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(54) Title: UV CURABLE FERROMAGNETIC COMPOSITIONS

(57) Abstract: The present invention discloses an ultraviolet light curable ferromagnetic composition and method for making such a composition that may be used to produce a ferromagnetic coating on a suitable substrate. These coatings may be used to produce printed capacitors and inductors. The disclosed composition does not contain any significant amount of volatile organic solvents.

UV CURABLE FERROMAGNETIC COMPOSITIONS

TECHNICAL FIELD

The present invention relates to ultraviolet light (uv) curable compositions capable of producing a ferromagnetic coating.

BACKGROUND OF THE INVENTION

Electronic components, such as capacitors and inductors, are typically applied to rigid circuit boards through the process of soldering. However, electronic components may be produced from curable ferromagnetic compositions. Such film coatings have previously been formed through thermosetting and heat curing processes.

Heat curable coatings require the use of organic solvents that contain a significant amount of volatile organic compounds (VOCs). These VOCs escape into the atmosphere while the heat curable coating dries. Such solvent based systems are undesirable because of the hazards and expenses associated with VOCs. The hazards include water and air pollution and the expenses include the cost of complying with strict government regulation on solvent emission levels. In contract, UV curable ferromagnetic film coatings contain reactive monomers instead of solvents; thus eliminating the detrimental effects of the VOCs.

UV curable coatings are cured through rapid photo-induced polymerizations instead of thermal energy which releases VOCs into the atmosphere. Since the UV curing process is essentially solvent free, the necessity for time consuming and expensive pollution abatement procedures is greatly reduced.

UV curable coatings offer several other benefits not associated with thermally cured coatings. First, faster cure times offer substantial economic benefits. Furthermore, heat sensitive materials can be safely coated and cured with

UV light without thermal degradation of heat sensitive substrates. Additionally, UV light is a relatively low cost of energy due to its widespread availability.

Although UV curable coatings are superior to their thermal counterparts, there are still disadvantages inherent in UV curable coatings. Since UV curable coatings require compositions with high molecular weight and viscosity, spray and brush application is often difficult. Additionally, many UV curable coatings require compositions that are prone to dispersion and instability.

Accordingly, there exists a need to provide environmentally safe UV curable ferromagnetic compositions which exhibit improved performance and workability. Additionally, there is a need to provide a method of applying an improved composition which furthers the goal of improved performance.

SUMMARY OF INVENTION

It is an object of the present invention to provide an improved composition that upon curing by ultraviolet light produces a ferromagnetic coating.

It is another object of the present invention to provide an improved composition suitable for producing screen printed capacitors and inductors.

It is another object of the present invention to provide an improved composition suitable for coating a suitable substrate that can be applied by spraying, screen printing, dipping, and brushing.

It is still another object of the present invention to provide an improved composition that does not contain any significant amount of volatile organic solvents that do not become incorporated in the active layer after curing.

The present invention discloses an ultraviolet light curable ferromagnetic composition and method for making such a composition that may be used to produce a coating on a suitable substrate. The disclosed composition does

not contain any significant amount of volatile organic solvents that do not become incorporated in the active layer after curing. Specifically, the ferromagnetic composition contains 5% or less volatile organic solvents by weight.

In accordance with one aspect of the invention, an ultraviolet light curable ferromagnetic composition is provided. The ferromagnetic composition comprises a mixture of one or more aliphatic acrylated oligomers, wherein the aliphatic acrylated oligomer mixture is present in an amount of about 15% to 45% of the ferromagnetic composition. All percentages of the ferromagnetic composition as expressed in this document refer to the weight percentage of the stated component to the total weight of the ferromagnetic composition in its fluid state at standard temperature and pressure.

The ferromagnetic composition preferably further comprises an acrylated epoxy oligomer in an amount of about 2% to 6%, an isobornyl acrylate monomer in an amount of about 15% to 25% of the ferromagnetic composition, a photoinitiator in an amount of about 1% to 10% of the ferromagnetic composition, a flow promoting agent in an amount of about 0.1% to 6% of the ferromagnetic composition, and a conductive/magnetic powder in an amount of about 20% to 60% of the ferromagnetic composition.

In accordance with yet another aspect of the invention, a method is provided for depositing a ferromagnetic coating on a substrate. The method comprises a first step of applying to the substrate a ferromagnetic fluid-phase composition ("ferromagnetic composition"). The ferromagnetic composition comprises a mixture of aliphatic acrylated oligomers, wherein the aliphatic acrylated oligomer is present in an amount of about 15% to 45% of the ferromagnetic composition. The ferromagnetic composition also includes an acrylated epoxy oligomer in an amount of about 2% to 6%, an isobornyl acrylate monomer in an amount of about 15% to 25% of the ferromagnetic composition, a photoinitiator in an amount of about 1% to 10% of the ferromagnetic composition, and a flow promoting agent in an amount of about 0.1% to 6% of the ferromagnetic

composition, and a conductive/magnetic powder in an amount of about 20% to 60% of the ferromagnetic composition.

The method also includes a second step of illuminating the ferromagnetic composition on the substrate with an ultraviolet light to cause the ferromagnetic composition to cure into the ferromagnetic coating.

In accordance with this method, the ferromagnetic composition can be selectively deposited on the substrate at specific locations where ferromagnetic plating is desired. It need not be applied to the entire substrate.

BEST MODE FOR CARRYING OUT THE INVENTION

Ferromagnetic Compositions

Reference will now be made in detail to presently preferred compositions or embodiments and methods of the invention, which constitute the best modes of practicing the invention presently known to the inventor.

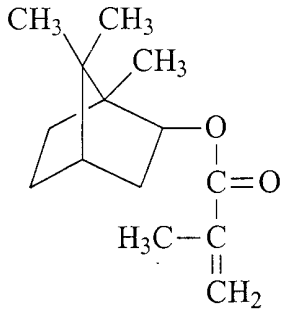
In accordance with one aspect of the invention, a presently preferred ultraviolet light curable ferromagnetic composition ("ferromagnetic composition") is provided. In this preferred embodiment, the ferromagnetic composition includes a mixture of aliphatic acrylated oligomers. The aliphatic acrylated oligomer mixture is present in an amount of about 15% to 45% of the ferromagnetic composition. The aliphatic acrylated oligomer mixture is more preferably present in an amount of about 25% to 35%, and most preferably about 30%. The aliphatic acrylated oligomer preferably comprises one or more urethane oligomers. Suitable aliphatic acrylated oligomers include Radcure Ebecryl 244 (aliphatic urethane diacrylate diluted 10% by weight with 1,6-hexanediol diacrylate), Ebecryl 264 (aliphatic urethane triacrylate diluted 15% by weight with 1,6-hexanediol diacrylate), Ebecryl 284 (aliphatic urethane diacrylate diluted 12% by weight with 1,6-hexanediol diacrylate) urethanes, commercially available from Radcure UCB Corp. of Smyrna, Georgia; Sartomer CN-961E75 (aliphatic urethane diacrylate blended with 25% by

weight ethoxylated trimethylol propane triacylate), CN-961H81 (aliphatic urethane diacrylate blended with 19% by weight 2(2-ethoxyethoxy)ethyl acrylate), CN-963A80 (aliphatic urethane diacrylate blended with 20% by weight tripropylene glycol diacrylate), CN-964 (aliphatic urethane diacrylate), CN-966A80 (aliphatic urethane diacrylate blended with 20% by weight tripropylene glycol diacrylate), CN-982A75 (aliphatic urethane diacrylate blended with 25% by weight tripropylene glycol diacrylate) and CN-983 (aliphatic urethane diacrylate), commercially available from Sartomer Corp. of Exton, Pennsylvania; TAB FAIRAD 8010, 8179, 8205, 8210, 8216, 8264, M-E-15, UVU-316, commercially available from TAB Chemicals of Chicago, Illinois; and Echo Resin ALU-303, commercially available from Echo Resins of Versaille, Missouri; and Genomer 4652, commercially available from Rahn Radiation Curing of Aurora, IL. The preferred aliphatic acrylated oligomers include Ebecryl 264 and Ebecryl 284. Ebecryl 264 is an aliphatic urethane triacrylate of 1200 molecular weight supplied as an 85% solution in hexanediol diacrylate. Ebecryl 284 is aliphatic urethane diacrylate of 1200 molecular weight diluted 10% with 1,6-hexanediol diacrylate. Combinations of these materials may also be employed herein.

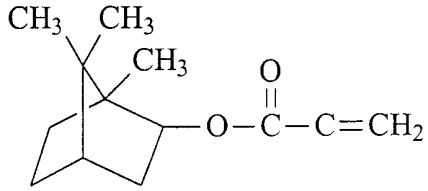
This preferred ferromagnetic composition further includes an acrylated epoxy oligomer. The acrylated epoxy oligomer is present in an amount of about 2% to 6%. The acrylated epoxy oligomer is more preferably present in an amount of about 3% to 5%, and most preferably about 4%. Suitable acrylated epoxy oligomers include Radcure Ebecryl 3603 (novolac epoxy acrylate diluted 20% by weight with tripropylene glycol diacrylate), commercially available from Radcure UCB Corp.; Sartomer CN-120 (difunctional bisphenol based epoxy acrylate) and CN-124 (difunctional bisphenol based epoxy acrylate), commercially available from Sartomer Corp.; and Echo Resin TME 9310 and 9345, commercially available from Echo Resins. The preferred acrylated epoxy oligomer is Ebecryl 3603, which is a tri-functional acrylated epoxy novolac. Combinations of these materials may also be employed herein.

The preferred ferromagnetic composition also includes an isobornyl acrylate monomer in an amount of about 15% to 25%. The isobornyl acrylate

monomer is more preferably present in an amount of about 18% to 22%. and most preferably about 20%. Suitable isobornyl acrylate monomers include Sartomer SR-423 (isobornyl methacrylate):



and SR-506 (isobornyl acrylate):



available from Sartomer Corp.; Radcure IBOA (isobornyl acrylate), commercially available from Radcure Corp.; IBOA and IBOMA, commercially available from CPS Chemical of Bradford, England; and Genomer 1121, commercially available from Rahn Radiation Curing. The preferred isobornyl acrylate monomer is Radcure IBOA, commercially available from Radcure Corp. Radcure IBOA is a high purity, low color monomer. Combinations of these materials may also be employed herein.

This preferred ferromagnetic composition also includes a photoinitiator in an amount of about 1% to 10% of the ferromagnetic composition. The photoinitiator is more preferably present in an amount of about 2% to 6%, and most preferably about 4.5%. Suitable photoinitiators include Irgacure 184 (1-hydroxycyclohexyl phenyl ketone), Irgacure 907 (2-methyl-1-[4-(methylthio)phenyl]-2-morpholino propan-1-one), Irgacure 369 (2-benzyl-2-N,N-dimethylamino-1-(4-morpholinophenyl)-1-butanone), Irgacure 500 (the combination of 50% by weight 1-hydroxy cyclohexyl phenyl ketone and 50% by weight

benzophenone),Irgacure 651 (2,2-dimethoxy-2-phenyl acetophenone), Irgacure 1700 (the combination of 25% by weight bis(2,6-dimethoxybenzoyl-2,4-,4-trimethyl pentyl) phosphine oxide, and 75% by weight 2-hydroxy-2-methyl-1-phenyl-propan-1-one), Darocur 1173 (2-hydroxy-2-methyl-1phenyl-1-propane) and Darocur 4265 (the combination of 50% by weight 2,4,6-trimethylbenzoyldiphenyl-phosphine oxide, and 50% by weight 2-hydroxy 2-methyl-1-phenyl-propan-1-one), available commercially from Ciba-Geigy Corp., Tarrytown, N.Y.; CYRACURE UVI-6974 (mixed triaryl sulfonium hexafluoroantimonate salts) and CYRACURE UVI-6990 (mixed triaryl sulfonium hexafluorophosphate salts) available commercially from Union Carbide Chemicals and Plastics Co. Inc., Danbury, Conn.; and Genocure CQ, Genocure BOK, and Genocure M.F., commercially available from Rahn Radiation Curing. The preferred photoinitiator is Irgacure 1700 commercially available from Ciba-Geigy of Tarrytown, New York. Combinations of these materials may also be employed herein.

The preferred ferromagnetic composition still further includes a flow promoting agent in an amount of about 0.1% to 6%, and preferably about 3%, of the paint composition. Suitable flow promoting agents include Genorad 17, commercially available from Rahn Radiation Curing; and Modaflow, commercially available from Monsanto Chemical Co., St. Louis, Missouri. The preferred flow promoting agent is Modaflow which is an ethyl acrylate and 2-ethylhexyl acrylate copolymer that improves the flow of the composition. Combinations of these materials may also be employed herein.

The preferred ferromagnetic composition still further includes a conductive/magnetic powder in an amount of about 20% to 60%. The conductive/magnetic powder is more preferably present in an amount of about 30% to 50%, and most preferably about 40%. The preferred conductive/magnetic powder is Ferrite powder commercially available from GFS Chemical located in Powell, Ohio.

To illustrate, the following example sets forth a presently preferred ferromagnetic composition according to this aspect of the invention.

Example 1

This example provides a preferred ferromagnetic composition according to the invention that may be applied to a substrate by screen printing. The ferromagnetic composition was made from the following components:

Component	Approximate Weight %
Ebecryl 264	15.1
Ebecryl 284	15.1
IBOA	19.9
Irgacure 1700	4.5
Ebecryl 3603	4.0
Modaflow	2.9
Ferrite	38.5
Total	**100.00**

In this example the IBOA and Irgacure 1700 are mixed in a pan with a propeller blade mixer for 30 seconds at a speed of 500 to 1000 rpm. In the next step, the Ebecryl 264, the Ebecryl 284, the Ebecryl 3603, and Modaflow are introduced into the pan and mixed for 1 to 2 minutes at a speed of 2000 rpm. In the final step, the Ferrite is added and mixed at 2000 rpm for 1 to 2 minutes. The mixing is temporarily suspended if the temperature exceed 100°F.

Method for Depositing a Ferromagnetic Coating

In accordance with still another aspect of the invention, a method is provided for depositing an ferromagnetic coating on a suitable substrate. The method comprises a first step of applying a ferromagnetic fluid-phase composition ("ferromagnetic composition") to the substrate.

The ferromagnetic composition comprises a mixture of aliphatic acrylated oligomers, wherein the aliphatic acrylated oligomer is present in an amount of about 15% to 45% of the ferromagnetic composition. The ferromagnetic composition also includes an acrylated epoxy oligomer in an amount of about 2% to

6%, an isobornyl acrylate monomer in an amount of about 15% to 25% of the ferromagnetic composition, a photoinitiator in an amount of about 1% to 10% of the ferromagnetic composition, and a flow promoting agent in an amount of about 0.1% to 6% of the ferromagnetic composition, and a conductive/magnetic powder in an amount of about 20% to 60% of the ferromagnetic composition.. The preferred ferromagnetic compositions according to this method are those described herein, for example, including the compositions described in example 1.

The ferromagnetic composition may be applied to the substrate using a number of different techniques. The ferromagnetic composition may be applied, for example, by direct brush application, or it may be sprayed onto the substrate surface. It also may be applied using a screen printing technique. In such screen printing technique, a "screen" as the term is used in the screen printing industry is used to regulate the flow of liquid composition onto the substrate surface. The ferromagnetic composition typically would be applied to the screen as the latter contacts the substrate. The ferromagnetic composition flows through the silk screen to the substrate, whereupon it adheres to the substrate at the desired film thickness. Screen printing techniques suitable for this purpose include known techniques, but wherein the process is adjusted in ways known to persons of ordinary skill in the art to accommodate the viscosity, flowability, and other properties of the liquid-phase composition, the substrate and its surface properties, etc. Flexographic techniques, for example, using pinch rollers to contact the ferromagnetic composition with a rolling substrate, also may be used.

The method includes a second step of illuminating the ferromagnetic fluid-phase composition on the substrate with an ultraviolet light to cause the ferromagnetic fluid-phase composition to cure into the ferromagnetic coating. This illumination may be carried out in any number of ways, provided the ultraviolet light or radiation impinges upon the ferromagnetic composition so that the ferromagnetic composition is caused to polymerize to form the coating, layer, film, etc., and thereby cures.

Curing preferably takes place by free radical polymerization, which is initiated by an ultraviolet radiation source. The photoinitiator preferably comprises a photoinitiator, as described above.

Various ultraviolet light sources may be used, depending on the application. Preferred ultraviolet radiation sources for a number of applications include known ultraviolet lighting equipment with energy intensity settings of, for example, 125 watts, 200 watts, and 300 watts per square inch.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A photocurable ferromagnetic composition comprising:

a photocurable organic mixture;

a photoinitiator; and

a conductive/magnetic powder.

2. The photocurable ferromagnetic composition of claim 1 wherein the photocurable organic mixture comprises:

an acrylated epoxy oligomer; and

an isobornyl acrylate monomer.

3. The photocurable ferromagnetic composition of claim 2 further comprising an acrylated aliphatic oligomer mixture.

4. The photocurable ferromagnetic composition of claim 3 further comprising a flow promoting agent.

5. The photocurable ferromagnetic composition of claim 4 wherein:

the acrylated epoxy oligomer is about 2% to 6% of the weight of the ferromagnetic composition;

the isobornyl acrylate monomer is about 15% to 25% of the weight of the ferromagnetic composition;

the photoinitiator is about 1% to 10% of the weight of the ferromagnetic composition;

the acrylated aliphatic oligomer mixture is about 15% to 45% of the weight of the ferromagnetic composition;

the flow promoting agent is about 0.1% to 6% of the weight of the ferromagnetic composition; and

the conductive/magnetic powder is about 20% to 60% of the weight of the ferromagnetic composition.

6. The photocurable ferromagnetic composition of claim 4 wherein:

the acrylated epoxy oligomer is about 3% to 5% of the weight of the ferromagnetic composition;

the isobornyl acrylate monomer is about 18% to 22% of the weight of the ferromagnetic composition;

the photoinitiator is about 2% to 6% of the weight of the ferromagnetic composition;

the acrylated aliphatic oligomer mixture is about 25% to 35% of the weight of the ferromagnetic composition;

the flow promoting agent is about 0.1% to 6% of the weight of the ferromagnetic composition; and

the conductive/magnetic powder is about 30% to 50% of the weight of the ferromagnetic composition.

7. The photocurable ferromagnetic composition of claim 4 wherein:

the acrylated epoxy oligomer is about 4% of the weight of the ferromagnetic composition;

the isobornyl acrylate monomer is about 20% of the weight of the ferromagnetic composition;

the photoinitiator is about 4.5% of the weight of the ferromagnetic composition;

the acrylated aliphatic oligomer mixture is about 30% of the weight of the ferromagnetic composition;

the flow promoting agent is about 3% of the weight of the ferromagnetic composition; and

the conductive/magnetic powder is about 40% of the weight of the ferromagnetic composition.

8. A method for coating a substrate with a photocurable ferromagnetic composition, the method comprising:

applying the ferromagnetic composition to the substrate, wherein the ferromagnetic composition includes:

the acrylated epoxy oligomer in an amount of about 2% to 6% of the weight of the ferromagnetic composition;

the isobornyl acrylate monomer in an amount of about 15% to 25% of the weight of the ferromagnetic composition;

the photoinitiator in an amount of about 1% to 10% of the weight of the ferromagnetic composition;

the acrylated aliphatic oligomer mixture in an amount of about 15% to 45% of the weight of the ferromagnetic composition;

the flow promoting agent in an amount of about 0.1% to 6% of the weight of the ferromagnetic composition; and

the conductive/magnetic powder in an amount of about 20% to 60% of the weight of the ferromagnetic composition.

9. The method of claim 8, wherein UV light used in illuminating impinges upon the ferromagnetic composition so that the ferromagnetic composition is caused to form a coating as it cures.

10. The method of claim 8, wherein the method of applying the ferromagnetic composition is spraying.

11. The method of claim 8, wherein the method of applying the ferromagnetic composition is screen printing.

12. The method of claim 8, wherein the method of applying the ferromagnetic composition is dipping the substrate into the composition sufficiently to cause the composition to uniformly coat the substrate.

13. The method of claim 8, wherein the method of applying the ferromagnetic composition is brushing.

14. The method of claim 8, wherein the method of applying the ferromagnetic composition is selectively depositing to the substrate at predetermined locations.

15. A method for coating a substrate with a photocurable ferromagnetic composition, the method comprising:

applying the ferromagnetic composition to the substrate, wherein the ferromagnetic composition includes:

the acrylated epoxy oligomer in an amount of about 3% to 5% of the weight of the ferromagnetic composition;

the isobornyl acrylate monomer in an amount of about 18% to 22% of the weight of the ferromagnetic composition;

the photoinitiator in an amount of about 2% to 6% of the weight of the ferromagnetic composition;

the acrylated aliphatic oligomer mixture in an amount of about 25% to 35% of the weight of the ferromagnetic composition;

the flow promoting agent in an amount of about 0.1% to 6% of the weight of the ferromagnetic composition; and

the conductive/magnetic powder in an amount of about 30% to 50% of the weight of the ferromagnetic composition;

illuminating the ferromagnetic composition with a UV light sufficient to cause the ferromagnetic composition to be incorporated into the ferromagnetic coating by the time the composition is cured.

16. The method of claim 15, wherein:

the acrylated epoxy oligomer is about 4% of the weight of the ferromagnetic composition;

the isobornyl acrylate monomer is about 20% of the weight of the ferromagnetic composition;

the photoinitiator is about 4.5% of the weight of the ferromagnetic composition;

the acrylated aliphatic oligomer mixture is about 30% of the weight of the ferromagnetic composition;

the flow promoting agent is about 3% of the weight of the ferromagnetic composition; and

the conductive/magnetic powder is about 40% of the weight of the ferromagnetic composition.

17. The ferromagnetic composition of claim 2 wherein the isobornyl acrylate monomer is selected from the group consisting of isobornyl acrylate, isobornyl methacrylate, and mixtures thereof.

18. The ferromagnetic composition of claim 2 wherein the photoinitiator is selected from the group consisting of:

1-hydroxycyclohexyl phenyl ketone;

2-methyl-1-[4-(methylthio)phenyl]-2-morpholino propan-1-;

the combination of 50% 1-hydroxy cyclohexyl phenyl ketone and 50% benzophenone;

2,2-dimethoxy-1,2-diphenylethan-1-one;

the combination of 25% bis(2,6-dimethoxybenzoyl-2,4-, 4-trimethyl pentyl phosphine oxide and 75% 2-hydroxy-2-methyl-1-phenyl-propan-1-one;

2-hydroxy-2-methyl-1-phenyl-1-propane;

the combination of 50% 2,4,6-trimethylbenzoyldiphenyl-phosphine oxide and 50% 2-hydroxy 2-methyl-1-phenyl-propan-1-one;

mixed triaryl sulfonium hexafluoroantimonate salts, mixed triaryl sulfonium hexafluorophosphate salts; and

mixtures thereof.

19. The ferromagnetic composition of claim 2 wherein the acrylated epoxy oligomer is selected from the group consisting of:

novolac epoxy acrylate diluted 20% by weight with tripropylene glycol diacrylate;

difunctional bisphenol based epoxy acrylate; and

mixtures thereof.

20. A method of making a photocurable ferromagnetic composition comprising:

mixing an isobornyl acrylate monomer and a photoinitiator in a pan;

introducing a flow promoting agent and an acrylated epoxy oligomer into the pan;

mixing the flow promoting agent and the acrylated epoxy oligomer in the pan;

introducing a conductive/magnetic powder into the pan; and

mixing the conductive/magnetic powder in the pan.

INTERNATIONAL SEARCH REPORT

Inter ɔnal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C09D4/06 C08F290/06 C08F290/14 C09D4/00 C08F220/18
C09D5/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C09D C08F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 180 757 A (LUCEY MICHAEL) 19 January 1993 (1993-01-19) column 5, line 51 -column 8, line 39 column 12, line 58 - line 65 column 17, line 46 -column 18, line 38 column 20, line 37 -column 21, line 18 examples claims 1-4,12,13,37,39,40,45-47,51,54,55	1,2
Y	idem.	3,4
A	idem.	5,8,15, 20

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
24 April 2001	10/05/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Bettels, B

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INTERNATIONAL SEARCH REPORT

Inter. ›nal Application No
PCT/US 01/00978

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 747 115 A (POOLE KAREN M ET AL) 5 May 1998 (1998-05-05) column 2, line 57 -column 3, line 10 examples claims 1,2,11,12,14	1,2
Y	idem.	3,4
X	EP 0 567 940 A (GLUNZ AG) 3 November 1993 (1993-11-03) column 1, line 48 -column 2, line 25 column 3, line 12 - line 54 column 4, line 3 - line 6 column 4, line 20-25 claims 1-10,12,13	1

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