coatings International (RadTech International)

Using a simple model for a two colour press with varnishing unit, the cost of UV curing is compared to thermally cured inks. The model shows that higher consumable costs (208,000 US dollars) for UV cured inks and varnishes, compared to thermally cured inks, are not offset by savings in energy costs (19,000 US dollars). Using discounted cash flow analysis, the higher capital costs of thermal equipment does offset the higher consumable costs of UV and over a six year period savings of 298,000 US dollars are predicted in present value terms. Additional savings in the use of UV are anticipated from reduced wastage and increased productivity. It is not obvious how the chemistry of existing UV raw materials can be changed to allow lower cost UV curable inks to be formulated. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE
Accession no.628050

Item 267
Nashville, Tn., 28th April-2nd May 1996, p.35-43. 895

UV CURING FOR TWO AND THREE PIECE CANS - STATUS AND NEW DEVELOPMENTS
Blake D E
Fusion UV Curing Systems (RadTech International)

The use of UV curable inks and coatings for rigid metal containers has grown substantially over the past decade. UV offset lithography on flat metal sheets has gained commercial acceptance to the point that it is often the
process of choice for new production lines. Multicolour offset UV decoration of formed aluminium containers has been in use at one production site for two decades, and seems poised to expand into new locations. The reasons for the success of UV curing are reviewed, including a census of two and three piece UV production lines throughout the world and a look at the economics of UV versus water- and solvent-based materials. Finally, new developments and needed technology advances for UV curing in this market are examined.

USA

Accession no.628049

Item 268

Nashville, Tn., 28th April-2nd May 1996, p.29-34. 895

CATIONIC UV COATING EXTRACTABLES

Carter J W; Davis M S; Jupina M J
Union Carbide Corp.
(RadTech International)

FDA-type migration experiments were conducted using a model cationic UV coating in an attempt to demonstrate that good container and packaging hygiene can be achieved if cationic UV inks and overprint varnishes are properly used to decorate and protect food containers and food packaging. After thermal processing, the coating samples were extracted two hours later using different food simulants (aq. ethanol solutions) and processing conditions to simulate different foods and applications. Extraction samples were analysed for epoxide and photoinitiator substances using GC and HPLC methods. Generally, ppb levels of UVR 6110, propylene carbonate (PC), diphenyl sulphide (DPS), and bis and thio salts were found. The concentrations of extractables depended on thermal treatment, processing temperature and solvent. 5 refs.

USA

Accession no.628048

Item 269

Patent Number: US 5496683 A 19960305

METHOD OF AND APPARATUS FOR OPTICALLY SHAPING PHOTO-SETTING RESIN

Asano J
Sony Corp.

A photosetting resin is shaped into a three-dimensional resin model by scanning successive resin solution layers of a photosetting resin solution with a radiation beam to form a stack of scanned set layers of photosetting resin, each of the layers having a shaped region of an isometric section. The radiation beam is scanned along a contour line of the shaped region to set the shaped region along the contour line, and scanned in a raster scanning mode to set the shaped region inwardly of the contour line. Specifically, the radiation beam is scanned along a first line which is spaced a first distance inwardly from the contour line thereby to set the shaped region along the first line, and the radiation beam is scanned inwardly from the contour line thereby to set the shaped region inwardly of the second line. The first distance is smaller than the second distance.

JAPAN

Accession no.625260

Item 270

Patent Number: US 5523383 A 19960604

PHOTOCURABLE RESIN COMPOSITION FOR THE PREPARATION OF A PRINTED WIRING BOARD AND PROCESS FOR THE PREPARATION OF PHOTOCURABLE RESIN

Ikeda N; Kuroki T; Yamaguchi T; Oomiya H
Nippon Petrochemicals Co.Ltd.

A process for the preparation of a photocurable resin comprises (a) imidating 20-80 mole% of the acid anhydride groups present in an adduct prepared by the addition reaction of an alpha-beta-unsaturated dicarboxylic acid anhydride to a conjugated diene polymer or copolymer with a primary amine to produce water and an amide, (b) reacting the thus formed water as a by-product with at least a part of the remaining acid anhydride groups in the adduct to produce the succinic acid groups by opening the ring of the acid anhydride groups, (c) dehydrating the thus produced succinic acid groups by heating to cause ring closure again thereby forming acid anhydride groups and (d) reacting at least 50 mole% of the acid anhydride rings present in the polymer with an alpha-beta-unsaturated monocarboxylic acid ester having an alcoholic hydroxyl group to conduct a half-esterification by opening the ring of the anhydride groups.

JAPAN

Accession no.623626

Item 271

Journal of Advanced Materials

PHOTO DYNAMIC MECHANICAL ANALYSIS FOR CURE MONITORING OF FIBER REINFORCED PHOTORESIN COMPOSITES

Renault T; Ogale A A
Clemson, University

The use of photo dynamic mechanical analysis (photo DMA) for cure monitoring of fibre reinforced photoresin composites is discussed and compared with existing techniques for such measurements. The influence of glass, quartz, and carbon fibres on the photocure of polyacrylate resins was determined by the photo DMA technique. Glass and quartz fibres were found to have no detectable effect on the cure kinetics of photoresins, but carbon fibres were
found to inhibit the cure significantly. A static and dynamic FEA were used to calculate the modulus of the cured composite from the results. 24 refs.
USA
Accession no.620020

Item 272
European Coatings Journal
No.12, 1996, p.911/7
NEW COATING TECHNOLOGIES FOR WOOD PRODUCTS. AN EVALUATION AND REVIEW
Tavakoli M; Riches S T; Shipman J; Thomas M
A review is presented of techniques and curing technologies for wood products. The temperature sensitivity of the substrate is a limiting factor in the choice of curing methods for wood coatings. The radiation curing market is discussed, the materials used are examined, and details are given of particular development areas such as water borne coatings which may have a significant impact on the industrial coating industry, due to increased environmental requirements. Curing techniques are reviewed together with equipment and safety aspects. Data on market sizes are presented. 54 refs.
EUROPE-GENERAL
Accession no.618715

Item 273
European Adhesives & Sealants
13, No.4, Dec.1996, p.7-10
COMPARATIVE TESTING OF RADIATION-CURABLE PSA'S
Nitzl K
This article looks at the comparative testing of radiation-curable pressure sensitive adhesives, and discusses investigations of various parameters such as: raw material selection, the difference between UV curing and electron beam curing, and the influence on the different adhesive properties of the residual oxygen content during curing. 5 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.617956

Item 274
Adhesives Age
 ULTRA LOW VOLTAGE CURING OF ACRYLIC HOT MELT PSAS
Ramharack R; Handran R; Shah S; Harihara D; Orloff J; Foreman P
National Starch & Chemical Co.
Recent advances in electron beam equipment design and in materials development have made electron beam curing of pressure-sensitive adhesives affordable, practical and possible. Aspects covered include the advantages of radiation processing, polymer synthesis, cured polymer profiles, ultra-low voltage curing and applications. 12 refs.
USA
Accession no.617927

Item 275
Adhesives Age
LIGHT CURING ADHESIVES IN ELECTRONICS MANUFACTURING: THREE CASE STUDIES
Swanson P
Intertronics
It is well known that adhesives use is growing throughout all industries, not just electronics, but it is surprising to find that industry spends more money on materials and accessories for adhesive bonding than for welding. It will not be many years before that adage is amended to include soldering as well. It is said that designers still regard adhesive technology with some suspicion, although this should not be the case in the electronics industry. The construction of the circuit board itself uses adhesive technology, as do most of the components on it. By volume, there is certainly more adhesive and protective resin than metal in a PCB assembly. However, production managers and process engineers need to be given confidence that adhesives do not need to be applied in either near laboratory conditions; practical adhesive application can be clean, fast and economical. 8 refs.
USA
Accession no.617925

Item 276
SAMPE Journal
EMI SHIELDING WITH LIGHTWEIGHT METAL FIBRE COMPOSITES
Wang J; Varadan V V; Varadan V K
Pennsylvania, State University
The requirement for lightweight, EMI shielding materials is widespread. The processing and performance of lightweight metal fibre composites are described. The composite is prepared by impregnating highly dispersed short metal fibres into a UV curable polymer matrix. Efficient electrical contacts between the thin fibres result in a fibre network with high electrical conductivity which is still light weight. Experimental results indicate that these metal fibre composites can offer satisfactory EMI shielding effectiveness over a wide frequency range despite the low fibre volume fractions used. 4 refs.
USA
Accession no.617524
AQUEOUS DISPERSIONS FOR ULTRAVIOLET LIGHT CURABLE COATINGS
Wang Z J; Arceneaux J A; Hall J
UCB Chemicals Corp.

Aqueous dispersions of UV curable resins are prepared and evaluated. The physical and rheological properties of these dispersions are determined, and the performance of these dispersions in coating systems studied. Coatings based on these dispersions have faster UV cure speed, better surface hardness, and better flexibility compared with coatings based on undispersed resins. 4 refs.

USA
Accession no.614964

SYNTHESIS AND CHARACTERISATION OF PH-SENSITIVE POLY(ORGANOPHOSPHAZENE) HYDROGELS
Alcock H R; Ambrosio A M A
Pennsylvania, State University

These novel polyphosphazenes bear various ratios of sodium oxybenzoate and methoxyethoxyethoxy side groups. These water-soluble macromolecules were crosslinked by cobalt-60 gamma-irradiation and the products were allowed to absorb water to form hydrogels. The equilibrium degree of swelling of these hydrogels was determined as a function of side group ratios, pH, ionic strength, cation charge and radiation dose. Release of a dye from the hydrogels was investigated as a model for the controlled release of bioactive agents or the semi-permeable membrane behaviour of the gels. 37 refs.

USA
Accession no.614936

REVIEW OF PROPERTIES AND USES OF RADIATION CURING FOR THE NEAR TERM AND FUTURE
Guarino J P
Radcure Specialties Inc. (TAPPI)

This paper presents information in some detail on radiation curing, and current and new applications for this process are discussed. Applications reviewed include laminating adhesives, aseptic packaging, particle board coatings, water-reducible UV coatings and resilient flooring which does not require waxing.

USA
Accession no.612406
MODERN DICHOIC FOR HIGH-POWER UV CURING
Mill A GEW Ltd.

It is explained that technical development of UV curing systems for the printing and converting industries has, to a large extent, been driven by market requirements for increasingly powerful lamps. This article discusses the development of modern substrates for the packaging trade (PE, PP, very thin heat-sensitive films etc.) that now brings the requirement for these powerful lamps to run cooler than their predecessors.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE
Accession no.612233

UV CURABLE POWDER COATING SYSTEMS: A PROMISING FUTURE
Witte F M; De Jong E S; Misev T A DSM Resins BV

A new powder coating system has been developed by DSM Desotech based on the maleate/vinyl ether (MA/VE) technology. It consists of a resin bearing maleic or fumaric acid in the polymer chain and a vinyl ether oligomer. The system is claimed to meet the necessary requirements for wood application, and being essentially a nonacrylate system, it exhibits no irritating or sensitising properties. Results are given of tests carried out on medium density fibreboard (MDF). 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE
Accession no.609396

UV-CURABLE TRANSPARENT ADHESIVES FOR FABRICATING PRECISION OPTICAL COMPONENTS
Murata N; Nishi S; Hosono S NTT Interdisciplinary Research Laboratories

UV-curable transparent epoxy adhesives, developed for the fabrication of optical communications precision devices, are described. The adhesives, using cyclohexane-type fluoroepoxy as the base resin and spherical quartz filler, are shown to have very low volume shrinkage of 1.2% during curing and the cured adhesives to have low thermal expansion coefficient of less than 0.00002/degree C. Sheets of the adhesives are colourless and transparent to visible light because the refractive index of the epoxy matrix resin is matched with that of the quartz filler. It is shown that these highly transparent adhesives can be cured to a depth of more than 5 mm by using 10mW/sq cm UV irradiation for 30 min. They also have high adhesive strength and good durability. They can, therefore, be used in the fabrication of optical components that require submicron positioning accuracy. 3 refs. (Adhesion Society of Japan, 30th Anniversary Meeting, Yokohama, Japan, Nov.1994)
JAPAN
Accession no.608811

WATER-BASED RADIATION-CURABLE LATEXES
Odeberg J; Rassing J; Jonsson J E; Wesslen B Lund Institute of Technology; Hoechst-Perstorp AB

PS/poly(butyl acrylate-co-glycidyl methacrylate)(P(BA-co-GMA)) core-shell latex particles were prepared via a two-stage emulsion polymerisation procedure. Morphological characterisation of the particles by TEM showed that the second stage polymerisation had to be performed at a low temp. (25C) in order to produce a uniform P(BA-co-GMA) shell around the PS core. The epoxy groups derived from the GMA comonomer could be used for the introduction of UV reactive unsaturated groups at the particle surfaces. Allyl amine and sodium acrylate were shown to be active as nucleophilic reactants in this reaction. The core-shell particles carrying unsaturated groups were film-forming at room temp. These films could be crosslinked by UV radiation, as shown by increased stiffness and gel content and decreased swelling in 1-butanol. 30 refs.

SCANDINAVIA; SWEDEN; WESTERN EUROPE
Accession no.608081

DIBLOCK COPOLYMER NANOFIBRES
Liu G; Qiao L; Guo A Calgary,University

A diblock nanofibre is defined as a cylindrically shaped aggregate of a diblock copolymer. In an isolated nanofibre in the solvent-free state, one block constitutes the crosslinked core and the other block forms the concentric shell. When dissolved in a good solvent, chains of the shell block would swell and stretch out into the solution phase. The method described here for making nanofibres was to prepare bulk samples from a diblock copolymer with a crosslinkable block as the cylindrical phase. Then the cylindrical phase was crosslinked. The dissolution of
the continuous un-crosslinked phase led to
disentanglement of different nanofibres. The diblock
copolymer contained blocks of PS and blocks of poly(2-
cinnamoylethyl) methacrylate. The PS blocks were much
longer than the poly(2-cinnamoylethyl) methacrylate
blocks. TEM micrographs are shown. 17 refs.

Item 287
Antec '96. Volume II. Conference proceedings.
Indianapolis, 5th-10th May 1996, p.1465-70. 012
UV CURING OF EPOXY RESINS FOR
MICROELECTRONICS
Bittmann E; Ehrenstein G W
Erlangen, Universitat
(SPE)
UV curing of thermoset material has become important
for quick and energy-saving production in many fields.
Besides the thin-layer applications there are approaches
for the curing of thicker layers one of which is the
encapsulation of microchips with UV curing silica filled
epoxies. The influence of different resin components and
processing parameters on product quality and process
speed is shown. Photocalorimetry as a means for
characterising the UV reaction is introduced and
compared to other methods. 6 refs.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE
Accession no.606367

Item 288
Paper, Film & Foil Converter
70, No.7, July 1996, p.52/4
LOOK AT THE STATUS OF UV/EB CURING
Lawson K
DSM Desotech Inc.
An overview of the status of UV/EB curing in North
America, presented by DSM Desotech at RadTech '96,
is outlined. It is indicated that UV/EB curing grew 12%
in 1995 and the total North American market now uses
more than 45,000 metric tons of UV and EB-curable
products. Clear overprint coatings for paper and
paperboard comprise the largest market. The growth of
UV/EB-curable inks has been strong, particularly in the
area of flexography. Electronic/opto-electronics, water-
reducible products and costs are also discussed.
NORTH AMERICA
Accession no.605957

Item 289
Adhesives Age
39, No.8, July 1996, p.26/32
NEXT GENERATION UV SILICONE RELEASE
COATINGS
Kerr S R
Rhone-Poulenc Inc.
A next generation UV silicone release system has evolved
from the latest technical innovations in cationic
photoinitiator chemistries. A novel iodonium-borate
photoinitiator has demonstrated what is claimed to be the
fastest cure response yet evaluated in the class of UV
curable epoxy silicones. The final cure performance of
these silicone release coatings has demonstrated highly
stable release for a variety of paper and film substrates,
and controlled release is provided for by modification with
the addition of a special CRA-minus UV silicone. Advantages of these release coatings are examined.
USA
Accession no.603629

Item 290
Modern Plastics International
26, No.9, Sept.1996, p.38/42
UV TECHNOLOGY CUTS FILAMENT WINDING
TIME
Graft G
Locitite has developed a UV-curable additive that it says
can reduce curing times for filament-winding resin
formulations by as much as two-thirds and speed up the
winding process by more than 50%. The product, Accuset,
allows the wet resin-impregnated fibres to be B-staged
before they are wound around the mandrel, rather than
after the winding is done. The UV system eliminates the
long thermal B-stage process, trimming curing time, and
prevents resin dripping, resulting in material savings as
high as 90%.
LOCTITE CORP.
USA
Accession no.604042

Item 291
Adhesives Age
39, No.9, Aug.1996, p.26/32
UV SILICONE RELEASE COATINGS: STATE OF
THE ART
Kerr S R
Edited by: Rhone-Poulenc
This article explains the properties and applications of
silicone release coatings, which provide "easy release"
surfaces for a variety of "sticky" applications. Silicone
release technologies are discussed, and information is
included on UV curable silicone release coatings and
cationic UV cure silicones. The article is supported by
several tables and graphs.
USA
Accession no.603629
Item 292
Patent Number: WO 9521220 A1 19950810
Japanese

COATING COMPOSITION AND SURFACE-COATED MOULDING PRODUCED THEREWITH
Watanabe H; Ige H; Yanagase A
Mitsubishi Rayon Co.Ltd.

A coating composition is disclosed, comprising (a) a crosslinking polymerisable compound having at least two (meth)acryloyloxy groups in its molecule or a mixture of this compound and a compound copolymerisable with it; (b) fine silica particles with their surfaces modified with a hydrolysate of a mixture of a silane compound capable of binding with (a) and another silane compound incapable of binding with (a); and (c) an initiator for actinic radiation-induced polymerisation. The composition can give a cured coating having a high surface strength and an excellent weathering resistance, and is applicable without using any solvent.

JAPAN
Accession no.598748

Item 293
European Coatings Journal
Nos.7/8, 1996, p.514-6

RADIATION CURED SILICONE COATINGS
Gross D
GE Silicones

The curing of silicone coatings using actinic radiation has been the subject of research at GE since the 1970’s. General Electric Silicones has commercialised proprietary UV curable product families based on these efforts. Two distinct technologies have been investigated: release coatings based upon epoxy silicone/onium salt chemistry and abrasion resistant coatings based on functionalised colloidal silica. Some recent advancements in these technologies and summarises the performance characteristics of several new commercial products based upon this work are described. 28 refs.

USA
Accession no.598746

Item 294
Boston, Ma., 26th-30th April 1992, p.806-15. 895

CATIONIC UV CURING TECHNOLOGY AND ITS PLACE IN METAL PACKAGING
(RadTech International)

The development of UV cured coatings based on cationic chemistry has proceeded rapidly in Europe over recent years. The industry recognises the superior properties which can be obtained from well formulated cationic systems. The technology was invented in the USA, where some original applications in fields such as flexible tubes and metal packaging are still running today. However, the development of new applications has not advanced as rapidly as in Europe outside the field of metal packaging. The qualities cationic technology has to offer in the context of the existing and potential UV markets in each geographic area are examined. It is considered how the needs of the metal packaging market can be met by combining tried and tested can handling technology with the latest high performance cationic UV coatings and high peak intensity microwave powered UV lamps. 13 refs.

USA
Accession no.592824

Item 295
Boston, Ma., 26th-30th April 1992, p.697-702. 895

NEW DEVELOPMENTS IN WATERBASED RADIATION CURABLE RESINS
Stenson P H
ICI Resins US
(RadTech International)

The development of monomer- and solvent-free waterborne radiation curable resins promises to advance radiation curing technology into markets where the use of conventional 100% solids radiation curable systems are prohibitive. Currently, it is estimated 60% of industrial coatings are spray applied. Waterbased radiation cure systems have excellent practical utility in spray applications and have the potential to eliminate acrylate monomer toxicity and VOC concerns. Details are given of a series of water-based radiation curable urethane polymers together with a discussion of their properties in UV coatings applications. Some typical UV wood, plastic and metal coating formulations based on these water-based radiation curable urethane polymer resins are described. 10 refs.

USA
Accession no.592810

Item 296
Boston, Ma., 26th-30th April 1992, p.535-40. 895

CATIONIC E-BEAM CURE OF EPOXY RESINS
Crivello J V; Fan M; Bi D
Rensselaer Polytechnic Institute
(RadTech International)

In recent years electron beam curing has focused on the use of multifunctional acrylates and methacrylates because of the low dose requirements of these monomers. Other monomers, such as conventional epoxides, require doses in the range of 100 Mrd. for their effective cure. The high doses needed for the cure of epoxy resins preclude the use of these monomers in commercial...
applications. A breakthrough now makes it possible to cure new types of epoxy resins at very low doses. Furthermore, cures can be carried out in ambient air. A study of the cure mechanism indicates that polymerisation takes place by a cationic mechanism. These epoxides have excellent thermal and chemical resistance as well as outstanding adhesion to metals and plastics. This discovery makes it possible to use electron beam curing for the fabrication of high performance inks, coatings, adhesives and composites. 19 refs.

USA

Accession no.592790

Item 297
Boston, Ma., 26th-30th April 1992, p.201-11. 895
ENHANCED UV CURING OF HEAVILY PIGMENTED COATINGS FOR THE WOOD INDUSTRY THROUGH INCREASED PEAK IRRADIANCE AND CAREFUL WAVELENGTH SELECTION
Schaeffer W R
Fusion UV Curing Systems Corp.
(RadTech International)

By using a UV light source producing a very high peak irradiance value in combination with a bulb having enhanced output, the solvent flash off time can be greatly reduced while UV curing is completed in a simple one-step process. Previously, curing of 4-5 mil (100-125 microns) pigmented coatings for the wood industry has required a three minute dwell at an elevated temperature to volatilise residual solvents. Then a 3 minute exposure of alternating low intensity TL03 and TL50 lamps to crosslink the bulk of the film, followed by completion of the surface cure with multiple rows of medium pressure mercury lamps. This results in a very long finishing tunnel requiring much floor space and extended processing time.

USA

Accession no.592754

Item 298
Boston, Ma., 26th-30th April 1992, p.190-200. 895
UV CURE FINISHING SYSTEMS FOR WOOD
Mahon W F; Nason D L
UCB Radcure Inc.
(RadTech International)

A comparison of the performance properties of 21 acrylated oligomers of various types (epoxy,urethane,and polyester) in six different monomers systems for coating wood is presented. Both sealer and topcoat formulae are examined. Of particular interest is establishing relationships between oligomer structure and properties, and actual performance for both sealers and top coats on wood. A total of 121 formulations are screened for suitability as sealers using viscosity, holdout, adhesion, sandability and cure speed as the main criteria. Formulations satisfying the minimum criteria for a sealer are evaluated under a number of topcoat formulations in order to develop numerous finishing systems for wood. The sealer-topcoat systems are tested for adhesion, abrasion resistance, resistance to yellowing and chemical resistance.

USA

Accession no.592753

Item 299
Boston, Ma., 26th-30th April 1992, p.112-5. 895
RECENT ADVANCES IN UV CURABLE EPOXYSILICONE RELEASE SYSTEMS
Riding K D
GE Silicones
(RadTech International)

In 1988, GE Silicones introduced a series of UV curable silicone polymers and the photocatalyst to the release coating industry. These materials are particularly useful as release coatings on a variety of film substances against most acrylic- and rubber-based pressure-sensitive adhesives. These materials offer many benefits to the release coatings industry such as low temperature cure, less capital investment than thermal or EB cure, a catalysed bath life of up to five days and stable aged release performance against a wide variety of aggressive acrylic adhesives. In addition, some of the new UV product offerings and new opportunities are discussed. 4 refs.

USA

Accession no.592742

Item 300
Boston, Ma., 26th-30th April 1992, p.62-7. 895
ADVANTAGES OF VISIBLE LIGHT PHOTOPOLYMER TECHNOLOGY IN STEREOLITHOGRAPHY
Stenson P H; McLean C H
ICI Resins US; ICI Specialties
(RadTech International)

Stereolithography is a relatively new fabrication process for the rapid accurate production of three-dimensional prototypes from CAD/CAM digital design information. The stereolithographic process produces three-dimensional prototypes by laser-induced polymerisation of a liquid photopolymer composition. The majority of current systems employ a low powered UV-tuned helium-cadmium or argon ion laser to effect the photopolymerisation of a UV-sensitive acrylate-based...
composition. Advances have been made in the properties of prototypes produced by the process, but the ultimate goal of generating functional parts has not been attained. The advantages of employing visible-light curing technology in the stereolithographic process as both a means of enhancing the principal advantage of the process (rapid generation of prototypes) and as an alternative route to the production of fully functional parts are discussed. The visible light argon ion laser hardware and photoinitiator/resin requirements for visible-light stereolithography are discussed. 6 refs.

USA
Accession no.592736

Item 301
Boston, Ma., 26th-30th April 1992, p.57-61. 895
RAPID PROTOTYPING AND RESIN DESIGN AT ALLIED-SIGNAL: CASE STUDY
Sitzmann E V; Brautigram R J; Srivasatava C M; Green G D
Allied-Signal Inc. (RadTech International)
A case study is presented describing Allied-Signal’s experience both as an end user as well as a resin supplier, which has resulted in the design of stereolithography resins useful for rapid prototyping. 8 refs.
USA
Accession no.592735

Item 302
RadTech Report
10, No.2, March/April 1996, p.29-30
EYEGLASS LENS RETAILERS SEE THE CLEAR BENEFITS OF UV CURING
Luette S
Fast Cast Corp.
The article supplies details of a new process, developed and marketed by Fast Cast Corp., which entails the UV polymerisation of plastic spectacle lenses directly to the final lens prescription. The process eliminates the need for further grinding and polishing, can be carried out on the retail or ophthalmic premises, and is completed in under an hour.
USA
Accession no.587449

Item 303
European Coatings Journal
No.3, March 1996, p.115-7
RADIATION CURABLE POWDER COATINGS
Witte F M
DSM Resins BV
A UV curable binder system for powder coating based on the maleate-vinyl ether chemistry, developed by DSM Resins, can be used on heat sensitive substrates such as thermoplastics or wood. The binder consists of an unsaturated polyester resin in which maleic acid or fumaric acid is incorporated, and a polyurethane containing vinyl ether unsaturation. Application on wood by electrostatic spraying with the trimbo-technique has been successfully carried out. A combination of IR radiation for melting and film formation and UV radiation for curing is used. 18 refs.
EUROPE-GENERAL
Accession no.584584

Item 304
Journal of Applied Polymer Science
59, No.12, 21st March 1996, p.1937-44
PHOTOPOLYMERISATION OF DENDRITIC METHACRYLATED POLysterS. I. SYNTHESIS AND PROPERTIES
Shi W; Ranby B
Sweden, Royal Institute of Technology
The effects of a photoinitiator and comonomer on the photopolymerisation process for methacrylated polyester resins were investigated by measuring the conversion of the unsaturation and physical properties. The photopolymerisation kinetics were investigated by measuring tack-free time, gel content, and pendulum hardness. 10 refs.
SCANDINAVIA; SWEDEN; WESTERN EUROPE
Accession no.583740
The divergent synthesis of a series of polydisperse dendritic polyesters based upon pentaerythritol and benzenetricarboxylic anhydride, modified by glycidyl methacrylate and methacrylic anhydride, is described. Rheological properties were investigated by measuring the dynamic viscosity of the dendritic polyesters. Thermomechanical properties are discussed. 13 refs.

SCANDINAVIA; SWEDEN; WESTERN EUROPE
Accession no.583738

Item 307
Adhesives Age
RADTECH EUROPE '95
Bowtell M

A review is presented of papers read at the RadTech Europe '95 conference and exhibition. Papers were devoted to new fields of application for radiation curing, ranging from medical uses and powder coatings to optoelectronics. The exhibition is reported to have been dominated by the development of UV and EB curing lamps. Topics covered included radiation curing of pressure sensitive adhesives, UV curing of styrenic block copolymer based pressure sensitive adhesives, controlled release modification of photocurable epoxy silicones, adherence problems associated with UV formulations, and health and safety of UV equipment.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE
Accession no.579521

Item 308
Macromolecular Symposia
Vol.102, Jan.1996, p.63-71
PHOTOINITIATED CATIONIC POLYMERISATION OF MULTIFUNCTIONAL SYSTEMS
Decker C; Decker D; Viet T N T; Xuan H L
CNRS

Different types of tridimensional polymer networks were synthesised by photoinitiated cationic polymerisation of vinyl ether and epoxy-functionalised oligomers and polymers. Polymerisation kinetics were followed by IR spectroscopy. Data are given for polyvinyl ether, polyisoprene, and polycrylic acid, 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE
Accession no.579275

Item 309
Adhesives Age
38, No.11, Oct.1995, p.37
PUTTING ON THE HEAT
DriQuik Co. has supplied Krueger International of Manitowac, Wisconsin, with a curing system for its new water-based adhesive lines. The article supplies details of the system, designed for substrates used as office wall partitions, including cloth and boards. The adhesive is flash-cured within 30 seconds in a DriQuik Combo Oven.

DRIQUIK CO.; INDUSTRIAL CHEMICAL & FINISHING EQUIPMENT; KRUEGER INTERNATIONAL; FULLER H.B.,CO.; UNION TOOL CORP.; CONVEYORS INC.
USA
Accession no.579256

Item 310
Pitture e Vernici
71, No.18, Nov.1995, p.26/31
Italian; English
ELECTRONIC COMPONENT SEALING USING UV AND HEAT CURING ADHESIVES/SEALANTS
Sheehan J
Loctite International

The sealing of electronic components such as relays and potentiometers in which Valox PBTP is the plastic most commonly used and copper the most widely used metal, is discussed. Disadvantages of heat curing epoxies are examined, and a solution to the problem of viscosity reduction at high temperature during heat curing is put forward in the form of epoxy resin UV curing and ambient curing systems.

Accession no.576809

Item 311
Journal of Polymer Science : Polymer Chemistry Edition
32, No.10, 30th July 1994, p.1893-8
LASER-INDUCED GENERATION OF THIN SILICONE LAYERS WITH HIGH CHEMICAL AND SPECTRAL PURITY
Roth W; Hoffmann K W; Kurz W
Siemens AG

Dimethylpolysiloxanes and dimethylsiloxane copolymers containing phenyl, n-hexyl or 3.3.3-trifluoropropyl groups or silicon-bound hydrogen atoms were crosslinked in the liquid phase using excimer lasers. Layer thicknesses of 1-300 micrometres were obtained. Disiloxanes and alkoxysilanes were deposited from the gas phase using laser-induced chemical vapour deposition. These layers were less than one micrometre thick. The excimer laser techniques produced polymers which were free of additives such as catalysts, initiators or sensitisers. 14 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.573645
Item 312

Patent Number: US 5422058 A 19950606

MOUNTING STRUCTURE OF SHEET GLASS ON WINDOW FRAME AND THE LIKE

Okamoto S

End edges of sheet glass in a desired size and shape are reinforced with UV curing resin. The reinforced glass does not break easily and is watertight.

JAPAN

Accession no.573133

Item 313

Patent Number: US 5420171 A 19950530

UV CURABLE TEMPORARY SOLDER MASK

Unruh G R
Tech Spray Inc.

An organic solvent soluble, aqueous non-alkaline soluble and peelable solder mask composition contains a reactive diluent monomer capable of polymerisation upon exposure to UV light and a photoinitiator serving as a free-radical source to initiate polymerisation.

USA

Accession no.571391

Item 314

Patent Number: US 5409971 A 19950425

FUNCTIONALISED MULTISTAGE POLYMERS

Wolfersberger M H; Schindler F J; Beckley R S; Novak R W
Rohm & Haas Co.

An aqueous, radiation-curable, functionalised latex polymer composition and its preparation are disclosed. The composition is a multistaged latex polymer formed from a first stage polymer and a second stage polymer having an alpha,beta-unsaturated carbonyl functionalisation which permits curing by UV radiation. The composition dries tack-free before curing. The final cured UV coating has excellent solvent resistance, water resistance, stain resistance, direct impact resistance and hot print resistance. The composition is useful in coatings, adhesives, inks and leather coatings, and is particularly useful as a coating on wood. The multistaged latex polymer is made by (a) forming a multistage polymer having a first stage polymer and a second stage polymer comprising at least one comonomer containing acid functionality; (b) partially neutralising the acid functionality of the second stage polymer of the multistage polymer with a base; and (c) reacting the multistage polymer having partially neutralised acid functionality with a monoethylenically unsaturated epoxide compound.

USA

Accession no.565184

Item 315

Radtech Report

OPTIMISING THE USE OF ULTRAFINE MICROPOROUS POLYAMIDE POWDERS TO OBTAIN LOW-GLOSS UV CURABLE COATINGS

Gallouedec F D C; Valot E; Bernard M
Elf Atochem North America Inc.; Elf Atochem SA; Cray Valley SA

The influence of the addition of ultrafine polyamide powders as matting agents in UV cured acrylate coatings was studied, with reference to viscosity response and gloss-reducing efficiency. This is compared with the effect of silicas, traditionally used in UV cured systems, and found to be superior. In addition, improved abrasion resistance was obtained. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; USA; WESTERN EUROPE

Accession no.564497

Item 316

Adhesives & Sealants Industry
2, No.2, April/May 1995, p.38-40

ADVANCES IN ELECTRONIC MANUFACTURING

Beasley J
EFOS USA Inc.

This article uses case histories to show different electronics-manufacturing processes that have successfully incorporated UV spot curing equipment to solve process problems. 3 refs.

USA

Accession no.564272

Item 317

Patent Number: US 5397813 A 19950314

PREMIUM RELEASE UV CURABLE EPOXYSILICONE COMPOSITIONS

Eckberg R P; Griswold R
General Electric Co.

Blends of high viscosity epoxy silicone polymers prepared from pre-crosslinked silicones with polyalkylsiloxyl polymers containing long chains of non-functionalised polyalkylsiloxyl groups and an effective amount of a suitable iodonium photocatalyst provide an ultraviolet curable low release silicone coating composition.

USA

Accession no.561657

Item 318

Journal of Applied Polymer Science
REACTIVE DILUENTS AND PROPERTIES OF ULTRAVIOLET-CURED POLYCARBONATE URETHANE ACRYLATES
Krongauz V V; Tortorello A J
DSM Desotech Inc.

Polymer films obtained from photocurable formulations were investigated by tensile methods and dynamic mechanical analysis. The polymer formulations contained photoinitiator, urethane diacrylate oligomer, and acrylic reactive diluent. The effect of testing temperature on tensile storage modulus of the films containing different concentrations of reactive diluents was studied. The data indicated that a variety of coatings with wide ranging but predictable properties can be formulated from previously examined starting materials but used at different concentrations. 17 refs.

USA
Accession no.561440

Item 319
Torrington, Ct., c.1994, pp.1. 11 ins. 20/4/95. 6A1-8953
ULTRA LIGHT-WELD VISIBLE AND UV LIGHT CURING ADHESIVE SYSTEMS FROM DYNAMAX
Dymax Corp.

Features and advantages are outlined of the new visible light curing adhesives from Dymax. The photocurable and lamp systems are designed to increase productivity and improve worker safety. Typical applications are indicated, and a product selector guide is included.

USA
Accession no.559148

Item 320
Torrington, Ct., c.1994, pp.4. 11 ins. 20/4/95. 6A1-8953
ULTRA LIGHT-WELD & VISICURE SELECTOR GUIDE
Dymax Corp.

Details are given of Ultra Light-Weld UV and visible light curable adhesives and the Visicure visible light curing lamps. The products are spectrally matched for fast curing of difficult to bond and UV blocked substrates. Properties of the various grades of adhesive are tabulated, and the suitability for each in specific applications is indicated. An application/equipment selector guide is included with details of the most appropriate products for use in electronics and medical applications, and for bonding plastics and glass.

USA
Accession no.559147

Item 321
Patent Number: US 5387492 A 19950207
ENERGY-CURABLE CYANATE COMPOSITIONS
McCormick F B; Brown-Wensley K A; DeVoe R J
Minnesota Mining & Mfg.Co.

Energy polymerisable compositions comprising at least one cyanate monomer and as curing agent an organometallic compound are disclosed. The compositions are useful in applications requiring high performance, such as high temperature performance; in composites, particularly structural composites; structural adhesives; tooling for structural composites; electronic applications such as printed wiring boards and semiconductor encapsulants; graphic arts; injection moulding and prepregs; and high performance binders.

USA
Accession no.558066

Item 322
Patent Number: US 5376586 A 19941227
METHOD OF CURING THIN FILMS OF ORGANIC DIELECTRIC MATERIAL
Beilin S I; Wang W V; Chou W T
Fujitsu Ltd.

A method of curing an organic dielectric layer, such as polyimide, used in a multichip module is disclosed. The method comprises heating the uncured polyimide layer to a temperature above its glass transition temperature, and irradiating the layer with a uniform flux of electrons, as in an e-beam apparatus. The process reduces deterioration at the interface between the dielectric films and the metal layers which occurs when high temperature thermal curing is utilised, and reduces the stress of the resulting film. Multiple dielectric layers can be applied in this manner.

JAPAN
Accession no.553116

Item 323
Kobunshi Ronbunshu
52, No.2, 1995, p.105-9
Japanese
PHOTO-SOLDER-RESIST INK COMPOSED OF VARIOUS OLIGO-ACRYLATES
Onodera S; Kakinuma M; Nakamura Y
Taiyo Ink Manufacturing Co.

The photochemical properties of various polyfunctional acrylates were evaluated using a UV-FTIR method, involving rapid scanning FTIR in situ with continuous UV irradiation during the curing procedure. Dipentaerythritol hexaacrylate(DPET-6A) showed the highest photochemical reactivity among the oligoacrylates used. Photocurable solder resist ink was prepared by mixing DPET-6A and resins carrying acrylate or epoxide side chains as well as carboxylic residues. The resist films thus obtained were used for the irradiation experiments. The consumptions of vinyl, epoxide and carboxylic groups were determined by FTIR spectroscopy and...
potentiometric titration analysis. The comparison with the degree of photoreaction of each functional group showed that the electrical resistivity of cured film was much affected by the space density of crosslinking. 11 refs.

JAPAN
Accession no.549033

Item 324
Journal of Coated Fabrics

UV CURING COATINGS FOR TEXTILES: COATINGS WITH A FUTURE
Krijnen E; Marsman M; Holweg R
TNO Centre for Textile Research

An overview is given of the results of research projects on UV-curable coatings for textiles and on UV-curable binders for pigment printing. The chemical background is outlined with reference to coating and binder properties and to blocking. The use of additives is then considered, including flame retardants in UV coatings and pigments in UV coatings. UV-curable binders for pigment printing are then discussed, covering 100% UV-curable binders and water-based UV-curable binders. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE
Accession no.548154

Item 325
Radtech Report
9, No.2, March/April 1995, p.19-23

UV LIGHT APPLICATION FOR EFFECTIVE PROCESSING
Fleischer J
Red Spot Paint & Varnish

Factors contributing to the successful use of UV curing systems are discussed and the example is given of its use in coatings for headlamp lenses. Types of curing lamp are described, and the considerations to be borne in mind for different kinds of applications. Also discussed are heat management, factors affecting cure, optical and thermodynamic factors, and reflector options. Maintenance of UV installations is emphasised, and results are included of tests carried out on a polycarbonate headlamp lens coating for weathering resistance.

USA
Accession no.547688

Item 326
Paint & Ink International
8, No.1, Jan/Feb.1995, p.4

RADIATION CURING OF WOOD FINISHES
Dufour P
UCB Chemicals,Speciality Chemicals Div.

The demand for environmentally friendly products amongst manufacturers of wooden furniture has led to a trend away from solvent-based and acid curing formulations. Water-based and radiation curable formulations are seen as the alternatives, and the methods and resins available for the latter are described.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE
Accession no.546160

Item 327
Patent Number: EP 641844 A1 19950308

DISTORTION CONTROL ADDITIVES FOR ULTRAVIOLET CURABLE COMPOSITIONS
Rex G C
Union Carbide Chemicals & Plastics Technology Corp.

These comprise a polyisocyanate, a polyol or polyol blend and an acrylate or methacrylate. They can provide substantial reductions in distortion, e.g. shrinkage, of objects produced by UV curing, e.g. stereolithography, of coating compositions.

USA
Accession no.545040

Item 328
Patent Number: WO 9421446 A1 19940929

THREE-DIMENSIONAL OBJECT PRODUCTION PROCESS
Langer H J; Reichle J
EOS GmbH Electro Optical Systems

A process for producing the object by successively solidifying individual layers of the object made of a liquid or powdery material by electromagnetic radiation has the disadvantage that the object either is deformed because of material shrinkage or has a lower quality surface when it is designed so as to reduce material shrinkage. To solve this problem, each layer is subdivided into an inner core zone and an outer enveloping zone. Exposure to radiation is differently controlled in the core zone and in the enveloping zone in order to generate different properties in each zone.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE
Accession no.543656

Item 329
Patent Number: US 5304628 A 19940419

RADIATION-CURING RESIN COMPOSITION
Kinoshita M; Ishikawa H
Dainippon Ink & Chemicals Inc.

A radiation curing resin composition is claimed comprising (a) a resin having a carboxylic acid group and an unsaturated double bond and (b) a compound containing a cyclocarbonate group. The composition is excellent in stability and curing properties and provides a cured film with good water, solvent, chemical and heat resistance.

JAPAN
Accession no.530235
**Item 330**

**METHOD OF INDICATING A CURE POINT FOR ULTRAVIOLET RADIATION CURING COMPOSITIONS BY COLOUR CHANGE**

Field A J; Strong M R  
Dow Chemical Corp.

Adding a dye with a visible colour to an UV radiation curable composition containing a photoinitiator which generates free radicals upon exposure to UV radiation produces a composition which changes visible colour upon exposure to UV radiation. This visible colour change indicates that the composition has cured. This cure indication is useful for compositions curable by UV radiation in the electronics and electrical industry.

**USA**  
**Accession no.510912**

**Item 331**

**DISTORTION REDUCTION IN ACRYLIC PHOTOPOLYMER OPTICAL FREEFORM FABRICATIONS WITH VISIBLE LIGHT LASERS**

Culley J  
Ball, State University (SPE)

A study was undertaken to determine the ideal working parameters for a laser modelling apparatus in order to create parts from acrylic photopolymers with the least possible distortion. The apparatus differed from standard stereolithographic equipment in using an applicator bar for applying each successive uncured polymer layer and a visible light laser for curing the polymer layers. The minimum amount of distortion was achieved using a scanning speed of 178 cm/sec with three traces per layer. 5 refs.

**USA**  
**Accession no.507229**

**Item 332**

**STYRENE-BASED POLYMER MOULDINGS AND PROCESS FOR THE PRODUCTION THEREOF**

Funaki K; Yamasaki Y  
Idemitsu Kosan Co.Ltd.

A styrene-based polymer moulding having mainly syndiotactic configuration is obtained and then irradiated with electron rays. This moulding is claimed to be inexpensive and have good heat resistance. It is useful for structural, food, and particularly for electrical or electronic applications due to its soldering resistance.

**JAPAN**  
**Accession no.501430**

**Item 333**

**SYNTHESIS OF POLY-N-ISOPROPYLACRYLAMIDE HYDROGELS BY RADIATION POLYMERISATION AND CROSSLINKING**

Nagaoka N; Safranj A; Yoshida M; Omichi H; Kubota H; Katakai R  
Gunma, University; Japan Atomic Energy Research Institute

Hydrogels of the above polymer were synthesized by a method of simultaneous radiation-induced polymerisation and crosslinking of an aqueous solution of the monomer without any additive. Below the lower critical solution temp.(LCST), the gels synthesised by lower doses swelled to a higher extent than the more crosslinked gels. Above LCST, the swelling percentage increased up to about 50 kGy and then decreased with an increase in the dose. It was thought that the microscopical structure of the gel, which changed from tree to ladder and then to broken ladder with increasing dose, was responsible for this behaviour. 25 refs.

**JAPAN**  
**Accession no.507229**

**Item 334**

**Macromolecules**

26, No.26, 20th Dec. 1993, p.7386-8

**SYNTHESIS OF POLY-N-ISOPROPYLACRYLAMIDE HYDROGELS BY RADIATION POLYMERISATION AND CROSSLINKING**

Nagaoka N; Safranj A; Yoshida M; Omichi H; Kubota H; Katakai R  
Gunma, University; Japan Atomic Energy Research Institute

Hydrogels of the above polymer were synthesized by a method of simultaneous radiation-induced polymerisation and crosslinking of an aqueous solution of the monomer without any additive. Below the lower critical solution temp.(LCST), the gels synthesised by lower doses swelled to a higher extent than the more crosslinked gels. Above LCST, the swelling percentage increased up to about 50 kGy and then decreased with an increase in the dose. It was thought that the microscopical structure of the gel, which changed from tree to ladder and then to broken ladder with increasing dose, was responsible for this behaviour. 25 refs.

**JAPAN**  
**Accession no.501430**
**Item 335**

London, 16th-18th Sept.1992, p.15/1-15/9. 6E

NEW UV-CURABLE SILICONE AS COATINGS FOR OPTICAL FIBRES

Rogler W; Stapp B; Faustmann J; Zapf F; Wewers D
Siemens AG; Goldschmidt Th.,AG

New UV-curable silicone acrylate polymers have been developed as primary coating materials for optical fibres. The refractive index was adjusted by introducing 1-phenylpropyl substituents into the siloxane backbone. The properties of the materials are discussed. When combined with specially adjusted urethane acrylates as secondary coating, coated fibres show excellent attenuation behaviour at low temperatures. 9 refs.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

Accession no.496037

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**Item 336**


UV-CURABLE EPOXY ADHESIVES.
DEVELOPMENT AND APPLICATION TO OPTICAL COMMUNICATIONS DEVICES

Maruno T; Murata N
NTT Interdisciplinary Research Laboratories

Two kinds of UV-curable durable epoxy adhesives have been developed for the fabrication of optical communications devices. The properties of these UV-curable precision adhesives and optical adhesives are discussed, including their durability, reactivity and water resistance. Practical results are given for a laser diode module and a precision glass capillary splicer for optical fibres. 12 refs.

JAPAN

Accession no.496036

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**Item 337**

Radtech Report

SURFACE-DISCHARGE PULSED LIGHT SOURCE FOR UV CURING

Schaefer R B
Schaf er Associates Inc.

The performance is described of a new, pulsed surface discharge UV lamp. It is described as having high intensity, high efficiency, partially controllable spectrum, and geometrical flexibility for a wide range of applications. Details are given of the mechanism of the lamp, its potential advantages and results of a UV cure test. 12 refs.

USA

Accession no.495022

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**Item 338**

Angewandte Makromolekulare Chemie

VOLUME CHANGE BY SOLVENT AND TEMPERATURE OF POLY(VINYL ALCOHOL) CROSSLINKED BY ELECTRON IRRADIATION

Yoshii F; Sudradjat A; Darwis D; Razzaq M T; Makuuchi K
Japan,Atomic Energy Research Institute;
Indonesia,National Atomic Energy Agency

Hydrogels that were responsive to heat and solvent were prepared by electron irradiation of water-swollen PVAI films. Elasticity and toughness was improved by boiling in water. The hydrogels underwent a large contraction when the water was replaced by acetone at 25°C. The hydrogels can be steam-sterilised and potential use in the concentrating of diluted solutions and for mechano-chemical actuator is suggested. 12 refs.

INDONESIA; JAPAN

Accession no.496536

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**Item 339**

European Polymer Journal
29, No.8, Aug.1993, p.1095-8

DIFFUSION IN POLYVINYL PYRROLIDONE HYDROGELS PREPARED BY RADIATION TECHNIQUE

da Silveira B I
Parana,Universidade

Hydrogels of polyvinyl pyrrolidone were prepared using 10 w/w% aqueous solutions and gamma radiation. Swelling experiments were carried out in water at 30°C and followed by weighing. The concentration of effective chains and the number-average molecular weight between crosslinks were calculated by considering the chain-end effects. Diffusion and partition coefficients of rhodamine dye were calculated by following the diffusion of the solute out of polyvinyl pyrrolidone gel cylinders into water at 30°C. The effect of gel structure on diffusion was studied by preparing gels with various radiation doses and polyvinyl pyrrolidone molecular weights. The concentration of effective chains increased with rise in radiation dose, indicating that hydrogels of controlled structure could be prepared. The molecular weight of the polymer altered the gel structure, particularly at lower absorbed radiation doses. Diffusion coefficient decreased with increase in radiation dose showing the influence of gel structure on solute diffusion. 17 refs.

BRAZIL

Accession no.486463

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**Item 340**

Rochester, NY, 18th-19th Sept.1990, Paper J. 012

STEREOLITHOGRAPHY
An overview is presented of a novel process, called StereoLithography, which creates three-dimensional plastics parts from CAD/CAM/CAE data in a matter of hours. Applications for this technology, which combines photopolymer chemistry with laser and optical scanning, include conceptual designs, prototypes, testing models and casting master patterns. Benefits and future directions of the process are briefly discussed.

USA
Accession no.474980

Item 341
Journal of Polymer Science : Polymer Chemistry Edition
31, No.4, 30th March 1993, p.977-82
NOVEL SURFACE FIXATION TECHNOLOGY OF HYDROGEL BASED ON PHOTOCHEMICAL METHOD. HEPARIN-IMMOBILISED HYDROGELATED SURFACE
Nakayama Y; Matsuda T
Japan,National Cardiovascular Center

Novel photoinduced surface process technology enables simultaneous hydrogel formation and its fixation on polymeric substrates. The process consists of layering two different types of photoreactive coatings on a polymeric surface, an azidophenyl-bearing polymer as an adhesive layer and cinnamoylated copolymer as a hydrogel layer, and subsequent UV irradiation. The photoreactive adhesive polymer coated on a substrate is poly(m-azidostyrene), in which photoreaction of phenyl azido groups is responsible for the chemical bonding between the substrate and hydrogel. N,N-dimethylacrylamide copolymer containing cinnamate moieties in the side chains, which undergo photocrosslinking via intermolecular dimerisation, is applied as an overcoat on the adhesive layer. UV irradiation resulted in the formation of hydrogel chemically bonded onto the substrate. This was confirmed by ESCA. A heparin-immobilised hydrogelated surface with controlled release characteristics was demonstrated. Biomedical use is suggested. 14 refs.

JAPAN
Accession no.474393

Item 342
Radtech Report
7, No.2, March/April 1993, p.18-23
CATIONIC UV CURING TECHNOLOGY AND METAL PACKAGING
Milton-Thompson A
Fusion Europe Ltd.

The qualities that cationic technology offers in the context of existing and potential UV markets are examined with respect to Europe and the US. Consideration is given to how the needs of the metal packaging market can be met by combining tried and tested can handling technology with the latest high performance cationic UV coatings and high peak intensity microwave-powered UV lamps. 14 refs.

EUROPEAN COMMUNITY; UK; WESTERN EUROPE
Accession no.472585

Item 343
Makromolekulare Chemie
194, No.3, March 1993, p.767-76
PHOTOCROSSLINKABLE POLYMERS FOR MEMBRANES: POLYAMIDES FROM N-CINNAMOYL-5-AMINOISOPHTHALIC ACID AND AROMATIC DIAMINES
Ommer H J; Ritter H
Wuppertal,Bergische Universitaet

N-Cinnamoyl-5-aminoisophthalic acid was synthesised by acylation of 5-aminoisophthalic acid with cinnamoyl chloride in DMAc solution. The direct polycondensation of the diacid with various aromatic diamines resulted in photoactive aromatic polyamides with inherent viscosities of 0.4 to 1.7 dL/g. The preparation of homogeneous and asymmetric photocrosslinkable membranes from N-methyl-2-pyrrolidone solution was performed. The mechanical stability of a film was improved by UV irradiation while the permselectivities of ethanol/water and tert-butyl methyl ether/methanol mixtures were not influenced by the photochemical crosslinking. 16 refs.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE
Accession no.471384

Item 344
Polymers Paint Colour Journal
183, No.4322, 10th Feb.1993, p.38/40
RADIATION CURABLE WATER DILUTABLE POLYESTER ACRYLATES
Philips M; Loutz J M; Peeters S; Destexhe R; Lindekens L
UCB (Chem) Ltd.

Several ways to prepare water-based UV-curable acrylates are described. New water-dilutable polyester acrylates were prepared having good reactivity. Cured coatings based on these products also exhibited good solvent and water resistance. Achieving low viscosities with a minimum amount of water remains a problem. 3 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE
Accession no.471384
It has only been during the past twenty years or so that ultraviolet light has been used to any great extent for the curing of adhesives. However, UV adhesives are generally not employed for large-scale applications today, but they are used in a range of structural bonding, sealing and potting situations. For example, the fact that no heat is required for the curing process makes them ideal for plastic substrates or electronic products which cannot be exposed to environments above 80°C. Details are given.

EUROPEAN COMMUNITY; UK; WESTERN EUROPE
Accession no.464402

ARCOR, A NEW PHOTOLITHOGRAPHY TECHNIQUE WITH ANTIREFLECTIVE COATING ON RESIST
Tanaka T; Hasegawa N; Shiraishi H; Okazaka S
Hitachi Ltd.

A new technique to overcome the multiple interference effect is described. It is called ARCOR (antireflective coating on resist). It improves linewidth accuracy and overlay accuracy by suppressing multiple interference. A clear antireflective film is spun onto the resist prior to the mark detecting for alignment and exposure. The film is subsequently removed and the resist developed in the conventional way. Results are given for the use of perfluoroalkyloxethyl, polysiloxane, polyethylvinylether and PVAL on novolak photoresists. 12 refs. (Presented at SPE 9th Int. Conf. on Photopolymers, Ellenville, N.Y., 28th-30th Oct. 1991)

JAPAN
Accession no.464276

MECHANISTIC STUDY ON CHEMICALLY AMPLIFIED RESIST SYSTEMS USING PINACOL REARRANGEMENT IN PHENOLIC RESIN
Uchino S-I; Frank C W
Hitachi Ltd.; Stanford,University

Reactions leading to insolubilisation were studied for novolak compositions containing hydrobenzoin, diphenylacetalddehyde, 2,2-diphenylmethyl-4,5-diphenyl-1,3-dioxolane, benzopinacol and diphenyliodonium triflate. 6 refs. (Presented at SPE 9th Int. Conf. on Photopolymers, Ellenville, N.Y., 28th-30th Oct. 1991)

JAPAN; USA
Accession no.464276

A new approach to negative tone resist is based on acid catalysed cleavage of acetal blocked aromatic aldehydes, which act as latent electrophiles and, under the influence of strong acid, react with the surrounding phenolic resin. If the acetal is polyfunctional or incorporated in a phenolic polymer chain, an increase in molecular weight, due to crosslinking, is observed. Lithographic property data are given for copolymers of 4-vinylphenol with 4-vinylbenzaldehyde that has been 1,3-dioxolane blocked, as well as for poly-4-hydroxystyrene (Resin-M) and di-dioxolyl-terephthal-aldehyde (difunctional crosslinker) in conjunction with an onium photoacid generator. 10 refs. (Presented at SPE 9th Int. Conf. on Photopolymers, Ellenville, N.Y., 28th-30th Oct. 1991)

SWITZERLAND; WESTERN EUROPE
Accession no.464275
**Item 350**

*Polymer Engineering and Science*

**T-BUTYLOXYCARBONYL BLOCKED HYDROXYPHENYL-METHACRYLATES. ON THE WAY TO QUARTER MICRON DEEP-UV LITHOGRAPHY**

Przybilla K-J; Dammel G P; Roschert H; Spiess W
Hoechst AG

Lithographic evaluation of hydroxyphenyl methacrylate polymers and copolymers, particularly poly-2-hydroxyphenyl methacrylate, which have been blocked by t-butyloxycarbonyl groups by reaction with di-t-butyldicarbonate, is presented. Advantages over polynvinyl phenol are emphasised, but adhesion to silicon problems are indicated unless the number of hydrophilic or unblocked groups is increased. 7 refs. (Presented at SPE 9th Int. Conf. on Photopolymers, Ellenville, N.Y., 28th-30th Oct. 1991)

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

Accession no. 464274

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**Item 351**

*Polymer Engineering and Science*

**ACID FORMATION FROM VARIOUS SULPHONATES IN A CHEMICAL AMPLIFICATION POSITIVE RESIST**

Ueno T; Schlegel L; Hayashi N; Shiraishi H; Iwayanagi T
Hitachi Ltd.

The quantum yield for acid generation from alkyl and arylsulphonic acid esters of various phenol derivatives was measured to see the effect of backbone structure on the efficiency of acid generation. Phenols were 1,2-dihydroxybenzenene, 1,3-dihydroxybenzenene, 1,4-dihydroxybenzenene, phenol, 1,1,1-tris(4-hydroxyphenyl)ethane, m,p-cresol novolak, 1,2,3-trihydroxybenzenene, 1,2,4-trihydroxybenzenene and 1,3,5-trihydroxybenzenene. The resist films comprised novolak resin, the above sulphonates and bisphenol A protected with t-butoxybenzyloxy groups. The sensitivity measurements indicated that the number of sulphphonyloxy groups bonded to a benzene ring was important. The higher the number of the sulphodoxy groups, the higher the efficiency of acid generation. 13 refs. (Presented at SPE 9th Int. Conf. on Photopolymers, Ellenville, N.Y., 28th-30th Oct. 1991)

JAPAN

Accession no. 464273

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**Item 352**

*Polymer Engineering and Science*

**ARYLMETHYL SULPHONES. A NEW CLASS OF PHOTOACID GENERATORS**

Novembre A E; Hanson J E; Kometani J M; Tai W W; West R J
AT & T Bell Laboratories; OCG Microelectronic Materials Inc.

The X-ray and deep UV radiation response is described for resist systems consisting of poly(4-tert-butoxybenzoxystere-co-sulphur dioxide) combined with an arylmethyl sulphane. A 2/1 copolymer resist functioned as a highly sensitive, 1.4nm X-ray, single-component, chemically amplified resist. Addition of 12 mol.% bis(3,4-dichlorobenzyl) sulphane (DCBS) improved 0.8 nm X-ray sensitivity, while 10 mol.% of DCBS improved deep UV sensitivity. Sulphones, such as DCBS, gave two-component resist formulations capable of resolution below 0.5 micrometres. 12 refs. (Presented at SPE 9th Int. Conf. on Photopolymers, Ellenville, N.Y., 28th-30th Oct. 1991)

USA

Accession no. 464267

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**Item 353**

*Surface Coatings International*
75, No. 12, Dec. 1992, p. 480-2

**VINYL ETHERS IN UV INDUCED CATIONIC AND CATIONIC-FREE RADICAL SYSTEMS**

Wilkins G J; Burlant W J; Plotkin J S; Vara F J
ISP Europe

The two commercial divinyl ethers discussed are triethylene glycol divinyl ether (DVE-3) and 1,4-cyclohexanediimethanol divinyl ether (CHVE). These materials and their properties are described; DVE-3 will give high flexibility, whereas CHVE gives hard brittle coatings with good stain resistance. Intermediate properties can be obtained by blending. 9 refs.

EUROPEAN COMMUNITY; UK; WESTERN EUROPE

Accession no. 464023

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**Item 354**

*Journal of Applied Polymer Science*

**EFFECT OF STRUCTURE ON THE THERMAL STABILITY OF PHOTOCURABLE URETHANE ACRYLATE FORMULATIONS**

Shama S A; Tortorello A J
DSM Desotech Inc.

Results are presented of a systematic study of the structure-property relationships of specific segments and components that may contribute to the thermal ageing characteristics of UV-curable coatings. 21 refs.

USA

Accession no. 431499
DIFFERENTIAL PHOTOCALORIMETRY: ADVANCEMENTS FOR THE ANALYSIS AND CHARACTERISATION OF FREE RADICAL, CATIONIC AND HYBRID PHOTOPOLYMERS

Sauerbrunn S R; Armbruster D C; Shickel P D
Du Pont De Nemours E I., & Co Inc.; Uvacute Chemical Corp.
(RadTech International)

Differential photocalorimetry (DPC) studies were conducted on a variety of free radical, cationic and hybrid photopolymers. Results presented elucidate the effects of critical formulating variables on cure speed and product performance properties. An understanding of these effects is said to provide key information for the development of new products, quality control of the manufacturing process, competitive analysis of materials and an insight into the mechanism of photopolymerisation. The utility of the Du Pont DPC as an advanced analytical instrument for the investigation of the photopolymerisation process is established. The Du Pont Thermomechanical Analyser was also employed. 5 refs.

USA
Accession no. 419798

ADVANCED COATINGS BASED ON FLUOROCARBONS

Head R A; Fitchett M
Imperial Chemical Industries Plc
(RadTech International)

A method is described for preparation of fluorine-containing polyols and introducing them into radiation curable oligomers, especially urethane acrylates. Differences between the fluorine-containing materials and their non-fluorine-containing precursors are discussed with respect to physical appearance and both surface and bulk polymer properties. It is shown that very low surface energy coatings can be obtained by use of these oligomers. The resulting polymers are found to be highly water resistant with respect to both uptake and transmission. 7 refs.

EUROPEAN COMMUNITY; UK; WESTERN EUROPE
Accession no. 418038

NETWORK FORMATION BY CHAIN CROSSTINKING PHOTOPOLYMERISATION AND ITS APPLICATIONS IN ELECTRONICS

Kloosterboer J G
Philips Research Laboratories.

Crosslinking photopolymerisation is discussed in detail in relation to the coating of optical fibres, the replication of optical discs and the replication of aspherical lenses used for laser read-out of optical discs. Brief mention is made in connection with the recording of holograms, optical waveguides and other components, wire coatings, miscellaneous optical coatings, and adhesives. Network formation itself is discussed with reference to shrinkage and ageing, trapping of radicals in a network, kinetic features, and studies relating polymer properties to photocuring conditions. The simulation of crosslinking polymerisation with a percolation model is also described. 250 refs.

NETHERLANDS; USA
Accession no. 362941

PHOTOPOLYMERIZATION OF SURFACE COATINGS

Roffey C G

Described in this book is the use of photopolymerisable coatings, the recent development of which has received its impetus from environmental legislation and energy saving requirements. A review of the literature covering more than 20 years is provided to give the reader adequate understanding of the theory and current practise of the subject. A revision summary guide of atomic and molecular structure is given along with a treatment of basic photochemical theory. The author describes ultraviolet curing materials and their application to the surface coatings industry.

UK
Accession no. 236816
Subject Index

A

ABRASION RESISTANCE, 22 29
81 160 181 194 211 213 214
220 228 298 315
ABSORPTION, 99 113 206
ABSORPTION SPECTRA, 221
ACCELERATED TEST, 113 186
ACCELERATOR, 110 127 198 336
ACID PHOTOGENERATION, 348
349 351 352
ACID RESISTANCE, 185
ACID TREATMENT, 326
ACRYLATE, 62 196 251 295 307
327 342
ACRYLATE COPOLYMER, 141
ACRYLATE GROUP, 77 86 160
ACRYLATE OLIGOMER, 136
ACRYLATED, 85 143 165 272
ACRYLIC, 83 94 96 118 197 223
288
ACRYLIC ACID COPOLYMER, 90 204
ACRYLIC COPOLYMER, 90
ACRYLIC ESTER POLYMER, 1
16 33 45 74 83 99 112 116 129
147 150 163 180 194 213 218
229 253
ACRYLIC POLYMER, 16 20 33
36 67 68 99 107 129 160 163
185 210 211 214 218 241 242
247 262 274 285 299 310 323
326 331
ACTINIC RADIATION, 74 93 134
151 162 230 292
ADDITION CURING, 86
ADITIVE, 2 33 45 58 90 99 107
110 113 143 163 177 182 213
214 215 219 222 235 250 272
280 284 290 324 327 333
ADHESION, 8 13 27 36 47 51 61
68 70 74 76 86 90 92 93 94 99
103 107 136 150 155 160 161
195 201 213 220 228 247 252
264 284 298 303 307 310 335
336 342 350
ADHESION PROMOTER, 103
122 174 257
ADHESIVE, 12 13 27 34 53 55 57
66 67 68 83 86 90 94 96 99 101
102 104 118 123 124 140 143
145 148 149 150 155 163 168
176 188 195 197 201 206 210
227 234 240 242 247 251 253
255 256 262 272 273 274 275

B

BACKBONE, 77 122 138 151
BAG, 47
BALL, 61 103
BANK NOTE, 259
BEAD, 141

C

CABLE, 14
CAN, 267 342
CARBON BLACK, 27 45 222
CARBON DIOXIDE, 30
CARBON FIBRE-REINFORCED
PLASTIC, 37 62 84 115 128
157 169 170 245 250 271 290
CARTON, 288
CAST FILM, 235
CASTING, 31 93 215 235 340
CASTOR OIL, 51
Subject Index

CATALYST, 58 235 248 317
CATIONIC, 22 51 60 66 125 127
130 182 213 220 231 272 289
342 353
CATIONIC CURING, 107 118 164
CATIONIC POLYMERISATION,
12 13 106 130 131 142 250 294
296 308
CERAMIC, 120 336
CHARACTERISATION, 106 116
128 141 153 196 224 278
CHEMICAL MODIFICATION, 10
58 92 107 204 212 217 304 305
306 311 349
CHEMICAL PROPERTIES, 7 32
70 81 94 125 150 175 210 213
214 224 228 258
CHEMICAL RESISTANCE, 7 14
32 70 81 83 94 102 119 125 135
150 175 185 194 210 213 214
224 228 258 296 298 329
CHEMICAL STRUCTURE, 16 29
31 35 73 82 99 107 133 140
148 341 343
CINNAMOYL GROUP, 207 221
341 343
CINNAMOYL ETHYL
METHACRYLATE COPOLYMER, 205 286 341
CINNAMOYL METHACRYLATE COPOLYMER, 137
CIRCUIT BOARD, 86 123
CLARITY, 186
CLEARCOAT, 7 18 109 257
CLOTHING, 46 237
CO-CURING AGENT, 99 213
COATABILITY, 94
COATED, 89 100 138 292
COATED FABRIC, 324
COATED METAL, 69 70 71 107
214 216 267 283 294 342
COBALT-60, 235 278
COEFFICIENT OF FRICTION,
183 213 219
COHESION STRENGTH, 53 94
197
COIL, 316 117
COLD CAST, 199
COLOUR, 99 213 220
COLOUR CHANGE, 330
COLOUR CODING, 14
COLOUR MEASUREMENT, 281
COLOUR STABILITY, 186
COLOUR STRENGTH, 92
COLOURANT, 74 125
COLOURING, 70 71
COMMUNICATIONS APPLICATION, 335 336
COMPACT DISC, 3 234
COMPATIBILITY, 107 201 219
256 315
COMPOSITE, 37 49 54 62 73 84
89 99 115 120 127 128 133 147
151 152 157 167 169 170 171
173 180 198 200 228 233 244
245 250 258 271 276 290 296
302 304 321 345
COMPOUNDING, 110 235 353
COMPRESSIBILITY, 15 38 93 110
256 315
CONDUCTIVE MATERIAL, 257
CONDUCTIVE POLYMER, 276
347
CONFERENCE, 83 90 107 110
159 203 213 235 288 307 331
CONTACT LENS, 59 212
CONTROL, 3 123 222 336
CONTROLLED-RELEASE, 205
278
CONVERSION, 31 79 99 163 221
353
CONVERTING, 225 282
COPYRIGHT, 97
CORROSION RESISTANCE, 32
70 107
COST, 49 55 66 81 127 198 210
214 225 238 249 266 281 288
290 302 342
COUPLING AGENT, 89 99 160
CRITICAL SOLUTION TEMPERATURE, 204 208
CROSSECTION, 11 23 24 25 30
31 32 35 38 42 44 47 52 56 68
85 86 90 94 97 99 102 105 108
110 111 113 115 129 132 133
137 141 155 158 172 204 207
213 215 217 221 235 236 237
238 243 248 251 323 292 307
311 338 349 357 358
CROSSLINKING AGENT, 58 235
CRYSTALLINITY, 133 148 191
196 215 229
CURE METER, 271
CURE RATE, 6 13 18 19 63 64 66
69 91 110 121 129 147 163 165
175 281 326 335 336 337 355
CURE TEMPERATURE, 6 29 62
69 95 99 110 159 162 222
CURE TIME, 7 13 18 29 84 101
117 118 127 213 222 290 336
CURING AGENT, 22 58 90 99 110
113 117 147 184 213 235 321
CURING LAMP, 66 67 307 319
320
CURING SYSTEM, 3 4 110 149 150
CYCLE TIME, 200 310

D

DAM, 123
DEBONDING, 90
DECOMPOSITION, 41 110 352
DECORATION, 8 136
DECORATIVE COATING, 58
DEGRADABLE, 35 85 141 146
248
DEGRADATION, 11 35 87 107
113 122 146 219 263 358
DENTAL APPLICATION, 50 99
DESIGN, 73 188 201 238 262 300
301 331
DIACRYPATE COPOLYMER, 43
DIACRYPATE POLYMER, 42 229
DIAGNOSTIC APPLICATION, 34
DIARYLIDONIUM SALT, 106
142 250
DICYCLPENTADIENE POLYMER, 106
DIELECTRIC PROPERTIES, 73
107 159 202 222 229 337
DIFFERENTIAL PHOTOCALORIMETRY, 355
DIFFERENTIAL SCANNING CALORIMETRY, 12 13 23 41
184
DIFFERENTIAL THERMAL ANALYSIS, 23 41 105 153 184
215 229
DIFFUSION, 339
DIFFUSIVITY, 25
DIGITAL VERSATILE DISC, 192
DIGITAL VIDEO DISC, 234
DISOCYANATE, 33 354
DILUENT, 99 129 159 151 164
174 181 184 244 272 353 359
DIMETHACRYLAMIDE COPOLYMER, 341
DIMETHYLAMINOETHYL METHACRYLATE COPOLYMER, 156 341
DIMETHYLSILOXANE COPOLYMER, 311
<table>
<thead>
<tr>
<th>Subject Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIOXOLANE COPOLYMER, 349</td>
</tr>
<tr>
<td>DIPENTAERYTHRITOL HEXAACRYLATE, 323</td>
</tr>
<tr>
<td>DISC, 234</td>
</tr>
<tr>
<td>DISCOLOURATION, 2 213</td>
</tr>
<tr>
<td>DISPERSIBILITY, 138</td>
</tr>
<tr>
<td>DISPERSING AGENT, 92 116 214</td>
</tr>
<tr>
<td>DISPERSION, 19 75 92 107 116 154 162 177 222 224 232 235 265 277 307</td>
</tr>
<tr>
<td>DIVINYL ETHER COPOLYMER, 43</td>
</tr>
<tr>
<td>DIVINYLETHER POLYMER, 353</td>
</tr>
<tr>
<td>DOPING, 27</td>
</tr>
<tr>
<td>DOSE RATE, 18 97 235 334</td>
</tr>
<tr>
<td>DRILL, 48</td>
</tr>
<tr>
<td>DROP ON DEMAND, 226</td>
</tr>
<tr>
<td>DRUG DELIVERY, 56 141 205</td>
</tr>
<tr>
<td>DRYING, 16 109 135 143 154 197 213 288 359</td>
</tr>
<tr>
<td>DRYING TIME, 7 272</td>
</tr>
<tr>
<td>DUAL CURING, 7 76 272</td>
</tr>
<tr>
<td>DURABILITY, 8 74 228 258 284 336</td>
</tr>
<tr>
<td>DYE, 226 278 330</td>
</tr>
<tr>
<td>DYNAMIC MECHANICAL ANALYSIS, 33 229 318</td>
</tr>
<tr>
<td>DYNAMIC MECHANICAL PROPERTIES, 90 173 229</td>
</tr>
<tr>
<td>DYNAMIC MECHANICAL THERMAL ANALYSIS, 84 128 157 194 220</td>
</tr>
<tr>
<td>DYNAMIC MODULUS, 90 335 358</td>
</tr>
<tr>
<td>DYNAMIC PROPERTIES, 90 173 229</td>
</tr>
<tr>
<td>ECONOMIC INFORMATION, 67 83 96 117 143 197 257 259 279 288 342</td>
</tr>
<tr>
<td>ELASTIC MODULUS, 65 172 271 318</td>
</tr>
<tr>
<td>ELASTIC PROPERTIES, 90 107 110 271</td>
</tr>
<tr>
<td>ELASTOMER, 13 24 28 40 42 44</td>
</tr>
<tr>
<td>46 57 64 66 68 83 85 87 88 94 96 101 102 103 108 110 111 121 126 136 138 140 143 148</td>
</tr>
<tr>
<td>149 150 158 159 161 162 164 165 167 168 174 177 178 182 187 191 193 201 203 214 222</td>
</tr>
<tr>
<td>224 227 231 236 237 238 251 253 255 261 263 264 265 266 267 268 270 273 275 277</td>
</tr>
<tr>
<td>293 295 299 300 301 307 308 309 312 326 327 328 329 330</td>
</tr>
<tr>
<td>ELECTRICAL APPLICATION, 167 330 332</td>
</tr>
<tr>
<td>ELECTRICAL CONDUCTIVITY, 86 147 347</td>
</tr>
<tr>
<td>ELECTRICAL PROPERTIES, 86 107 159 222 229</td>
</tr>
<tr>
<td>ELECTRICAL RESISTIVITY, 323</td>
</tr>
<tr>
<td>ELECTROMAGNETIC, 120 276 328 359</td>
</tr>
<tr>
<td>ELECTRON BEAM CURING, 1 2 46 47 49 62 83 103 104 108 127 135 148 161 164 165 169</td>
</tr>
<tr>
<td>170 173 179 191 198 203 210 225 233 246 250 251 258 259 261 262 263 272 273 274 279</td>
</tr>
<tr>
<td>280 288 296 307 318 322 332 358</td>
</tr>
<tr>
<td>ELECTRON BEAM LITHOGRAPHY, 347</td>
</tr>
<tr>
<td>ELECTRON MICROSCOPY, 27 235</td>
</tr>
<tr>
<td>ELECTRONIC APPLICATION, 80 118 123 132 153 175 202 252 270 275 287 310 316 320 321</td>
</tr>
<tr>
<td>322 330 332 345 346 347 348 349 350 351 352 358</td>
</tr>
<tr>
<td>ELECTROOPTICAL PROPERTIES, 43</td>
</tr>
<tr>
<td>ELECTROSTATIC DEPOSITION, 71 78 257</td>
</tr>
<tr>
<td>ELECTROSTATIC SPRAYING, 70</td>
</tr>
<tr>
<td>ELONGATION, 108 160 235 320 335</td>
</tr>
<tr>
<td>ELONGATION AT BREAK, 108 263 318 358</td>
</tr>
<tr>
<td>EMISSION, 117 154 165 214 288</td>
</tr>
<tr>
<td>EMISSION CONTROL, 143 342</td>
</tr>
<tr>
<td>EMULATION, 5 81 107 109 154 189 214 235 344</td>
</tr>
<tr>
<td>ENCAPSULATION, 65 80 86 123 175 358</td>
</tr>
<tr>
<td>ENERGY CONSERVATION, 70 91 143 176 266 288 359</td>
</tr>
<tr>
<td>ENERGY CONSUMPTION, 69 84 197</td>
</tr>
<tr>
<td>ENGINE, 223</td>
</tr>
<tr>
<td>ENVIRONMENT, 68 104 107 213 214 232 259 260 291 359</td>
</tr>
<tr>
<td>ENVIRONMENTAL LEGISLATION, 326</td>
</tr>
<tr>
<td>ENVIRONMENTAL PROTECTION, 10 12 214 283</td>
</tr>
<tr>
<td>ENVIRONMENTALLY FRIENDLY, 143 154 210 249</td>
</tr>
<tr>
<td>ENZYME IMMOBILISATION, 39</td>
</tr>
<tr>
<td>EPOXIDE COPOLYMER, 6 EPOXY ACRYLATE</td>
</tr>
<tr>
<td>COPOLYMER, 295</td>
</tr>
<tr>
<td>EPOXY ACRYLATE POLYMER, 9 92 108 112 136 154 165 211 213 271 326</td>
</tr>
<tr>
<td>EPOXY GROUP, 22 106 162</td>
</tr>
<tr>
<td>EPOXY RESIN, 6 9 10 23 26 27 50 51 60 62 65 66 73 86 107 118 125 127 131 134 142 153</td>
</tr>
<tr>
<td>164 166 170 184 202 213 214 220 250 252 272 283 284 287 288 290 296 308 310 316 325</td>
</tr>
<tr>
<td>358</td>
</tr>
<tr>
<td>EPOXY SILICONE COPOLYMER, 83 134 179 183 289 291 299 307 317</td>
</tr>
<tr>
<td>EQUIPMENT, 3 4 7 34 66 96 165 222 225 269 307 309 316 325</td>
</tr>
<tr>
<td>ETHOXYETHOXYETHYL ACRYLATE COPOLYMER, 148</td>
</tr>
<tr>
<td>ETHYLENE-PROPYLENE-DIENE TERPOLYMER, 110</td>
</tr>
<tr>
<td>ETHYLENE-VINYL ACETATE COPOLYMER, 68</td>
</tr>
<tr>
<td>ETHYLHEXYL ACRYLATE COPOLYMER, 90</td>
</tr>
<tr>
<td>EVANESCENT WAVE POLYMERISATION, 218</td>
</tr>
<tr>
<td>EVAPORATION, 31 107 213</td>
</tr>
<tr>
<td>EXCIMER, 91 311 357</td>
</tr>
<tr>
<td>EXCITED STATE, 99 131</td>
</tr>
<tr>
<td>EXTENSOMETER, 72</td>
</tr>
<tr>
<td>EXTINCTION COEFFICIENT, 206 358</td>
</tr>
<tr>
<td>EXTRUSION, 110 222</td>
</tr>
<tr>
<td>FABRICATION, 49 152 169 250 336</td>
</tr>
<tr>
<td>FAILURE, 84 155</td>
</tr>
<tr>
<td>FAST CURING, 220 307</td>
</tr>
<tr>
<td>FIBRE, 49 128 271</td>
</tr>
<tr>
<td>FIBRE BOARD, 71 117</td>
</tr>
<tr>
<td>FIBRE CONTENT, 62</td>
</tr>
<tr>
<td>FIBRE GLASS, 134 151 271</td>
</tr>
<tr>
<td>FIBRE OPTIC, 134</td>
</tr>
<tr>
<td>FIBRE-REINFORCED PLASTIC, 37 54 62 84 128 170 250 271 276</td>
</tr>
<tr>
<td>FILAMENT WINDING, 198 244 290</td>
</tr>
<tr>
<td>FILLER, 33 45 54 57 99 107 123 147 160 211 222 235 250 281 284 287 290 296 308 310 316 325 333 336</td>
</tr>
<tr>
<td>FILM, 21 30 31 33 36 40 47 76 88 90 97 102 108 116 124 132 166</td>
</tr>
</tbody>
</table>

© Copyright 2001 Rapra Technology Limited
Subject Index

G

GEL PERMEATION
CHROMATOGRAPHY, 41 148
174 212 243
GENERATOR, 222
GLASS, 48 124 163 312 320 335
336
GLASS FIBRE, 134 151 271
GLASS FIBRE-REINFORCED
PLASTIC, 37 62 115 200 271
290 304
GLASS TRANSITION
TEMPERATURE, 18 33 38 50
62 71 83 84 105 107 108 123
127 128 140 148 170 217 251
256 306 318 322 335 349 350
352 358
GLOSS, 51 92 214 249 258 281
288 315 342
GLOVE, 46 237
GLYCIDYL METHACRYLATE COPOLYMER, 6 105 285
GLYCOLIC ACID COPOLYMER, 141
GOLF BALL, 61 103
GOLF CLUB, 290
GRAPHIC ART APPLICATION, 165 321
GRAPHITE FIBRE-
REINFORCED PLASTIC, 115
128 157 169 250
GRAVIMETRIC ANALYSIS, 87
115 128 174
GRAVURE COAT, 342
GRAVURE PRINTING, 249 288
GROWTH RATE, 143 165 197 259
288 303

H

HARDNESS, 16 18 50 57 66 69 71
81 90 108 109 110 111 136 154
160 163 181 189 191 200 213
214 224 252 264 265 283 303
305 308 320
HEADLAMP, 325
HEALTH HAZARD, 46 99 117
143 165 236 249 283 307 359
HEAT AGEING, 194
HEAT CURING, 29 72 86 160 173
266 310
HEAT DEGRADATION, 87 107
175
HEAT RESISTANCE, 41 47 67 94
102 105 118 123 128 134 158
197 231 280 329 332 336
HEAT SENSITIVITY, 70 76 78
126 282 283 338
HEAT STABILITY, 83 107 255
HEATING, 110 121 159 168 222
223 252 309
HIGH DENSITY
POLYETHYLENE, 90 94
HINDERED AMINE, 113 126 186
HOLOGRAM, 218 358
HOT MELT ADHESIVE, 67 68 83
94 150 197 210 242 253 255
280 307
HOT PRINT RESISTANCE, 314
HUMIDITY RESISTANCE, 150
HYDROGEL, 15 56 59 85 141 204
209 212 215 240 248 278 334
338 339 341
HYDROLYSIS, 228 235 335
HYDROPHILIC, 16 58 85 133 146
344
HYDROPHOBIC, 85
HYDROXYBUTYL ACRYLATE COPOLYMER, 13
HYDROXYETHYL METHACRYLATE COPOLYMER, 90 141
HYDROXYETHYL METHACRYLATE POLYMER, 39 99
HYDROXYPHENYL METHACRYLATE COPOLYMER, 350

I

IMAGE TRANSFER, 93
IMAGING, 74 75 218
IMPACT PROPERTIES, 220 304
314
IMPLANT, 146
IMPREGNATION, 276
INFRARED CURING, 272
INFRARED HEATING, 159 222
INFRARED SPECTROSCOPY, 10
13 16 20 23 31 41 43 44 79 87
99 111 115 129 131 141 146
148 157 158 163 172 187 305
306 308 309 357
INITIATOR, 2 5 9 16 19 22 29 31
43 44 45 51 54 55 58 60 63 64
71 74 76 77 78 80 83 90 91 92
94 98 99 102 106 109 111 121
122 125 126 127 130 131 134
138 142 145 155 158 160 163
174 178 179 186 191 193 195
196 200 202 206 211 213 215
220 226 250 254 268 272 292
INJECTION MOLDING, 321
INK, 8 58 61 74 91 92 96 100 103
104 114 119 125 135 136 143
144 165 177 178 182 213 226
<table>
<thead>
<tr>
<th>Subject Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>249 260 266 272 279 281 288</td>
</tr>
<tr>
<td>296 314 323 342 344 359</td>
</tr>
<tr>
<td>INSULATION, 68 159 214 276</td>
</tr>
<tr>
<td>INTEGRATED CIRCUIT, 288 358</td>
</tr>
<tr>
<td>INTELLIGENT MATERIAL, 215</td>
</tr>
<tr>
<td>INTERFACIAL POLYMERISATION, 198</td>
</tr>
<tr>
<td>INTERPENETRATING POLYMER NETWORK, 85</td>
</tr>
<tr>
<td>IODONIUM COMPOUND, 289</td>
</tr>
<tr>
<td>IONENE POLYMER, 99 116</td>
</tr>
<tr>
<td>ISOCYANATE, 6 214</td>
</tr>
<tr>
<td>ISOCTYL ACRYLATE COPOLYMER, 13</td>
</tr>
<tr>
<td>ISOPEPHORONE DIISOCYANATE COPOLYMER, 79</td>
</tr>
<tr>
<td>ISOPRENE, 273</td>
</tr>
<tr>
<td>ISOPRENE COPOLYMER, 137</td>
</tr>
<tr>
<td>ISOPROPYL ACRYLAMIDE COPOLYMER, 204</td>
</tr>
<tr>
<td>ITACONIC ANHYDRIDE COPOLYMER, 90</td>
</tr>
<tr>
<td>KINETICS, 16 31 79 106 131 281 359</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>LABEL, 55 67 68 83 94 210 289 291</td>
</tr>
<tr>
<td>LACQUER, 154</td>
</tr>
<tr>
<td>LAMINATE, 48 89 93 148 163 200 206 230 279 291 326</td>
</tr>
<tr>
<td>LAMP, 66 96 282 325 337 359</td>
</tr>
<tr>
<td>LASER, 89 300 311 331 336 340 358</td>
</tr>
<tr>
<td>LASER CURING, 91 129 272 331</td>
</tr>
<tr>
<td>LATEX, 40 87 162 214 235 236 237 238 285 314</td>
</tr>
<tr>
<td>LAYER, 49 75 89 311</td>
</tr>
<tr>
<td>LAYER POLYMERISATION, 198</td>
</tr>
<tr>
<td>LEACHING, 40 87</td>
</tr>
<tr>
<td>LEATHER FINISH, 314</td>
</tr>
<tr>
<td>LEGISLATION, 246 342 359</td>
</tr>
<tr>
<td>LEGION, 17 22 25 64 121 212 227 302 325 358</td>
</tr>
<tr>
<td>LIGHT ABSORPTION, 91 99 102 186 213 221</td>
</tr>
<tr>
<td>LIGHT BEAM, 66</td>
</tr>
<tr>
<td>LIGHT CURING, 90 118 275</td>
</tr>
<tr>
<td>LIGHT DEGRADATION, 107 126 291</td>
</tr>
<tr>
<td>LIGHT-EMITTING DIODE, 132</td>
</tr>
<tr>
<td>LIGHT GUIDE, 3</td>
</tr>
<tr>
<td>LIGHT INTENSITY, 99 118 358</td>
</tr>
<tr>
<td>LIGHT SCATTERING, 99 212 243</td>
</tr>
<tr>
<td>LIGHT SENSITIVE, 155</td>
</tr>
<tr>
<td>LIGHT STABILISER, 107 113 126 186</td>
</tr>
<tr>
<td>LIGHTING APPLICATION, 66</td>
</tr>
<tr>
<td>LIQUID CRYSTAL, 43 79 82 97 139 229</td>
</tr>
<tr>
<td>LIQUID CRYSTAL DISPLAY, 88</td>
</tr>
<tr>
<td>LIQUID CRYSTAL POLYMER, 42 52 133 139 180 207 217 231</td>
</tr>
<tr>
<td>LITHOGRAPHY, 63 136 165 204 218 267 271 279 331 347 349 350 351 352</td>
</tr>
<tr>
<td>LOW DENSITY POLYETHYLENE, 37</td>
</tr>
<tr>
<td>LOW TEMPERATURE CURING, 6 117 193 196 257 283 285 303</td>
</tr>
<tr>
<td>LOW VISCOSITY, 12 110 165 214 342</td>
</tr>
<tr>
<td>MACHINERY, 28 57 64 73 102 114 176 192 203 222 227 230 233 238 262 269 274 288</td>
</tr>
<tr>
<td>MAGNETRON, 222</td>
</tr>
<tr>
<td>MALEATE COPOLYMER, 38 69 181 283</td>
</tr>
<tr>
<td>MALEIMIDE COPOLYMER, 43 350</td>
</tr>
<tr>
<td>MALEIMIDE POLYMER, 244</td>
</tr>
<tr>
<td>MANUFACTURE, 96 129 230 269 316 322 328</td>
</tr>
<tr>
<td>MAR RESISTANCE, 7</td>
</tr>
<tr>
<td>MARKET, 96 257 279 342</td>
</tr>
<tr>
<td>MARKET SHARE, 67 117 143 288 303</td>
</tr>
<tr>
<td>MARKET SURVEY, 86 288</td>
</tr>
<tr>
<td>MASKING TAPE, 210</td>
</tr>
<tr>
<td>MATERIAL REPLACEMENT, 68 81 117 197 223 281 345</td>
</tr>
<tr>
<td>MATERIALS SELECTION, 71 96 319 320</td>
</tr>
<tr>
<td>MATTE, 38</td>
</tr>
<tr>
<td>MEAT PACKAGING, 47</td>
</tr>
<tr>
<td>MEDICAL APPLICATION, 15 68 85 90 118 141 155 210 255 278 307 320 338</td>
</tr>
<tr>
<td>MEMBRANE, 39 98 139 156 172 208 209 278 343</td>
</tr>
<tr>
<td>MERCURY LAMP, 91 213 215</td>
</tr>
<tr>
<td>METAL ADHESION, 159 342</td>
</tr>
<tr>
<td>METAL FIBRE-REINFORCED PLASTIC, 276</td>
</tr>
<tr>
<td>METAL INSERT, 159 222</td>
</tr>
<tr>
<td>METALLISING, 347</td>
</tr>
<tr>
<td>METHACRYLATE, 15 62 196 327</td>
</tr>
<tr>
<td>METHACRYLATE COPOLYMER, 6</td>
</tr>
<tr>
<td>METHACRYLATE POLYMER, 63 74 99 207</td>
</tr>
<tr>
<td>METHACRYLIC ACID COPOLYMER, 350</td>
</tr>
<tr>
<td>METHACRYLIC ESTER, 15 62 196</td>
</tr>
<tr>
<td>METHACRYLIC ESTER COPOLYMER, 6</td>
</tr>
<tr>
<td>METALLISING, 347</td>
</tr>
<tr>
<td>MICROCHIP, 65 153</td>
</tr>
<tr>
<td>MICROELECTRONIC, 287 352</td>
</tr>
<tr>
<td>MICROGEL, 204</td>
</tr>
<tr>
<td>MICROGRAPHY, 87</td>
</tr>
<tr>
<td>MICROLENS, 124</td>
</tr>
<tr>
<td>MICRONISED, 315</td>
</tr>
<tr>
<td>MICROPOROUS, 315</td>
</tr>
<tr>
<td>MICROSPHERE, 137</td>
</tr>
<tr>
<td>MICROWAVE ABSORPTION, 110 157 159 222 342</td>
</tr>
<tr>
<td>MICROWAVE CURING, 27 37 73 84 120 123 128 157 167 168 171 325</td>
</tr>
<tr>
<td>MOISTURE, 66 212 214 248</td>
</tr>
<tr>
<td>MOISTURE CURING, 86</td>
</tr>
<tr>
<td>MOISTURE RESISTANCE, 67 88 122</td>
</tr>
<tr>
<td>MOLECMULAR STRUCTURE, 16 29 31 35 73 82 99 107 133 140 148 152 155 184 210 212 221 229 231 247 248 278 304 305 306 308 311 334 335 354 359</td>
</tr>
<tr>
<td>MOLECULAR WEIGHT, 20 24 32 33 63 92 99 108 140 143 162 210 248 286 306 339</td>
</tr>
<tr>
<td>MONITORING, 34 176 187 271</td>
</tr>
<tr>
<td>MOULD, 54 89 302</td>
</tr>
<tr>
<td>MOULDING, 59 64 121 169 227 292 332</td>
</tr>
<tr>
<td>MULTICHIP MODULE, 322</td>
</tr>
<tr>
<td>MULTILAYER, 47 132</td>
</tr>
<tr>
<td>NAIL POLISH, 58</td>
</tr>
<tr>
<td>NANOCOMPOSITE, 72 133</td>
</tr>
<tr>
<td>NANOFIBRE, 286</td>
</tr>
</tbody>
</table>
Subject Index

NANOPARTICLE, 82 160 218
NANOPOROUS, 139
NANOSPHERE, 137 205
NATURAL RUBBER, 40 222 236 237 238
NEAR-INFRARED RADIATION, 117
NEMATIC, 97 217 229 231
NEOPRENE, 222
NETWORK, 33 42 44 52 133 141 212 215 229 231 235
NEURAL NETWORK, 188
NITRILE RUBBER, 46 222
NITROGEN, 12 13 19 248
NITROGEN INERTING, 164
NOVOLAK RESIN, 348
NUCLEAR MAGNETIC RESONANCE, 10 20 41 155 215 243 308
NYLON, 37 107 315 343

O
OCTANOYLETHYL METHACRYLATE COPOLYMER, 205
ODOUR, 92 249
ODOUR-FREE, 342
OPACITY, 76 78 147 281
OPHTHALMIC APPLICATION, 25 227 302
OPTICAL AMPLIFICATION, 105
OPTICAL ANISOTROPY, 97 207
OPTICAL APPLICATION, 17 22 64 101 105 112 121 124 134 160 218 221 284
OPTICAL CLARITY, 122
OPTICAL DATA STORAGE, 218
OPTICAL DISC, 101 192 234 358
OPTICAL FIBRE, 14 77 100 112 119 122 134 151 165 174 288 335 336 358
OPTICAL PROPERTIES, 22 25 71 87 90 92 93 97 99 122 135 192 213 214 221 325 335 336 346 358
OPTICAL WAVEGUIDE, 105 221
OPTOELECTRONICS, 307
ORGANO SILICONE POLYMER, 55 66 214 272
ORTHOPAEDIC APPLICATION, 11 35 146
OUTDOOR APPLICATION, 95
OVEN CURING, 290
OVERHEATING, 159 222
OXIDATIVE DEGRADATION, 107
OXIDATIVE STABILITY, 335

P
OXHRANE POLYMER, 75 87
OXGEN, 129 156 163 273 291
OXGEN BARRIER, 64 121
OXGEN INHIBITION, 196
OXGEN PERMEABILITY, 156 172
PACKAGING, 47 114 123 136 165 182 213 214 225 246 249 260 266 267 268 275 279 282 294 342
PAINT, 71 126 147 214 223 303
PEEL STRENGTH, 90 94 102 140 148 149 150 155 197 251 256 313
PENDANT GROUP, 58 90 357
PENDULUM TEST, 18 71 109 154
PENTAFLUOROSTYRENE COPOLYMER, 105
PERCOLATION, 31 358
PERMSELECTIVITY, 208 343
PEROXIDE Vulcanisation, 200
PH, 209 215 235 248 278
PHOTOCATALYST, 317
PHOTOACID, 348 349 351
PHOTOACTIVITY, 220
PHOTOALIGNMENT, 97
PHOTOCALORIMETRY, 70 153 281 287
PHOTOCHEMISTRY, 213 215 221 323 359
PHOTODEGRADATION, 2 107 113 291
PHOTODIMERISATION, 221
PHOTODYNAMIC ANALYSIS, 271
PHOTOELECTRON SPECTROSCOPY, 36
PHOTOINITIATOR, 2 5 9 16 19 22 29 31 44 45 51 54 58 60 63 64 71 74 77 78 80 83 90 91 92
94 99 102 106 109 111 121 122 125 126 130 134 138 142 145 155 158 160 163 174 178 179
186 191 193 195 196 202 206 211 213 215 220 226 250 254 268 272 289 305 308 313 318 335 349 351 352 358 359
PHOTOLITHOGRAPHY, 204 271 300
PHOTOLYSIS, 15 99 107 131 268
PHOTOMICROGRAPHY, 87
PHOTOXIDATIVE DEGRADATION, 107
PHOTORESIST, 288 346 347 348 349 350 351 352 359
PHOTOSENSITIVITY, 25 90 138 204 206 271 319 323 359
PHYSICAL PROPERTIES, 40 116 215 231 238 304 305 315 353
PIGMENT, 18 45 71 74 76 91 92 99 107 113 177 213 226 254 258 272 281 283 297 324 325 336 342 354
POLYACRYLIC ACID, 56 75 209
POLYACRYLOYL PROLINE METHYL ESTER, 208
POLYALKENE, 149 150
POLYBENZOTRIAZOLE, 199
POLYBISGLYCINICIDYL METHACRYLATE, 99
POLYBISMALEIMIDE, 169 170
POLYBUTADIENE, 149 150
POLY BUTYLENE TEREPTHALATE, 310
POLYCAPROLACTONE, 75
POLYCARBONATE, 27 75 160 163 192 234 318 325 358
POLYCARBONATE URETHANE ACRYLATE, 318
POLYCHLOROPRENE, 222
POLYCLINAMOYLETHYL METHACRYLATE, 243 286

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Subject Index

POLYCYANOACRYLATE, 66
POLYDIACRYLATE, 42 229
POLYDICYCLOPENTADIENE, 106
POLYDIMETHYLSILOXANE, 24 25 235 311 335
POLYDIVINYL ETHER, 353
POLYEPOXIDE, 6 9 10 23 26 27 50 51 60 62 65 66 73 86 107 118 125 127 131 142 153 164 166 170 184 202 213 214 220 250 252 272 283
POLYEPOXY ACRYLATE, 9 92 112 136 154 165 211 213 271 326
POLYESTER ACRYLATE, 5 92 108 109 136 154 165 188 211 213 326
POLYESTER FIBRE, 52
POLYESTERETHER, 97
POLYETHER, 122 131 142
POLYETHER ACRYLATE, 9 211
POLYETHYLENE, 37 90 94 155 279 282
POLYETHYLENE GLYCOL, 116 344
POLYETHYLENE GLYCOL ACRYLATE, 98
POLYETHYLENE GLYCOL DIACRYLATE, 107
POLYETHYLENE GLYCOL METHACRYLATE, 98
POLYETHYLENE OXIDE, 75 87 215
POLYETHYLENE TEREPTHALATE, 102
POLYGLYCIDYL ETHER, 22
POLYHYDROXYETHYL METHACRYLATE, 39 99
POLYHYDROXYPHENYL METHACRYLATE, 350
POLYIMIDE, 84 115 123 128 157 322
POLYIONENE, 99 116
POLYSISOCYANATE, 6 327
POLYSISOPRENE, 308
POLYSISOPROPYL ACRYLAMIDE, 215 334
POLYLACTIC ACID, 85
POLYMALDEIMIDE, 244
POLYMER DISPERSED LIQUID CRYSTAL, 43 79
POLYMERIC RELEASE AGENT, 55 93 219
POLYMERISATION MECHANISM, 23 106 142 156 304 305 306 308 355
POLYMETHYL METHACRYLATE, 63 74 99 107 163 207
POLYMETHYLPHENYLISILOXANE ACRYLATE, 335
POLYOL, 50 327 354 356
POLYOLEFIN, 107 122 206 285
POLYORGANOPHOSPHAZENE, 278
POLYORGANOSILOXANE, 24 25 55 66 214 272
POLYOXYETHYLENE, 75 87 215
POLYPENTAERYTHRITOL TETRAACRYLATE, 31
POLYPENTAERYTHRITOL TRIACRYLATE, 99 218
POLYPERFLUOROALKYL ETHER, 346
POLYPHENYLENE OXIDE, 75
POLYPHENYLPHENYL SILICONE ACRYLATE, 335
POLYOL, 50 327 354 356
POLYOLEFIN, 107 122 206 285
POLYORGANOPHOSPHAZENE, 278
POLYORPHOSPHAZINE, 172
POLYPROPYLENE, 282
POLYSILICONE ACRYLATE, 112
POLYSILOXANE, 55 66 80 144 164 214 252 272 288 289 291 293 311 335 346
POLYSTYRENE, 37 75 83 243 285 286 332
POLYSTERENE, 37 75 83 243
POLYURETHANE DIMETHACRYLATE, 99
POLYURETHANE-ACRYLATE, 5
POLYURETHANE METHACRYLATE, 63
POLYVINYL BENZENE, 75 243
POLYVINYL CHLORIDE, 75 94 163 279 280 337
POLYVINYL CINNAMATE, 30 221
POLYVINYL ETHER, 107 125 130 164 194 195 220 231 303 308 353
POLYVINYL ETHYL ETHER, 346
POLYVINYL METHYL ETHER, 75 215
POLYVINYL PHENOL, 349
POLYVINYL PYRIDINE, 215
POLYVINYL PYRROLIDONE, 339
POLYVINYLIDENE FLUORIDE, 107
POLYVINYLCHLORIDE, 75 94 163 279 280 337
POROSITY, 205 208 213
POST CURING, 54 64 121
POTTING COMPOUND, 80 86 321 345
POWDER COATING, 6 9 18 69 70 71 76 78 95 107 113 117 126 187 191 193 196 214 216 223 239 257 283 288 303 307 315 328 333 336
PRECURING, 59 235
PREDRYING, 109
PREPOLYMER, 107 112 116 196 210
PREPREG, 157 321
PRESS FORMING, 49
PRESSURE, 30 48 110 227
PRESSURE-SENSITIVE, 67
PRESSURE-SENSITIVE ADHESIVE, 12 13 53 55 68 83 90 94 102 140 148 149 150 155 176 188 195 197 201 210 242 247 251 253 255 256 262 273 274 279 280 299 307 358
PRETREATMENT, 8
PRIMER, 8 70 214 264
PRINTED CIRCUIT, 86 123 270 275 321 358
PRINTED WIRING BOARD, 123
PRINTING, 61 92 93 103 104 125
PRINTING INK, 58 91 92 114 144 177 178 213 260 281
PRINTING PLATE, 93 138
PRODUCT ANNOUNCEMENT, 3
PRODUCT COST, 66 127 198 210 225 319
PROTECTIVE CLOTHING, 46

© Copyright 2001 Rapra Technology Limited

121
<table>
<thead>
<tr>
<th>Subject Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROTECTIVE COATING, 58 86</td>
</tr>
<tr>
<td>126 163</td>
</tr>
<tr>
<td>PROTOTYPE, 127 269 301 331</td>
</tr>
<tr>
<td>340</td>
</tr>
<tr>
<td>PULSED, 64 121 337</td>
</tr>
<tr>
<td>Q</td>
</tr>
<tr>
<td>QUALITY CONTROL, 34 110 346</td>
</tr>
<tr>
<td>QUARTZ, 213 271 284 311</td>
</tr>
<tr>
<td>R</td>
</tr>
<tr>
<td>RADIANT HEAT, 147 159</td>
</tr>
<tr>
<td>RADICAL POLYMERISATION, 12 13 55 138</td>
</tr>
<tr>
<td>RADOPACITY, 99</td>
</tr>
<tr>
<td>RAMAN SPECTROSCOPY, 10 27</td>
</tr>
<tr>
<td>161</td>
</tr>
<tr>
<td>RAPID PROTOTYPING, 301 331</td>
</tr>
<tr>
<td>REACTIVE DILUENT, 99 164</td>
</tr>
<tr>
<td>244 272 289 313 318</td>
</tr>
<tr>
<td>REACTIVITY, 6 50 92 111 131</td>
</tr>
<tr>
<td>211 323 344 353</td>
</tr>
<tr>
<td>REAL TIME, 19 31 79</td>
</tr>
<tr>
<td>RECORDING MEDIA, 192 234</td>
</tr>
<tr>
<td>358</td>
</tr>
<tr>
<td>RECYCLING, 81 214 241 249 260</td>
</tr>
<tr>
<td>REFLECTOR, 91 213 282 325</td>
</tr>
<tr>
<td>REFRACTIVE INDEX, 24 25 105</td>
</tr>
<tr>
<td>122 124 194 221 284 335 336</td>
</tr>
<tr>
<td>346 358</td>
</tr>
<tr>
<td>REINFORCED PLASTIC, 33 37</td>
</tr>
<tr>
<td>49 54 62 73 84 89 115 120 127</td>
</tr>
<tr>
<td>128 151 157 169 170 171 173</td>
</tr>
<tr>
<td>198 200 233 235 244 245 250</td>
</tr>
<tr>
<td>258 271 276 290 302 304 345</td>
</tr>
<tr>
<td>RELEASE AGENT, 55 93 219 227</td>
</tr>
<tr>
<td>RELEASE COATING, 83 164 179</td>
</tr>
<tr>
<td>183 289 291 293 299</td>
</tr>
<tr>
<td>REPAIRING, 48 127 147</td>
</tr>
<tr>
<td>RESIDUAL STRESS, 27 110 127</td>
</tr>
<tr>
<td>RESIN TRANSFER MOLDING, 169</td>
</tr>
<tr>
<td>RESIST, 347 348 349 352</td>
</tr>
<tr>
<td>REVIEW, 12 13 66 86 120 165 210</td>
</tr>
<tr>
<td>272 279 307 318 358</td>
</tr>
<tr>
<td>RHEOLOGICAL PROPERTIES, 40 70 92 94 99 107 108 110 116</td>
</tr>
<tr>
<td>129 130 160 165 166 178 182</td>
</tr>
<tr>
<td>188 190 195 196 197 201 213</td>
</tr>
<tr>
<td>214 216 220 224 265 306 343</td>
</tr>
<tr>
<td>344</td>
</tr>
<tr>
<td>ROLLING BALL TEST, 256</td>
</tr>
<tr>
<td>ROOF, 214</td>
</tr>
<tr>
<td>ROOM TEMPERATURE CURING, 86 310</td>
</tr>
<tr>
<td>RUBBER, 13 24 28 40 42 44 46 57</td>
</tr>
<tr>
<td>64 66 68 83 85 87 88 94 96 101</td>
</tr>
<tr>
<td>102 103 108 110 111 121 126</td>
</tr>
<tr>
<td>136 138 140 143 148 149 150</td>
</tr>
<tr>
<td>158 159 161 162 164 165 167</td>
</tr>
<tr>
<td>168 174 177 178 182 187 191</td>
</tr>
<tr>
<td>193 201 203 214 222 224 227</td>
</tr>
<tr>
<td>228 235 236 237 238 251 253</td>
</tr>
<tr>
<td>255 261 263 264 265 266 267</td>
</tr>
<tr>
<td>268 270 273 275 277 293 295</td>
</tr>
<tr>
<td>299 300 301 307 308 309 312</td>
</tr>
<tr>
<td>326 327 328 329 330 335 336</td>
</tr>
<tr>
<td>346 358</td>
</tr>
<tr>
<td>SAFETY, 46 213 249 301 307 316</td>
</tr>
<tr>
<td>SATELLITE, 127</td>
</tr>
<tr>
<td>SATURATED POLYESTER, 304</td>
</tr>
<tr>
<td>305 306</td>
</tr>
<tr>
<td>SCANNING ELECTRON MICROSCOPY, 15 27 84 347</td>
</tr>
<tr>
<td>348 349</td>
</tr>
<tr>
<td>SCRATCH RESISTANCE, 144</td>
</tr>
<tr>
<td>213 214 325</td>
</tr>
<tr>
<td>SCREEN PRINTING, 129 165 259</td>
</tr>
<tr>
<td>358</td>
</tr>
<tr>
<td>SEALANT, 65 96 110 145 168 310</td>
</tr>
<tr>
<td>316</td>
</tr>
<tr>
<td>SELF-DRYING, 16 109 143 154</td>
</tr>
<tr>
<td>197 213</td>
</tr>
<tr>
<td>SEMICONDUCTOR, 123 167 288</td>
</tr>
<tr>
<td>321</td>
</tr>
<tr>
<td>SEPARATION MEMBRANE, 208</td>
</tr>
<tr>
<td>SHEAR, 15 67 84 90 94 102 128</td>
</tr>
<tr>
<td>149 150 182 210 251 256 280</td>
</tr>
<tr>
<td>336</td>
</tr>
<tr>
<td>SHEAR ADHESION FAILURE TEMPERATURE, 94 102 149</td>
</tr>
<tr>
<td>SHEET, 27 230 279</td>
</tr>
<tr>
<td>SHELF LIFE, 94 127 147 200 214</td>
</tr>
<tr>
<td>SHRINK WRAPPING, 47</td>
</tr>
<tr>
<td>SHRINKAGE, 7 26 50 60 63 66 99</td>
</tr>
<tr>
<td>127 208 220 284 327 328 336</td>
</tr>
<tr>
<td>358</td>
</tr>
<tr>
<td>SILANE COMPOUND, 8 292</td>
</tr>
<tr>
<td>SILICA, 99 160 163 213 228 235</td>
</tr>
<tr>
<td>287 292 315</td>
</tr>
<tr>
<td>SILICON DIOXIDE, 99 163 228</td>
</tr>
<tr>
<td>235</td>
</tr>
<tr>
<td>SILICONE, 219 291</td>
</tr>
<tr>
<td>SILICONE ACRYLATE POLYMER, 164 335</td>
</tr>
<tr>
<td>SILICONE POLYMER, 55 66 107</td>
</tr>
<tr>
<td>112 144 164 214 252 272 288</td>
</tr>
<tr>
<td>289 291 293 311 335 346</td>
</tr>
<tr>
<td>SILICONE RUBBER, 222 235</td>
</tr>
<tr>
<td>SMART CARD, 65</td>
</tr>
<tr>
<td>SMEAR RESISTANCE, 125</td>
</tr>
<tr>
<td>SMOOTHNESS, 51 76</td>
</tr>
<tr>
<td>SOFT CONTACT LENSES, 59</td>
</tr>
<tr>
<td>SOLDER MASK, 313</td>
</tr>
<tr>
<td>SOLDER RESISTANCE, 323 332</td>
</tr>
<tr>
<td>SOLVENT CASTING, 31 215</td>
</tr>
<tr>
<td>SOLVENT RESISTANCE, 14 83</td>
</tr>
<tr>
<td>102 119 135 194 213 224 314</td>
</tr>
<tr>
<td>329 344</td>
</tr>
<tr>
<td>SOLVENTLESS, 10 70 83 94 107</td>
</tr>
<tr>
<td>118 130 151 201 210 213 214</td>
</tr>
<tr>
<td>249 288 292 307</td>
</tr>
<tr>
<td>SOYABEAN OIL, 166</td>
</tr>
<tr>
<td>SPACE APPLICATION, 127 152</td>
</tr>
<tr>
<td>SPECTACLES, 302</td>
</tr>
<tr>
<td>SPIN COATING, 132 347</td>
</tr>
<tr>
<td>SPORTS APPLICATION, 103 214</td>
</tr>
<tr>
<td>SPOT CURING, 66</td>
</tr>
<tr>
<td>SPRAY DRYING, 16 109 143 154</td>
</tr>
<tr>
<td>197 213</td>
</tr>
<tr>
<td>SPRAYING, 70 165 265 283 295</td>
</tr>
<tr>
<td>SPREADING, 28 101</td>
</tr>
<tr>
<td>STABILITY, 41 83 94 102 105 118</td>
</tr>
<tr>
<td>123 128 134 158 231 329</td>
</tr>
<tr>
<td>STAIN RESISTANCE, 213 314</td>
</tr>
<tr>
<td>353</td>
</tr>
<tr>
<td>STEAM STERILISATION, 338</td>
</tr>
<tr>
<td>STEREOGRAPHY, 63 165</td>
</tr>
<tr>
<td>218 279 300 301 327 331 340</td>
</tr>
<tr>
<td>STORAGE MODULUS, 90 229</td>
</tr>
<tr>
<td>318</td>
</tr>
<tr>
<td>STRENGTH, 47 173 235 264 335</td>
</tr>
<tr>
<td>336</td>
</tr>
<tr>
<td>STRESS, 27 31 110 123 127 168</td>
</tr>
<tr>
<td>169</td>
</tr>
<tr>
<td>STRESS-STRAIN PROPERTIES, 110 235 293 335</td>
</tr>
<tr>
<td>STRIPPABLE COATING, 346</td>
</tr>
<tr>
<td>STRUCTURAL ADHESIVE, 321</td>
</tr>
<tr>
<td>STRUCTURAL APPLICATION, 332</td>
</tr>
<tr>
<td>STRUCTURAL COMPOSITE, 49</td>
</tr>
<tr>
<td>321</td>
</tr>
<tr>
<td>STYRENE-BUTADIENE-STYRENE BLOCK COPOLYMER, 44 94 102 111</td>
</tr>
<tr>
<td>210</td>
</tr>
<tr>
<td>STYRENE-ISOPRENE-STYRENE BLOCK COPOLYMER, 44 94</td>
</tr>
<tr>
<td>SULFUR DIOXIDE COPOLYMER, 352</td>
</tr>
<tr>
<td>SURGICAL ADHESIVE, 90</td>
</tr>
<tr>
<td>SURGICAL APPLICATION, 11 35</td>
</tr>
<tr>
<td>90 146 155 237 240</td>
</tr>
<tr>
<td>SWELLING, 15 56 85 141 209 215</td>
</tr>
<tr>
<td>235 248 278 285 334</td>
</tr>
</tbody>
</table>
T

TACK, 87 94 149 150 197 251 256
TACKIFIER, 12 13 149 150 195
201 251 256
TANK, 127
TAPE, 55 68 83 90 94 150 197 210
TAPE WINDING, 198 244
TEMPERATURE, 7 16 62 78 87 90 102 110 123 159 212 215 222 223 229 231 235 282 318 335
TEMPERATURE DEPENDENCE, 31 41 52 110 209 229
TEMPERATURE RESISTANCE, 68
TENSILE PROPERTIES, 40 52 72 110 171 200 220 263 304 318 320 335 336 338 358
TEST, 2 19 27 81 82 90 110 153 156 187 232 253 256 264 278 287 304 305 306 307 318 331 340
TESTING, 13 70 71 108 109 164 166 169 185 195 200 203 211 251 256 273 325 336
THERMAL CURING, 52 64 70 76 88 128 173 189 196 200
THERMAL DEGRADATION, 41 87 107 175 194
THERMAL PROPERTIES, 33 41 107 116 128 145 159 210 222 306 318
THERMAL STABILITY, 41 47 67 94 102 105 118 123 128 134 158 197 228 231 280 329 332 355 366 354
THERMOGRAVIMETRIC ANALYSIS, 84 87 105 115 128 156 174
THERMOELECTRICAL PROPERTIES, 62 119 335
THERMOOXIDATIVE DEGRADATION, 107
THERMOPLASTIC ELASTOMER, 44 83 111 307
THICKNESS, 16 28 62 90 107 127 159 264 281 282 288 311 331 346 353
TISSUE ENGINEERING, 15 141 181 211 249 342 344
TOOLING, 321
TOOLS, 49
TOPOCOAT, 61 103
TOUGHENING AGENT, 61 103
TOUGHNESS, 47 160 220 235 338
TOXICITY, 67 99 117 165 295 359
TRANSMISSION ELECTRON MICROSCOPY, 27 82 285 286
TRANSPARENCY, 22 87 92 93 186 192 212 214 281 284 333 336
TRIGLICYCIDYL ISO CYANURATE, 6 117 201 251 256
TRIMETHYLOLPROPANE DIALYL ETHER COPOLYMER, 79
TRIMETHYLOLPROPANE TRIACRYLATE POLYMER, 31 99
TUBE, 290 294
TURNTABLE, 101

U

ULTRAVIOLET OFFSET LITHOGRAPHY, 267
ULTRAVIOLET PHOTORESIST, 347 348 349 350 351
ULTRAVIOLET RESISTANCE, 150 197 258 352
ULTRAVIOLET SPECTRA, 91 102 207 323
ULTRAVIOLET STABILISER, 113 126
URETHANE ACRYLATE COPOLYMER, 126 165
URETHANE ACRYLATE OLIGOMER, 148 165
VISCOELASTIC PROPERTIES, 68 99 117 165 295 359
VACUUM METALLISATION, 325
VARNISH, 126 211 249 342 344
VEHICLE ENGINE, 223
VIBRATIONAL SPECTROSCOPY, 10 16 23 27 44 99 115 129 146 163
VIDEO DISC, 358
VINYL BENZALDEHYDE COPOLYMER, 113 126
VINYL ETHER COPOLYMER, 69 181 283
VINYL ETHER GROUP, 77
VINYL ETHER POLYMER, 107 125 130 164 194 195 220 231 353
VINYL PHENOL COPOLYMER, 349
VOLATILE ORGANIC COMPOUND, 165 213 214 288 295 307
VULCANISATION, 87 110 159 200 222 235 236 237 238
VULCANISATION TIME, 7 13 18 29 84 101 117 118 127 213 222

W

WALL COVERING, 214
WARM MELT, 12 13 149 150
WASTE DISPOSAL, 214 241
WATER ABSORPTION, 16 50 99 127 213 278 335 356
WATER PERMEABILITY, 107 356
WATER RESISTANCE, 51 201 214 220 224 312 314 329 336 344 356
WATER SOLUBLE, 33 40 87 205 212 236 278 339 344
WAVEGUIDE, 105 221 358
WAVELENGTH, 28 99 118 206 222 231 325
WEAR RESISTANCE, 22 29 81 160 181 194 213 214 220 228
WEATHER RESISTANCE, 7 70 74 113 185 186 191 199 228 258 261 263 292 325 358
WELDING, 275
WETTING, 36 92 107 177 213 214
WINDOW FRAME, 312
WIRE COATING, 358
WOOD, 58 76 78 81 165 181 190 211 224 257 264 265 272 281 283 297 298 303 314 326
WOOD FINISH, 143 211 283
WOUND DRESSING, 15 90

© Copyright 2001 Rapra Technology Limited
Subject Index

X

X-RAY RESISTANCE, 352
X-RAY SCATTERING, 82 139
X-RAY SPECTROSCOPY, 36

Y

YARN, 49
YELLOWING, 2 186 213 261 263
YOUNG’S MODULUS, 65 172 271 318