

Patent # 1729

**CIRCUIT COMPONENTS
PREPARED FROM ALLYLATED AMIDE COMPOUNDS**

5 The priority of US provisional application number 60/091,505 is
claimed under 35 USC 119 (e).

 This invention relates to circuit component compositions prepared
from allylated amide compounds useful in the fabrication of printed wire
boards.

10 The complementary components to active microelectronic conductive
circuits are resistors, capacitors, and inductors, known as passive
components. These components, both the active circuits and the passives,
are supported and interconnected on printed wire boards (PWB) in
microelectronic devices.

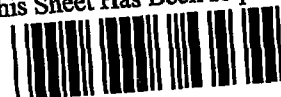
15 While the integration of active circuit functions using silicon integrated
circuits been a major success, the integration of passive components is still in
the developmental stage. Many of the passive components remain discrete,
individual components, and often exceed in number by an order of magnitude
the number of active integrated circuits on PWBs. This has increased the
20 complexity of the PWBs and decreased the available surface area for other

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devices. The only alternative in the past has been to increase the size of the printed wire boards.

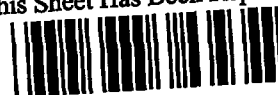
More recent advances in circuit board design provide for planar components formed on layers of the printed wire board, or for components
5 buried in recesses in the board, resulting in a higher packaging efficiency. This integration of passive components reduces the number of electrical contacts or transitions between the active and passive components, which provides a consequent improvement in electrical performance and a reduction in mechanical stress at these transition points.

10 The utilization of integral passive components would be particularly advantageous in thin-film packages, and there is a significant effort within the industry to develop organic materials that will function reliably as passive components in microelectronic devices, particularly for thin-film packages. Moreover, as it is expensive to discard printed wire boards, it would be a
15 manufacturing advantage to have an organic material that can be reworked.

In order to achieve the required mechanical performance and desired reworkability, relatively high molecular weight thermoplastics would be the preferred compositions. These materials, however, have high viscosity or even a solid film form, which are drawbacks to the manufacturing process.

20 Today, one of the primary thrusts within the semiconductor industry is to develop suitable materials for passive components, and particularly materials that would be reworkable.

This invention relates to circuit components prepared from compositions containing allylated amide compounds, a free-radical initiator
25 and/or a photoinitiator, optionally one or more mono- or polyfunctional vinyl compounds, and optionally fillers or other additives.



In another embodiment, this invention is a method for making an electronic circuit component on a printed wire board from a reworkable curable circuit component composition comprising the steps: (a) providing a curable circuit component composition; (b) applying the curable composition to the printed wire board; and (c) curing the composition *in situ*.

The allylated amide compounds, and the vinyl compounds, if any, used in the compositions for the fabrication of circuit components are curable compounds, meaning that they are capable of polymerization, with or without crosslinking. As used in this specification, to cure will mean to polymerize, with or without crosslinking. Cross-linking, as is understood in the art, is the attachment of two polymer chains by bridges of an element, a molecular group, or a compound, and in general will take place upon heating. As cross-linking density is increased, the properties of a material can be changed from thermoplastic to thermosetting, which consequently increases polymeric strength, heat-and electrical resistance, and resistance to solvents and other chemicals.

It is possible to prepare polymers of a wide range of cross-link density, from tacky, elastomeric to tough glassy polymers, by the judicious choice and amount of mono- or polyfunctional compounds. The greater proportion of polyfunctional compounds reacted, the greater the cross-link density. If thermoplastic properties are desired, the compositions of this invention can be prepared from mono-functional compounds to limit the cross-link density. However, a minor amount of poly-functional compounds can be added to provide some cross-linking and strength to the composition, provide the amount of poly-functional compounds is limited to an amount that does not diminish the desired thermoplastic properties. Within these parameters,



the strength and elasticity of individual circuit component compositions can be tailored to a particular end-use application.

The cross-link density can also be controlled to give a wide range of glass transition temperatures in the cured circuit component composition to
5 withstand subsequent processing and operation temperatures. For some circuit component compositions, the Tg may be chosen so that the composition will reflow after cure, thus providing the ability to rework the circuit component on the substrate.

In the inventive compositions, the allylated amide compounds, and
10 the vinyl compounds if used in combination with the allylated amide compounds, will be present in the curable circuit component compositions in an amount from 2 to 98 weight percent based on the organic components present (excluding any fillers).

The compositions will further comprise at least one free-radical
15 initiator, which is defined to be a chemical species that decomposes to a molecular fragment having one or more unpaired electrons, highly reactive and usually short-lived, which is capable of initiating a chemical reaction by means of a chain mechanism. The free-radical initiator will be present in an amount of 0.1 to 10 percent, preferably 0.1 to 3.0 percent, by weight of the
20 allylated amide or allylated amide and vinyl compound (excluding any filler).

The free radical curing mechanism gives a fast cure and provides the composition with a long shelf life before cure. Preferred free-radical initiators include peroxides, such as butyl peroctoates and dicumyl peroxide, and azo compounds, such as 2,2'-azobis(2-methyl-propanenitrile) and 2,2'-azobis(2-
25 methyl-butanenitrile).

Alternatively, the circuit component compositions may contain a photoinitiator, such as is sold by Ciba Specialty Chemicals under the

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trademark Irgacure, in lieu of the free-radical initiator, and the curing process may then be initiated by UV radiation. The photoinitiator will be present in an amount of 0.1 to 10 percent, preferably 0.1 to 3.0 percent, by weight of the allylated amide or vinyl compound, or a combination of both allylated amide and vinyl compounds (excluding any filler). In some cases, both photoinitiation and free-radical initiation may be desirable. For example, the curing process can be started by UV irradiation, and in a later processing step, curing can be completed by the application of heat to accomplish a free-radical cure.

10 In general, these compositions will cure within a temperature range of 50° to 250°C, and curing will be effected within a length of time of less than one minute to four hours. As will be understood, the time and temperature curing profile for each adhesive composition will vary, and different compositions can be designed to provide the curing profile that will be suited to the particular industrial manufacturing process.

Ease of application, even when thermoplastic properties are desired for the circuit component, is achieved by using relatively low molecular weight reactive oligomers or pre-polymers and curing these *in situ* after application to the substrate on which the circuit component is to be formed. Applying the materials in an uncured state gives high processibility, and the resultant cured composition provides high mechanical performance.

Circuit components can include resistors, conductors, inductors, dielectrics, capacitors, and combinations of these. It will be understood that all resistors necessarily exhibit some conductance, and all conductors exhibit some resistance, and that resistors and conductors form a continuum of resistance and conductance depending on the specific property of the individual component. This continuum is also the case for dielectrics and



capacitors. A dielectric may function as a true dielectric or isolating component, or as a capacitor, depending on the specific dielectric constant for the component. By the judicious choice of filler, these compositions can be formulated to give a broad range of resistivity, conductivity, capacitance, or
5 dielectric properties as needed for the specific circuit component.

Providing the precise type and amount of filler for obtaining the electrical properties desired for a specific end use application is within the expertise of one skilled in the art. Exemplary conductive fillers are silver, copper, gold, platinum, palladium. Exemplary resistive fillers are carbon black,
10 carbon fiber, and graphite. Exemplary capacitance fillers are barium titanate and titanium dioxide. The fillers will be present typically in an amount of 20 to 90 percent by weight of the total circuit component composition.

By way of example, acceptable commercial values of resistivity for conductive materials are in the range of 0.200 ohms per square or less, and
15 for resistive materials are in the range of 0.005 to 10M ohms per square, as tested by ASTM-D-257.

The components formed from the inventive materials on the printed wire boards will be formed using the techniques for making circuit components and printed wire boards known to those skilled in the art. As will
20 be understood, these components can be those that are designated in the art as planar or buried components. The invention herein is formed by using relatively low molecular weight reactive oligomers or pre-polymers and curing these *in situ* after application to the substrate on which the circuit component is to be formed.

25 In general, the circuit components are formed in combination with via holes, which are Z directional, present in the printed circuit boards for interconnecting surface devices or components with conductive layers on or

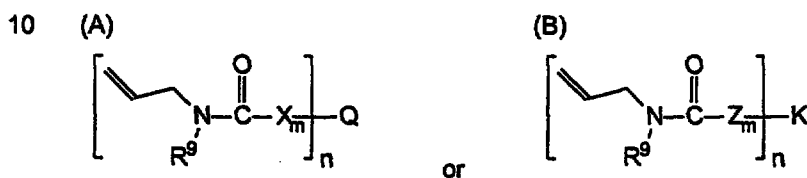


in the printed circuit board. The circuit component is formed as a geometric configuration conductively interconnected with the conductive layers in the printed circuit board. The curable circuit component composition is deposited in the configuration by conventional techniques and cured *in situ*.

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Allylated Amide Compounds

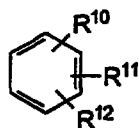
The allylated amide compounds suitable for use in the compositions of this invention have a structure represented by the formulas A and B as depicted here:



As used throughout this specification, the notation C(O) refers to a carbonyl group. For these specific formulae, when lower case "n" is the integer 1, the compound will be a mono-functional compound; and when lower case "n" is an integer 2 to 6, the compound will be a poly-functional compound.

20 Formula A represents those compounds in which:

R⁹ is H, an alkyl or alkyleneoxy group having 1 to 18 carbon atoms, allyl, aryl, or substituted aryl having the structure



in which R¹⁰, R¹¹, and R¹² are independently

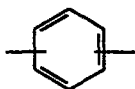
H or an alkyl or alkyleneoxy group having 1 to 18 carbon atoms;

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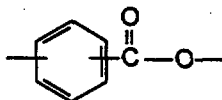


each X independently is an aromatic group selected from the aromatic groups having the structures (I) through (V):

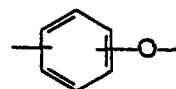
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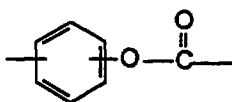


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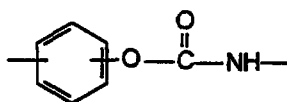


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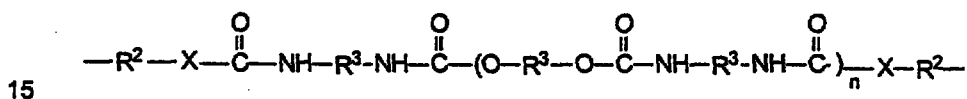


(V)



and Q is a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the backbone in the chain, and in which any heteroatom present may or may not be directly attached to X;

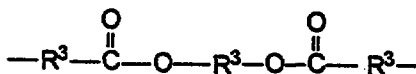
or Q is a urethane having the structure:



in which each R^2 independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; X is O, S, N, or P; and n is 0 to 50;

20

or Q is an ester having the structure:



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in which R³ is an alkyl or alkyloxy chain having up to 100 atoms in the chain,

which chain may contain aryl substituents;

or Q is a siloxane having the structure:

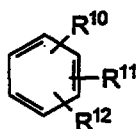
$-(CR^1_2)_e-[SiR^4-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R¹ substituent

- 5 independently for each position is H or an alkyl group having 1 to 5 carbon atoms and the R⁴ substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e and g are independently 1 to 10 and f is 1 to 50; and

m is 0 or 1, and n is 1 to 6.

- 10 Formula B represents those compounds in which

R⁹ is H, or an alkyl or alkyleneoxy group having 1 to 18 carbon atoms, or an allyl group, or an aryl or substituted aryl having the structure



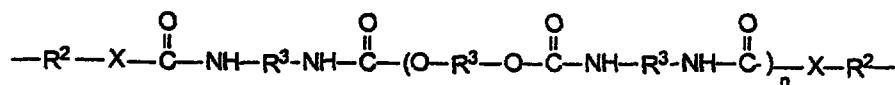
in which R¹⁰, R¹¹, and R¹² are independently

H or an alkyl or alkyleneoxy group having 1 to 18 carbon atoms;

- 15 Z is a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the backbone in the chain, and in which any

- 20 heteroatom present may or may not be directly attached to K;

or Z is a urethane having the structure:

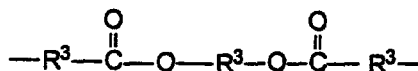


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in which each R^2 independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; X is O, S, N, or P; and n is 0 to 50;

5 or Z is an ester having the structure:



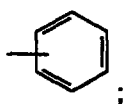
in which R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents;

or Z is a siloxane having the structure:

10 $-(\text{CR}^1_2)_e-[\text{SiR}^4_2-\text{O}]_f-\text{SiR}^4_2-(\text{CR}^1_2)_g-$ in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms and the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e and g are independently 1 to 10 and f is 1 to 50;

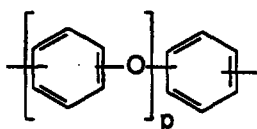
15 K is an aromatic group selected from the aromatic groups having the structures (VI) through (XIII) (although only one bond may be shown to represent connection to the aromatic group K, this will be deemed to represent any number of additional bonds as described and defined by n):

(VI)



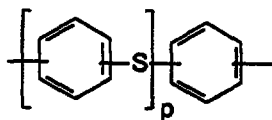
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(VII)



in which p is 1 to 100;

(VIII)

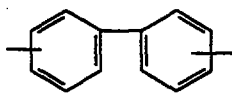


in which p is 1 to 100;

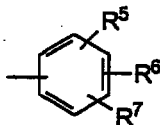
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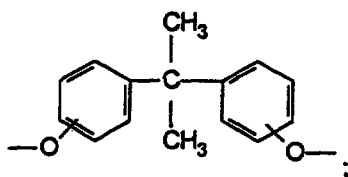


(X)



- 5 in which R^5 , R^6 , and R^7 are a linear or branched chain alkyl, alkylloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the backbone in the chain, and in which any heteroatom present may or may not be directly attached to the aromatic ring; or R^5 , R^6 , and R^7 are a siloxane having the structure $-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CH_3)_g-$ in which the R^1 substituent is H or an alkyl group having 1 to 5 carbon atoms and the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e is 1 to 10 and f is 0 to 50;
- 10
- 15

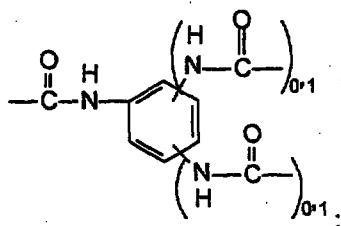
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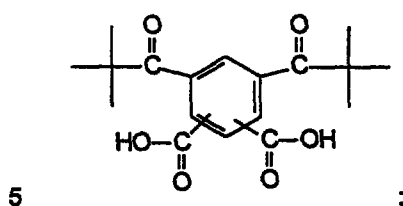
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(XII)



and (XIII)



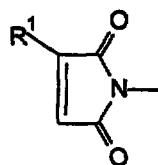
and m is 0 or 1 and n is 1 to 6.

Vinyl Compounds

The compounds suitable for use in the adhesive compositions of this invention have a structure represented by one of the formulae:



M represents a vinyl group and can be the maleimide moiety having the structure:

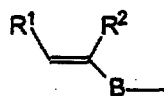


in which R¹ is H or C₁ to C₅ alkyl; or

or the vinyl moiety having the structure:

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in which R^1 and R^2 are H or an alkyl having

1 to 5 carbon atoms, or together form a 5 to 9 membered ring with the

carbons forming the vinyl group; B is C, S, N, O, C(O), O-C(O), C(O)-O,

C(O)NH or C(O)N(R^6), in which R^6 is C_1 to C_5 alkyl. Preferably, B is O, C(O),

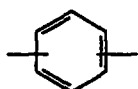
5 O-C(O), C(O)-O, C(O)NH or C(O)N(R^6); more preferably B is O, C(O), O-

C(O), C(O)-O, or C(O)N(R^6).

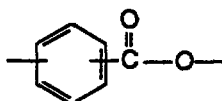
X independently is an aromatic group selected from the aromatic

groups having the structures (I) through (V):

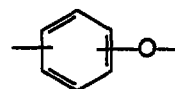
(I)



(II)

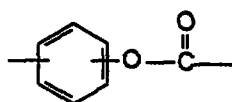


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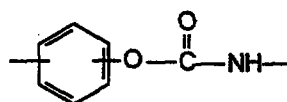


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(IV)



(V)



, and

Preferably, X is structure (II), (III), (IV) or (V), and more preferably is structure

(II).

15

Q and Z independently can be a linear or branched chain alkyl,

alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine,

alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100

atoms in the chain, which may contain saturated or unsaturated cyclic or

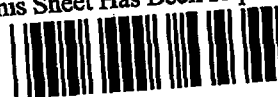
heterocyclic substituents pendant from the chain or as part of the backbone in

20

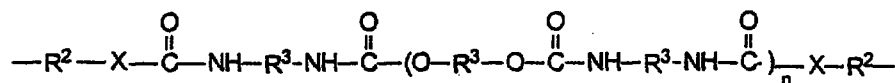
the chain, and in which any heteroatom present may or may not be directly

attached to X;

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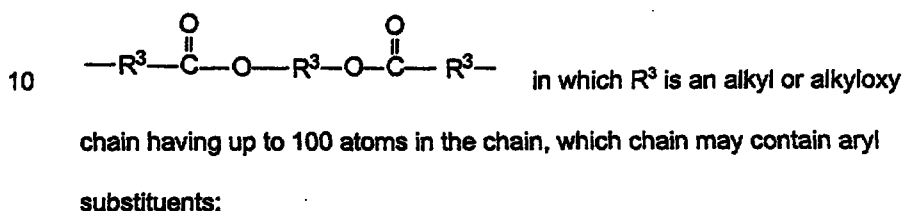


or Q and Z independently can be a urethane having the structure:



- 5 in which each R^2 independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; X is O, S, N, or P; and n is 0 to 50;

or Q and Z independently can be an ester having the structure:



or Q and Z independently can be a siloxane having the structure:

- 15
$$-(CR^1_2)_e-[SiR^4-O]_f-SiR^4_2-(CR^1_2)_g-$$
 in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms and the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e and g are independently 1 to 10 and f is 1 to 50.

- 20 Preferably, Q and Z will be a linear or branched chain alkyl, alkyloxy, alkylene, or alkyleneoxy species having up to about 100 atoms in the chain, as described with pendant saturated or unsaturated cyclic or heterocyclic substituents, or a siloxane as described, and more preferably is a linear or branched chain alkyl species or siloxane, as described.

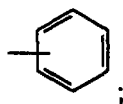
- 25 K is an aromatic group selected from the aromatic groups having the structures (VI) through (XIII) (although only one bond may be shown to

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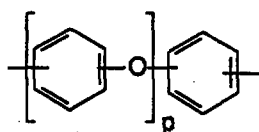


represent connection to the aromatic group K, this will be deemed to represent any number of additional bonds as described and defined by n):

(VI)

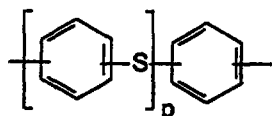


(VII)



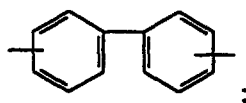
in which p is 1 to 100;

5 (VIII)

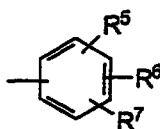


in which p is 1 to 100;

(IX)



(X)



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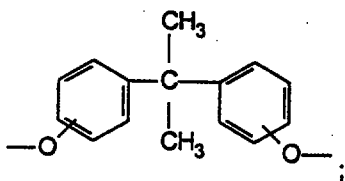
in which R^5 , R^6 , and R^7 are a linear or branched

chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the

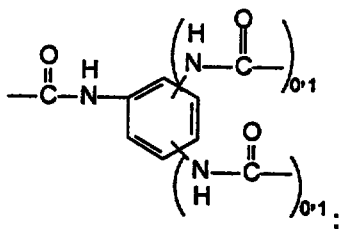
15 backbone in the chain, and in which any heteroatom present may or may not be directly attached to the aromatic ring; or R^5 , R^6 , and R^7 are a siloxane having the structure $-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CH_3)_g-$ in which the R^1 substituent is H or an alkyl group having 1 to 5 carbon atoms and the R^4 substituent independently for each position is an alkyl group having 1 to 5
20 carbon atoms or an aryl group, and e is 1 to 10 and f is 0 to 50;



(XI)

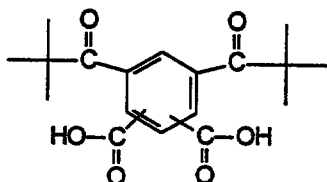


(XII)



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and (XIII)



10 Preferably, K is structure (VIII), (X) or (XI), more preferably is structure (X) or (XI), and most preferably is structure (X).

Other Composition Components

Depending on the nature of the substrate, the composition may also contain a coupling agent. A coupling agent as used herein is a chemical species containing a polymerizable functional group for reaction with the maleimide and other vinyl compound, and a functional group capable of condensing with metal hydroxides present on the surface of the substrate. Such coupling agents and the preferred amounts for use in compositions for

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particular substrates are known in the art. Suitable coupling agents are silanes, silicate esters, metal acrylates or methacrylates, titanates, and compounds containing a chelating ligand, such as phosphine, mercaptan, and acetoacetate. When present, coupling agents typically will be in amounts up
5 to 10 percent by weight, and preferably in amounts of 0.1-3.0 percent by weight, of the maleimide and other monofunctional vinyl compound.

In addition, the compositions may contain compounds that lend additional flexibility and toughness to the resultant cured composition. Such compounds may be any thermoset or thermoplastic material having a Tg of
10 50°C or less, and typically will be a polymeric material characterized by free rotation about the chemical bonds, such as can be obtained by the presence of carbon-carbon double bonds adjacent to carbon-carbon single bonds, the presence of ester and ether groups, and the absence of ring structures. Suitable such modifiers include polyacrylates, poly(butadiene), polyTHF (
15 polymerized tetrahydrofuran), CTBN (carboxy-terminated butyronitrile) rubber, and polypropylene glycol. When present, toughening compounds may be in an amount up to about 15 percent by weight of the maleimide and other monofunctional vinyl compound.

Siloxanes may also be added to the compositions to impart
20 elastomeric properties. Suitable siloxanes are the methacryloxypropyl-terminated polydimethyl siloxanes, and the aminopropyl-terminated polydimethylsiloxanes, available from United Chemical Technologies.

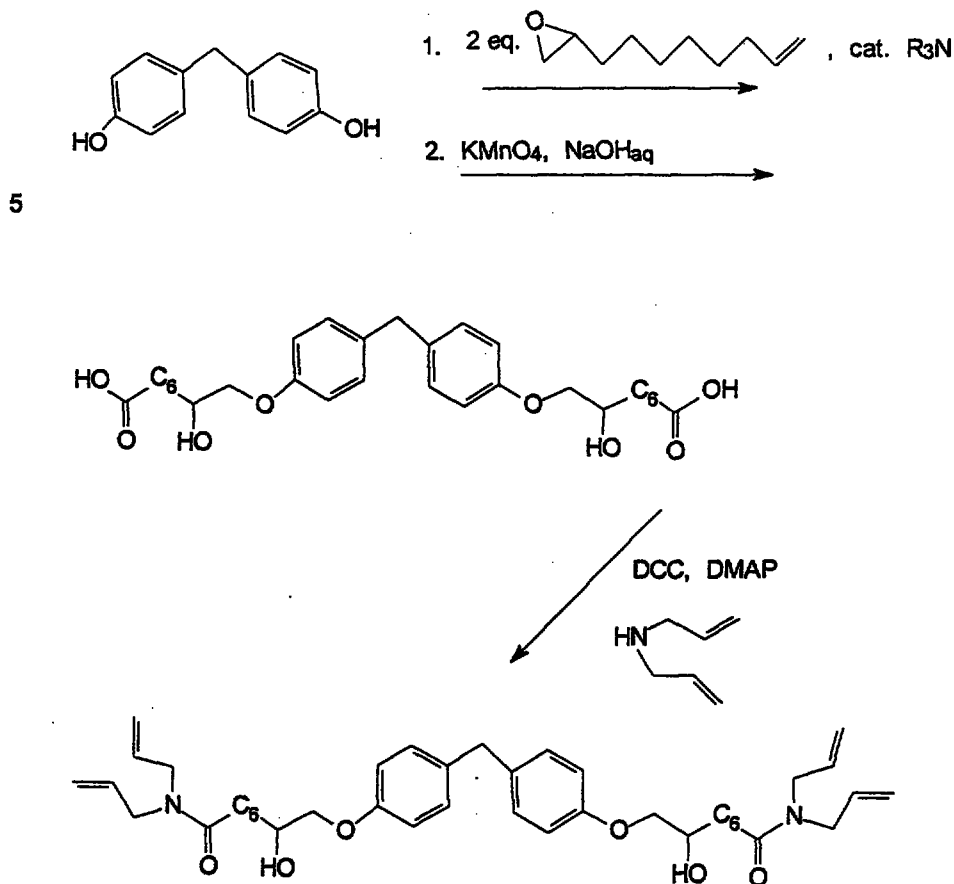
The composition may also contain organic fillers, such as, polymers to adjust rheology. Other additives known and used in the art may also be
25 used for specific purposes, such as, adhesion promoters. The selection of the types and amounts suitable is within the expertise of one skilled in the art.

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EXAMPLE 1

Preparation of Bis Phenol F - Bis(diallylamide)



10

Bisphenol F (200.3 g, 1 mol) is solvated in tetrahydrofuran (THF) (500 mL) in a 2 L three-necked flask equipped with mechanical stirrer and reflux condenser. To this solution is added 1, 2-epoxy-9-decene (308.5 g, 2 mol) and benzyldimethylamine (0.67 g, 5 mmol). The solution is warmed to 80°C for 7 hours and then allowed to cool to room temperature. Solvent is removed *in vacuo* to yield an oil.

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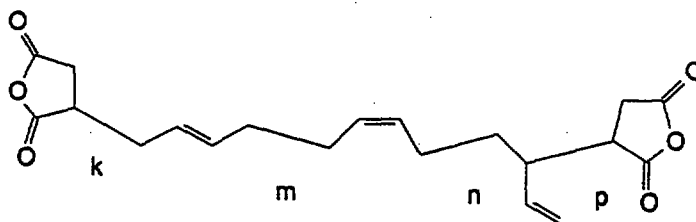
- The intermediate isolated above (508.8 g, 1 mol) is dissolved in THF (1 L) and H₂O (1 L) in a 3 L three-necked flask equipped with mechanical stirrer, reflux condenser and internal temperature probe under nitrogen. To this solution is added KMnO₄ (316 g, 2 mol), and the resulting mixture
- 5 warmed to 80°C for 5 hours. The reaction is allowed to cool to room temperature and bulk solvent is removed *in vacuo*. The resulting material is solvated in CH₂Cl₂ (1 L), filtered, and washed with H₂O (3X1 L). The isolated organics are dried over MgSO₄ and solvent removed *in vacuo* to yield a diacid intermediate.
- 10 The above diacid (544.8 g, 1 mol) is combined with diallylamine (194.3 g, 2 mol) and CH₂Cl₂ (1 L) in a 3 L three-necked flask equipped with a mechanical stirrer, addition funnel and internal temperature probe under nitrogen. The solution is cooled to 4°C in an ice bath. The addition funnel is charged with dicyclohexylcarbodiimide (DCC) (412.7 g, 2 mol) dissolved in
- 15 CH₂Cl₂ (300 mL), and this solution added to the stirred amine solution over the course of 60 minutes. The reaction is stirred on the ice bath for an additional 30 minutes. The mixture is allowed to warm to room temperature and further stirred for 4 hours. The solution is filtered to remove precipitated dicyclohexylurea (DCU). The isolated organics are dried over MgSO₄ anhyd.,
- 20 filtered and solvent removed *in vacuo* to yield the bis(diallylamide) product.

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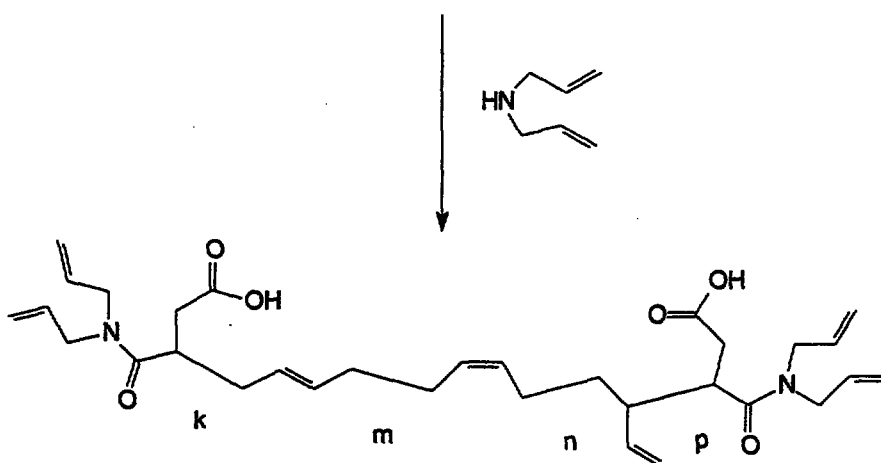


EXAMPLE 2

Preparation of Poly(butadiene)bis(diallylamide)



Ricon 131MA12



5

Diallylamine (97.15 g, 1mol) is solvated in acetone (500 mL) in a 2 L three-necked flask equipped with mechanical stirrer, addition funnel and internal temperature probe under nitrogen. The solution is cooled on an ice bath. Maleinized poly(butadiene) (Ricon 131MA5, Ricon Resins Inc., 1766 g) dissolved in acetone (500 mL) is charged into the addition funnel and added to the cooled amine solution over the course of 60 minutes maintaining an internal temperature $<10^{\circ}\text{C}$. The solution is stirred on ice for an additional 60 minutes, then allowed to warm to room temperature and stirred for another 2 hours. Solvent and residual diallylamine are removed *in vacuo* to yield the poly(diallylamide).

15



EXAMPLE 3

Preparation of Dimer Bis(diallylamide) or 10,11-Dioctyl-1, 20-eicosyl bis(diallylamide)

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Dimer acid (sold under the trademark Empol 1024 by Unichema, 20.5 g, 35.7 mmol) was solvated in anhydrous toluene (250 mL) in a 500 mL four-necked flask equipped with reflux condensor, addition funnel, and magnetic stirring under nitrogen. This solution was warmed to 80°C, and oxalyl chloride (12.5 mL, 143 mmol) was added dropwise over the course of 60 minutes. Evolution of CO₂, CO and HCl was immediately evident. The reaction was stirred for an additional 3 hours after the addition was complete, allowed to cool to room temperature and solvent removed *in vacuo* to yield an orange oil. IR and ¹H NMR spectral data were consistent with the desired bis(acid chloride) product.

10

15

Diallyl amine (10.0 mL) was solvated in diethyl ether (Et₂O) (200 mL) in a 500 mL three-necked flask equipped with mechanical stirrer, addition funnel and internal temperature probe under nitrogen. NaOH (3.2 g, 80 mmol) dissolved in H₂O (100 mL) was added to this solution. This solution was cooled to 4°C on an ice bath. The bis(acid chloride) described above was solvated in Et₂O (20 mL), charged into the addition funnel and added to the stirred amine solution over the course of 30 minutes, maintaining an internal temperature <10°C. This solution was stirred on ice for an additional one hour, then allowed to warm to room temperature, and stirred for an additional 4 hours. The organic layer was isolated and washed with 5% HCl_{aq} (200 mL), and H₂O (2x200mL). The isolated organics were dried over MgSO₄ anhydrous, filtered, and the solvent removed *in vacuo* to yield an

20

25



orange oil (87%), which exhibited IR and ¹H NMR spectral data consistent with the desired bis(diallylamide).

EXAMPLE 4

5 Preparation of Palmitoyl allylamide

Monoallylamide is prepared from allyl amine (57.1 g, 1mol), palmitoyl chloride (274.9 g, 1 mol) and NaOH (40 g, 1 mol) using the Schotten-Baumann conditions described above for the synthesis of Example 3.

10 EXAMPLE 5

Allylamide/BMI Die Attach Adhesive

The following reagents were combined and manually mixed to yield a
15 homogenous die attach composition:

20	Azeloylbis(diallylamide) (prepared from azeloyl dichloride and diallylamine utilizing the same general procedure as in Example 3)	0.521 g
	Bismaleimide, sold as Versalink P-650 by Henkel	1.678 g
	<i>t</i> -Butyl-2-ethylhexanoate	0.043 g
25	Metal diacrylate (sold as product number 633 by Sartomer)	0.023 g
	γ -Methacryloxypropyl-trimethoxysilane	0.024 g
	Silver powder from Chemet Corporation, RA-0081	5.148 g

30 The adhesive was used to bond a 80 x 80 mil silicon die to various metal leadframes as listed below (Ag/Alloy 42 indicates silver coated Alloy 42, an Fe/Ni alloy; Ag/Cu indicates silver coated copper). Die Shear Strength was measured using an HMP Model 1750 die shear tester with digital force

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gauge DFI 50 (Chatillon) at room temperature (RDSS, room die shear strength) and at 240°C (HDSS, hot die shear strength) after curing for 60 seconds on a 200°C hotplate (condition 1), and after curing for 60 seconds on a 200°C hotplate followed by 4 hours in a 175°C oven (condition 2). The results are reported here and show commercially acceptable die shear values.

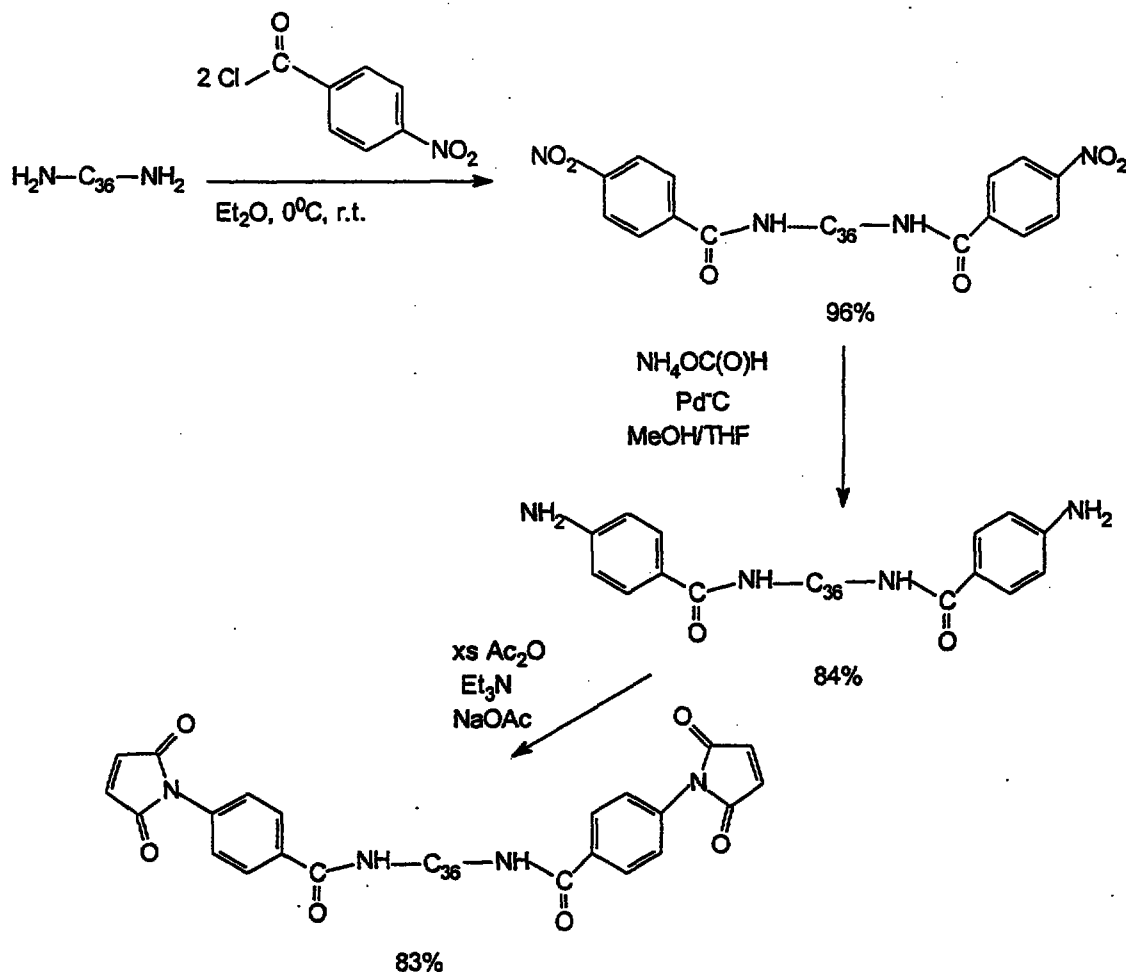
<u>Leadframe</u>	<u>Cure Condition 1</u>		<u>Cure Condition 2</u>	
	RDSS	HDSS	RDSS	HDSS
Ag/Alloy 42	1.72	0.87	5.65	0.92
Ag/Cu	2.15	0.58	4.65	0.74
Cu	1.76	0.48	3.60	0.85
Pd	1.94	1.18	4.56	1.25

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EXAMPLE 6

Preparation of Benzamido-endcapped Dimer Diamine Bismaleimide



5

Dimer diamine (sold as Versamine 552 by Henkel, 20.0 g, 37 mmol)
 was solvated in diethyl ether (Et_2O) (200 mL) in a 500 mL three-necked flask
 equipped with an addition funnel, magnetic stirring, internal temperature probe
 and nitrogen inlet/outlet. NaOH_{aq} (11.7 mL of 6.25 M solution diluted with 100
 mL H_2O , 73 mmol) was added with vigorous stirring. This solution was
 placed under a steady flow of nitrogen and cooled to 3°C on an ice bath with
 stirring. The addition funnel was charged with *p*-nitrobenzoyl chloride (13.6 g,

10



73 mmol) in Et₂O (50 mL), and this solution was added to the reaction vessel over the course of 60 minutes, maintaining an internal T < 10°C. The reaction was stirred at ~3°C for an additional 60 minutes after this addition was complete, then allowed to warm to room temperature and stirred for another 4
5 hours. The solution was transferred to a separatory funnel and the isolated organic layer washed with distilled H₂O (300 mL), 5% HCl_{aq} (300 mL), NaCl_{aq} (250 mL) and distilled H₂O (2x250 mL). The organics were isolated, dried over MgSO₄ anhyd., filtered and the solvent removed *in vacuo* to yield the dinitro compound as a viscous yellow oil which exhibited acceptable ¹H NMR
10 and IR spectra (30.0 g, 96 %).

The dinitro compound described above (5.0 g, 5.9 mmol) was dissolved in methanol (MeOH) (25 mL) and tetrahydrofuran (THF) (5 mL) in a 250 mL three-necked flask equipped with magnetic stirring, reflux condensor and nitrogen inlet/outlet. The solution was placed under nitrogen, and 5% Pd-
15 C (0.96 g) were added with stirring. Ammonium formate (3.4 g, 55 mmol) was added and the reaction stirred at room temperature for 2 hours. Carbon dioxide evolution was immediately observed. The reaction solution was filtered, and bulk filtrate solvent was removed *via* rotary evaporator. The resulting viscous oil was dissolved in Et₂O (150 mL), washed with distilled
20 H₂O (150 mL), isolated and dried over MgSO₄ anhyd. Solvent was removed *in vacuo* to yield the diamine as a sticky tan oil, which exhibited acceptable ¹H NMR and IR spectra (3.9 g, 84%).

Maleic anhydride (0.5 g, 5.1 mmol) was dissolved in acetone (10 mL) in a 250 mL three-necked flask equipped with magnetic stirring, addition
25 funnel and nitrogen inlet/outlet. The solution was cooled on an ice bath and placed under nitrogen. The addition funnel was charged with an acetone (10mL) solution of the diamine described above (2.0 g, 2.60 mmol), which

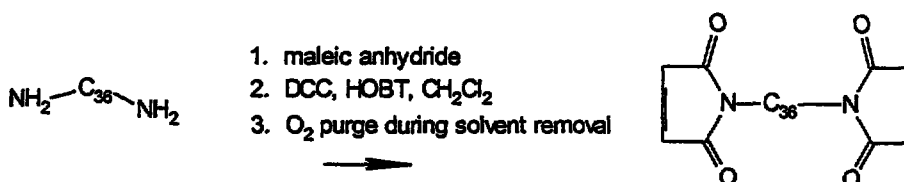


was added dropwise over 30 minutes. The reaction was stirred for an additional 30 minutes on the ice bath, then allowed to warm to room temperature, and stirred for another 4 hours. To the resulting slurry was added acetic anhydride (Ac_2O) (1.54 mL, 160 mmol), triethyl amine (Et_3N) (0.23 mL, 1.63 mmol) and sodium acetate (NaOAc) (0.16 g, 1.9 mmol). The resulting slurry was heated to mild reflux for 5 hours. The reaction was allowed to cool to room temperature, and solvent removed via rotary evaporator to yield a brown oil. This material was dissolved in CH_2Cl_2 (250 mL) and washed with distilled H_2O (200 mL), satd. NaHCO_3 (200 mL) and distilled H_2O (200 mL). Emulsions were broken by adding NaCl when necessary. The organic layer was isolated, dried over MgSO_4 anhyd. and solvent removed *in vacuo* to yield the bismaleimide, a brown solid (2.0 g, 83%). The resin exhibited satisfactory ^1H NMR, ^{13}C NMR and IR spectra, which indicated slight contamination with acetic acid.

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EXAMPLE 7

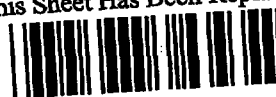
Preparation of 20-Bismaleimido-10,11-dioctyl-eicosame (and isomers)



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In a 5 L multi-neck flask equipped with a drying tube, thermometer, slow addition funnel, mechanical stirrer and nitrogen purge maleic anhydride (98.06 g, 1.02 equivalents on $-\text{NH}_2$) was dissolved in 500 ml tetrahydrofuran (THF). Stirring was begun and the solution was chilled with a dry ice/water bath. Slow addition of dimer diamine (Versamine 552, Henkel, 245.03 g, 0.4477 mol) in 250 ml THF was begun. Addition was carried out over 1 hour.

25



After addition was complete the ice bath was removed and 375 ml of THF was rinsed through the slow addition funnel to incorporate solidified diamine. After one hour the ice bath was replaced around the flask. 1-Hydroxy-benzotriazole (96.79 g, 0.80 equivalents on $-NH_2$) was added rinsing into the
5 flask with 50ml THF. When the temperature had reached 5°C slow addition of dicyclohexylcarbodiimide (DCC) (188.43 g, 1.02 equivalents on $-NH_2$) in 200ml THF was begun. The temperature during addition was kept below ten degrees. After DCC addition was complete the slow addition funnel was rinsed with 80 ml of THF. The ice bath was removed. The reaction was
10 monitored by IR. When it appeared that the isoimide has been converted to maleimide (approximately 4 hours after the completion of DCC addition) the mixture was filtered, rinsing the solids with THF. The orange solution was placed in the freezer overnight.

The solution was removed from the freezer and allowed to warm to
15 room temperature. Hydroquinone (0.0513 g) was added to the solution. A partial strip of the THF was carried out on a rotary evaporator with the temperature maintained below 28°C. The solution was concentrated to approximately 800 ml. Much particulate matter was visible. The solution was placed in freezer overnight.

20 The mixture was removed from the freezer and allowed to warm. The solids were filtered, rinsing with THF. The filtrate was transferred to a 2 L multi-neck flask equipped with a mechanical stirrer, vacuum line connected to a trap, and a glass tube attached by tubing to a drying tube. The remaining THF was stripped at room temperature by pulling a vacuum and bubbling air
25 through the material while stirring. The resultant thick, creamy-tan colored semi-solid was placed in the freezer overnight.

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The semi-solid was removed from the freezer and allowed to warm. The semi-solid was dissolved in 450 ml each of methanol and hexane, and washed with 50% methanol/water (4 x 250 ml) to remove 1-hydroxybenzotriazole (HOBt). It was attempted to extract the product with 5 hexane. After addition of 300 ml of hexane separation was not observed. The mixture was washed with additional water (3 x 250 ml). The organic phase was placed in the freezer overnight.

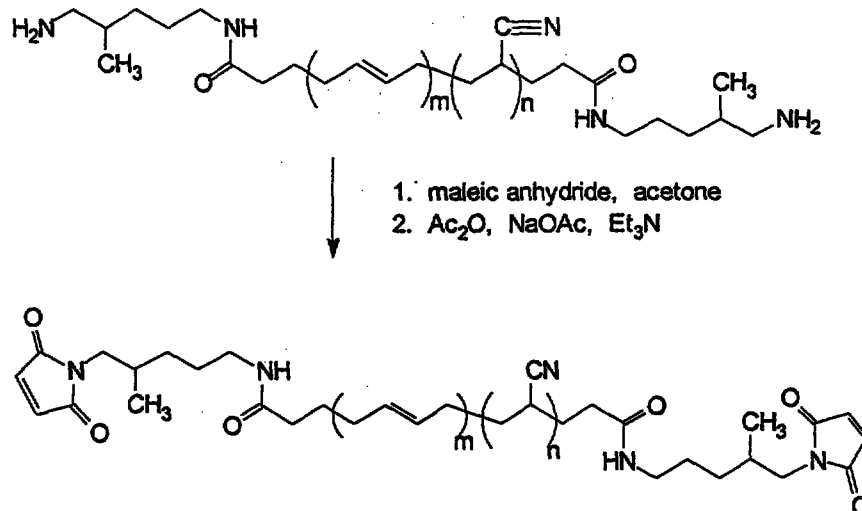
The material was removed from the freezer. Two layers were apparent. The upper layer was clear and yellow in color. The bottom layer 10 was a orange and cloudy. The material was poured cold into a separatory funnel. The top layer was hexane and the desired product. The bottom layer was extracted with hexane (6 x 200 ml), separation occurred easily. The combined extracts were dried over anhydrous magnesium sulfate and filtered, rinsing the solids with hexane. The solvent was stripped to an approximate 15 volume of 750 ml on a rotary evaporator with the temperature not exceeding 24°C. The remaining solvent was stripped off using a vacuum/air bubbling set-up at room temperature to give the desired product in 67% yield.

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EXAMPLE 8

Preparation of Butadiene-Acrylonitrile Bismaleimide



5

Amino-terminated butadiene-acrylonitrile (sold as Hycar resin 1300

X42 ATBN by BF Goodrich, in which the m and n depicted in the structure are integers to provide a number average molecular weight of 3600) (450 g, 500

10 mmol based on amine equivalent weight $\text{AEW} = 450\text{g}$) was dissolved in CHCl_3 (1000 mL) in a 3 L four-necked flask equipped with addition funnel, mechanical stirrer, internal temperature probe and nitrogen inlet/outlet. The stirred solution was placed under nitrogen and cooled on an ice bath. The addition funnel was charged with maleic anhydride (98.1 g, 1 mol) in CHCl_3
15 (50 mL) and this solution was added to the reaction over 30 minutes, maintaining the internal reaction temperature below 10°C . This mixture was stirred for 30 minutes on ice, then allowed to warm to room temperature and stirred for an additional 4 hours. To the resulting slurry was added acetic anhydride (Ac_2O) (653.4 g, 6 mol), triethyl amine (Et_3N) (64.8 g, 0.64 mol) and
20 sodium acetate (NaOAc) (62.3 g, 0.76 mol). The reaction was heated to mild

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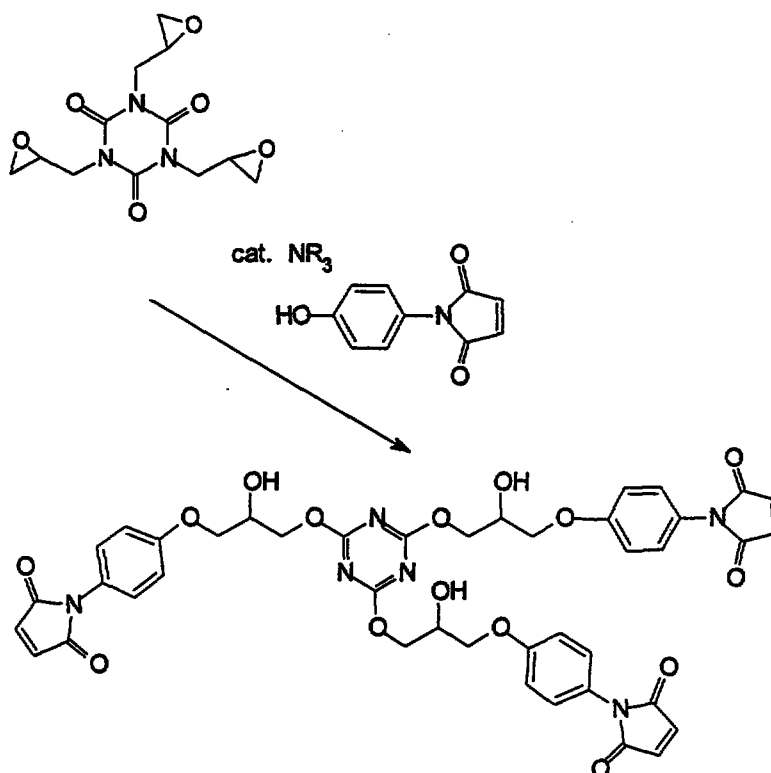


reflux for 5 hours, allowed to cool to room temperature, and subsequently extracted with H₂O (1 L), satd. NaHCO₃ (1 L) and H₂O (2x1 L). Solvent was removed *in vacuo* to yield the maleimide terminated butadiene acrylonitrile.

5

EXAMPLE 9

Preparation of Tris(maleimide)
Derived From Tris(epoxypropyl)isocyanurate



10

Tris(epoxypropyl)isocyanurate (99.0 g, 0.33 mol) is dissolved in THF (500mL) in a 2 L three-necked flask equipped with mechanical stirrer, internal temperature probe and nitrogen inlet/outlet. To this solution is added hydroxyphenylmaleimide (189.2 g, 1 mol) and benzyldimethylamine (1.4 g, 0.05 wt. %). The solution is heated to 80°C for 7 hours. The reaction then is allowed to cool to room temperature, is filtered, and the filtrant washed with 5

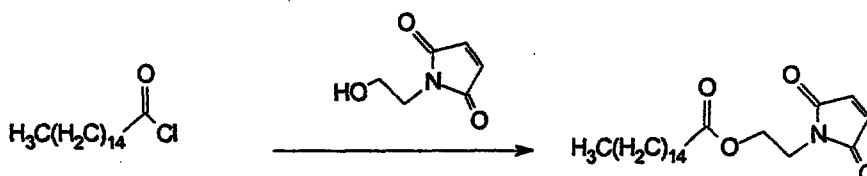


% HCl_{aq} (500 mL) and distilled H_2O (1 L). The resulting solid, triazinetris-(maleimide), is vacuum dried at room temperature.

EXAMPLE 10

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Preparation of Maleimidoethylpalmitate



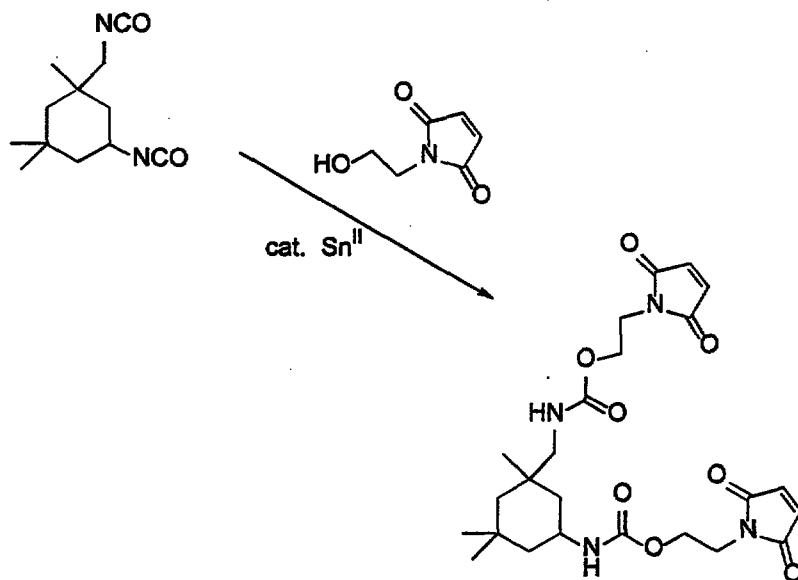
- Palmitoyl chloride (274.9 g, 1 mol) is dissolved in Et_2O (500 mL) in a
- 10 2 L three-necked flask equipped with mechanical stirrer, internal temperature probe, addition funnel and nitrogen inlet/outlet. NaHCO_3 (84.0 g, 1 mol) in distilled H_2O (500 mL) is added with vigorous stirring and the solution cooled on an ice bath under nitrogen. The addition funnel is charged with hydroxyethylmaleimide (141 g, 1 mol) in Et_2O (100 mL) and this solution
- 15 added to the reaction over a period of 30 minutes, maintaining an internal $T < 10^\circ\text{C}$ during the addition. The reaction is stirred for another 30 minutes on ice, then allowed to warm to room temperature and stirred for 4 hours. The reaction is transferred to a separatory funnel and the isolated organic layer washed with distilled H_2O (500 mL), 5% HCl_{aq} (500 mL) and distilled H_2O
- 20 (2x500 mL). The organics are isolated, dried over MgSO_4 anhyd., filtered and solvent removed *in vacuo* to yield the aliphatic maleimide.

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EXAMPLE 11

Preparation of Bismaleimide Derived from 5-Isocyanato-1-(isocyanatomethyl)- 1, 3, 3-trimethylcyclohexane



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5-Isocyanato-1-(isocyanatomethyl)-1, 3, 3-trimethylcyclohexane

(111.15 g, 0.5 mol) is solvated in THF (500 mL) in a 1 L three-necked flask equipped with mechanical stirrer, addition funnel and nitrogen inlet/outlet.

The reaction is placed under nitrogen, and dibutyltin dilaurate (cat. Sn^{II})

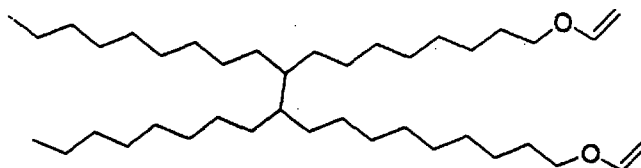
- 10 (6.31g, 10 mmol) and hydroxyethylmaleimide (141 g, 1 mol) are added with stirring, and the resulting mixture heated for 4 hours at 70°C. The addition funnel is charged with hydroxyethylmaleimide (141 g, 1 mol) dissolved in THF (100 mL). This solution is added to the isocyanate solution over 30 minutes, and the resulting mixture heated for an additional 4 hours at 70°C. The
- 15 reaction is allowed to cool to room temperature and solvent removed *in vacuo*. The remaining oil is dissolved in CH_2Cl_2 (1 L) and washed with 10% HCl_{aq} (1 L) and distilled H_2O (2x1 L). The isolated organics are dried over MgSO_4 , filtered and the solvent removed *in vacuo* to yield the maleimide.

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EXAMPLE 12

Preparation of Dimer Divinyl Ether Derived From Pripol 2033



"Dimer Divinyl Ether" (and cyclic isomers)

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Bis(1, 10-phenanthroline)Pd(OAc)₂ (0.21 g, 0.54 mmol) was dissolved in a mixture of butyl vinyl ether (8.18 g, 81.7 mmols), heptane (100 mL) and "dimer diol" (sold as Pripol 2033 by Unichema, 15.4 g, 27.2 mmol) in 2 L three-necked flask equipped with a mechanical stirrer under nitrogen.

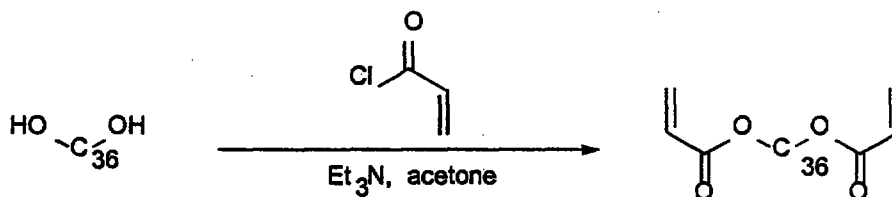
- 10 This solution was heated to light reflux for 6 h. The solution was allowed to cool to room temperature and subsequently poured onto activated carbon (20 g) and stirred for 1 hour. The resulting slurry was filtered, and excess butyl vinyl ether and heptane were removed *in vacuo* to yield the divinyl ether as a yellow oil. The product exhibited acceptable ¹H NMR, FT-IR and ¹³C NMR
- 15 spectral characteristics. Typical viscosity ~100 cPs.

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EXAMPLE 13

Preparation of Dimer Diacrylate Derived From Dimer Diol (Pripol 2033)



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A dimer diol (sold as Pripol 2033 by Unichema, 284.4 g, 500 mmol) is dissolved in dry acetone (500 mL) in a 1 L three-necked flask equipped with mechanical stirrer, addition funnel and internal temperature probe under nitrogen. Triethylamine (101.2 g, 1 mol) is added to this solution and the solution cooled to 4°C on an ice bath. Acryloyl chloride (90.5 g, 1 mol) solvated in dry acetone (100 mL) is charged into the addition funnel and added to the stirred reaction solution over the course of 60 minutes, maintaining an internal temperature <10°C. This solution is stirred on ice for an additional 2 hours, then allowed to warm to room temperature and stirred for 4 hours. Bulk solvent is removed *via* a rotary evaporator, and the remaining residue solvated in CH₂Cl₂ (1 L). This solution is washed with 5% HCl_{aq} (800 mL), and H₂O (2x800mL). The isolated organics are dried over MgSO₄ anhyd. and filtered, and the solvent removed *in vacuo* to yield the diacrylate as an oil.

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EXAMPLE 14

Preparation of N-ethylphenyl Maleimide

4-Ethyl aniline (12.12g) was dissolved in 50 ml of anhydrous ethyl ether and slowly added to a stirred solution of 9.81 g of maleic anhydride in

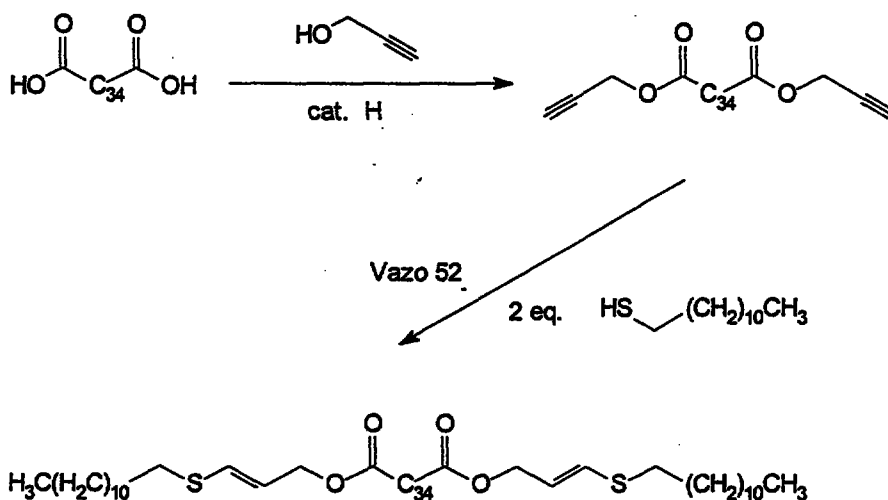
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100 ml of anhydrous ethyl ether chilled in an ice bath. After completion of the addition, the reaction mixture was stirred for 30 minutes. The light yellow crystals were filtered and dried. Acetic anhydride (200 ml) was used to dissolve the maleamic acid and 20 g of sodium acetate. The reaction mixture was heated in an oil bath at 160°C. After 3 hours of reflux, the solution was cooled to room temperature, placed in a 1L beaker in ice water and stirred vigorously for 1 hour. The product was suction-filtered and recrystallized in hexane. The collected crystalline material was dried at 50°C in a vacuum oven overnight. FTIR and NMR analysis showed the characteristics of ethyl maleimide.

EXAMPLE 15

Preparation of Bis(alkenylsulfide)



Dimer acid (sold under the trademark Empol 1024 by Unichema) (574.6 g, 1 mol) and propargyl alcohol (112.1 g, 2 mol) are solvated in toluene (1 L) in a 3 L three-necked flask equipped with mechanical stirring and a Dean-Stark distillation apparatus. Concentrated H_2SO_4 (6 mL) is added and



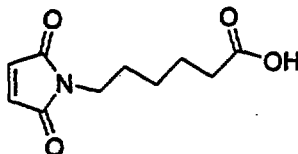
the solution refluxed for 6 hours until 36 mL of H₂O is azeotropically distilled.

The solution is allowed to cool to room temperature, is washed with H₂O (2X1L), dried over MgSO₄ anhyd. and the solvent removed *in vacuo* to yield the propargyl ester intermediate as an oil.

- 5 This ester intermediate (650.7 g, 1 mol) is solvated in THF (200 mL) in a 1L three-necked flask equipped with reflux condensor, mechanical stirrer and internal temperature probe under nitrogen. Lauryl mercaptan (404.8 g, 2 mol) and 2,2'-azobis(2,4-dimethylpentanenitrile) (sold under the trademark Vazo 52 by DuPont) (11 g) are added and the resulting mixture heated to
- 10 70°C on an oil bath with stirring for 7 hours. The reaction is allowed to cool to room temperature and solvent removed *in vacuo* to yield the alkenyl sulfide as an oil.

EXAMPLE A.

- 15 Preparation of 6-maleimidocaproic acid



6-maleimidocaproic acid

- The acid functional maleimide, 6-maleimidocaproic acid, was
- 20 synthesized using known methodology.¹ Aminocaproic acid (100 g, 7.6x10⁻¹ mols) was dissolved in glacial acetic acid (50 mL) in a 500 mL four-necked flask equipped with mechanical stirring, an internal temperature probe and an addition funnel. The addition funnel was charged with a solution of maleic anhydride (74.8 g, 7.6x10⁻¹ mols) dissolved in acetonitrile (75 mL). This



solution was added to the aminocaproic acid at room temperature dropwise over 1 hour, maintaining an internal reaction temperature less than 35°C. The reaction was stirred for three hours after the addition was complete. The reaction slurry was filtered, and the isolated filtrate was dried in a vacuum oven (P-25 T) overnight at 70°C to yield 166 g of off white solid (95%). The product amic acid exhibited FT-IR and ¹H NMR spectral characteristics consistent with literature data.

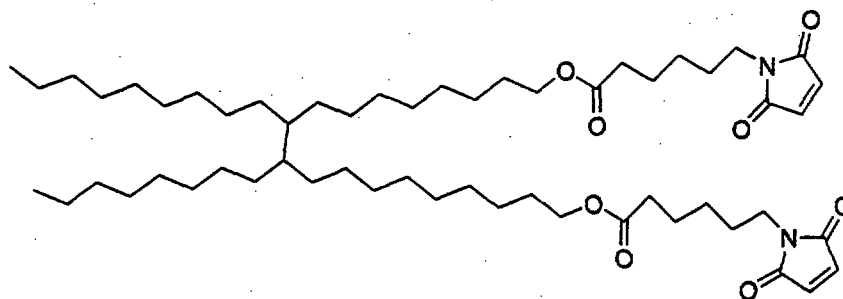
The amic acid described above (166 g, 7.2x10⁻¹ mols) was solvated in a solution of toluene (200 mL), benzene (200 mL) and triethylamine (211 mL, 1.51 mol) in a 1 L three-necked flask equipped with mechanical stirring and a Dean-Stark trap under nitrogen. This solution was heated to reflux for 4 h and the water produced collected in the Dean-Stark trap. Distilled water (400 mL) was added to the reaction flask to dissolve the triethylammonium salt of the product which largely separated from the bulk solution during the reaction. This aqueous layer was isolated, acidified to pH~1 with 50% HCl, and extracted with ethyl acetate (600 mL). This organic layer was washed with distilled water (400 mL). The isolated organic layer was dried over MgSO₄, followed by solvent removal *in vacuo* to yield an off white solid (76.2 g, 50%). The product 6-maleimidocaproic acid was spectrographically identical to literature material by FT-IR and ¹H NMR.

EXAMPLE B.

Preparation of "Dimer Diester Bismaleimide"

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"Dimer Diester Bismaleimide" (and cyclic isomers)

Pripol 2033 ("dimer diol", Uniqema, 92.4 g, 1.69×10^{-1} mols), 6-maleimidocaproic acid (75.0 g, 3.55×10^{-1} mols) and H_2SO_4 (0.50 mL, $\sim 8.5 \times 10^{-3}$ mols) were slurried in toluene (300 mL) in a 1 L four-necked flask equipped with mechanical stirrer, a Dean-Stark trap and an internal temperature probe under nitrogen. The reaction was heated to light reflux for two hours and the water evolved collected in the Dean-Stark trap. The trap was drained and ~ 50 mL of toluene solvent was distilled off of the reaction to remove trace moisture and drive the esterification equilibrium to completion. The reaction was allowed to cool to room temperature, additional toluene (100 mL) was added (on the laboratory scale it is preferable to add diethyl ether in place of toluene at this point), and the solution was washed with saturated NaHCO_3 aq. (300 mL) and distilled water (300 mL). The organic layer was isolated and dried over anhydrous MgSO_4 , and the solvent removed *in vacuo* to yield an orange oil (107.2 g, 68%). The material can be further purified by eluting a toluene solution of the resin through a short plug of silica or alumina. This liquid bismaleimide resin exhibited acceptable FT-IR, ^1H NMR, and ^{13}C NMR data. Typical $\eta \sim 2500$ cPs.

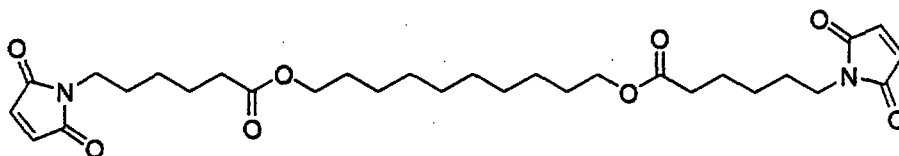
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EXAMPLE C.

Preparation of "Decane Diol Diester Bismaleimide"



"Decane Diol Diester Bismaleimide"

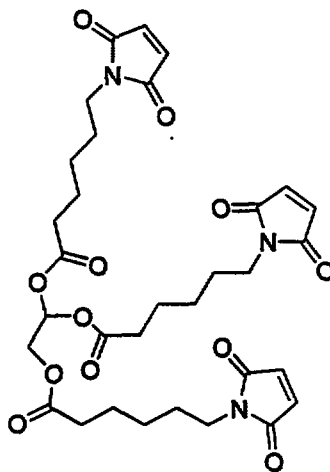
The general procedure described in Example B. was applied

- 5 substituting decane diol (29.5 g, 1.69×10^{-1} mols) for Pripol 2033. This process yielded a solid, moderately soluble bismaleimide (54.9 g, 58%). The product exhibited satisfactory FT-IR and ^1H NMR data.

EXAMPLE D

10

Preparation of "Glycerol Triester Tris(maleimide)"



The protocol outlined in example B. was utilized substituting glycerol (10.4 g, 1.13×10^{-1} mol) for Pripol 2033. The product was a viscous liquid which exhibited acceptable FT-IR and ^1H NMR data.

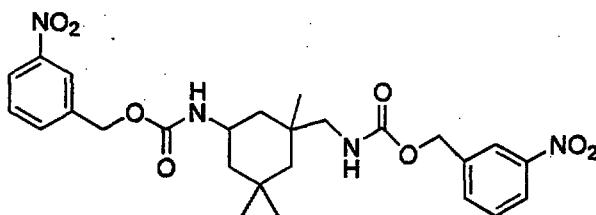
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EXAMPLE E.

Preparation of "Bis(*m*-nitrobenzyl carbamate) of IPDI"



"Bis(*m*-nitrobenzyl carbamate) of IPDI"

5

Isophorone diisocyanate ("IPDI", 100.0 g, 4.5×10^{-1} mols), *m*-nitrobenzyl alcohol (137.8 g, 9.0×10^{-1} mols) and dibutyl tin dilaurate (2.8 g, 4.5×10^{-3} mols) were solvated in dry toluene (1500 mL) in a 2L three-necked flask equipped with mechanical stirrer, reflux condensor and internal temperature probe under nitrogen. The resulting solution was heated to 90°C for 4 h. No isocyanate band was observed in the IR of the solids portion of the sample. The solution was allowed to cool to room temperature and washed with distilled H₂O (100 mL). The organic layer was isolated and solvent removed *in vacuo* to yield a yellow liquid which exhibited acceptable FT-IR and ¹H NMR characteristics.

10

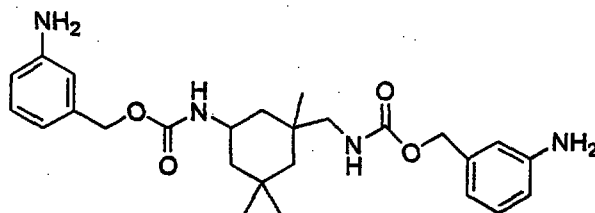
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EXAMPLE F.

Preparation of "Bis(*m*-aminobenzyl carbamate) of IPDI"



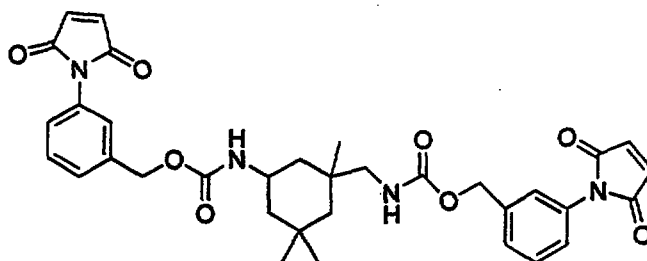
"Bis(*m*-aminobenzyl carbamate) of IPDI"

5

The dinitro compound from Example E. (8.28 g, 1.57×10^{-2} mols) was dissolved in ethanol (100 mL) in a 500 mL three-necked round bottom flask equipped with magnetic stirring under nitrogen. Cyclohexene (28.6 mL, 2.82×10^{-1} mols) was added, followed by 5% Pd/C (4.14 g). The resulting
10 slurry was refluxed lightly for 6.5 h. The FT-IR of a filtered aliquot of this solution exhibited no nitro stretching bands at 1529 cm^{-1} and 1352 cm^{-1} . The bulk solution was allowed to cool to room temperature and filtered. Solvent was removed *in vacuo* to yield a yellow semisolid (6.6 g, 90%) which exhibited acceptable FT-IR and ^1H NMR spectral characteristics.

15

EXAMPLE G.



Preparation of "Bis(*m*-maleimidobenzyl carbamate) of IPDI"

"Bis(*m*-maleimidobenzyl carbamate) of IPDI"

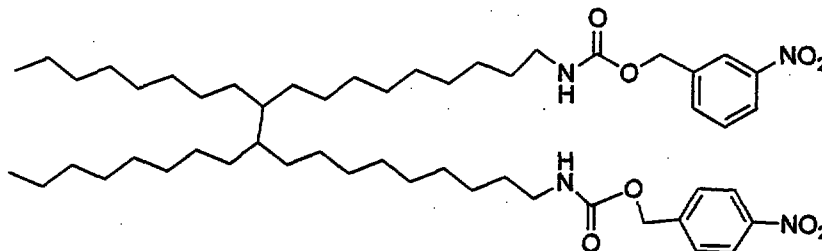
The diamine from Example F (6.6 g, 1.41×10^{-2} mols) was solvated in
5 acetone (60 mL) in a 250 mL four-necked flask equipped with magnetic stirrer
and addition funnel under nitrogen and cooled to 4°C. Maleic anhydride (2.76
g, 2.82×10^{-2} mols) dissolved in acetone (20 mL) was added over the course of
30 minutes. The resulting solution was stirred at 4°C for 1 h, and
subsequently was allowed to warm to room temperature and stirred overnight.
10 FT-IR analysis indicated no maleic anhydride remained as judged by the
absence of the anhydride stretching band at $\sim 1810 \text{ cm}^{-1}$.

To the above amic acid solution was added acetic anhydride (8.5 mL,
 9.0×10^{-2} mols), triethylamine (1.26 mL, 9.0×10^{-3} mols) and sodium acetate
(0.88 g, 1.1×10^{-2} mols). The resulting solution was refluxed lightly for 4 h
15 under nitrogen. The reaction was allowed to cool to room temperature and
bulk solvent was removed *in vacuo*. The resulting viscous liquid was
resolvated in methylene chloride (200 mL) and extracted with distilled water
(3x200 mL). The organics were then dried over MgSO_4 anhyd., filtered and
solvent removed *in vacuo* to yield a light brown solid (6.75 g, 76%). This
20 material exhibited acceptable FT-IR and ^1H NMR spectral features.

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Preparation of "Bis(m-nitrobenzyl carbamate) of DDI 1410"



"Bis(m-nitrobenzyl carbamate) of DDI 1410" (and cyclic isomers)

5 DDI 1410 (Henkel, "Dimer Diisocyanate", 99.77 g, 1.65×10^{-1} mols
based on 13.96 % NCO), *m*-nitrobenzyl alcohol (50.8 g, 3.32×10^{-1} mols) and
dibutyltin dilaurate (0.5 mL, 8.3×10^{-4} mols) were solvated in toluene (150 mL)
in a 1 L four-necked flask equipped with mechanical stirrer, reflux condensor
and internal temperature probe under nitrogen. The reaction was heated to
10 85°C for 2.5 h. FT-IR analysis of an aliquot of the reaction indicated complete
consumption of isocyanate functionality as judged by the lack of a band at
2272 cm^{-1} . Solvent was removed from the reaction in vacuo to yield a yellow
oil which solidified upon standing at room temperature (152.4 g, 102% (trace
toluene)). This solid exhibited satisfactory FT-IR and ^1H NMR spectral
15 features.



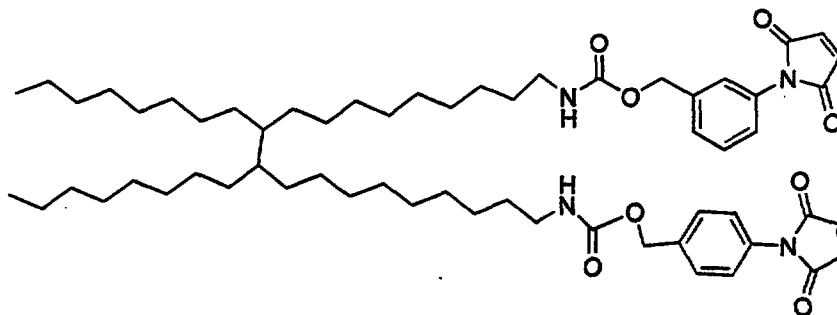
Preparation of "Bis(*m*-aminobenzyl carbamate) of DDI 1410"

"Bis(*m*-aminobenzyl carbamate) of DDI 1410" (and cyclic isomers)

The diamine product of Example H (39.6 g, 4.32×10^{-2} mols) and
5 stannous chloride dihydrate (97.55 g, 4.32×10^{-1} mols) were slurried in ethyl
acetate (300 mL) in a 1L three-necked flask equipped with mechanical stirrer
and a reflux condensor under nitrogen. The reaction was heated to light
reflux and stirred vigorously for 3 h. The solution was allowed to cool to room
temperature and brought to pH 7-8 with a solution of saturated sodium
10 bicarbonate. The mixture was pushed through a 25 micron filter to yield a
mixture which separated into a cloudy aqueous layer and a moderately clear
organic layer. The aqueous layer was isolated and washed with ethyl acetate
(100 mL). The organic layers were combined, washed with distilled water
(300 mL) and dried over anhydrous MgSO_4 . The slurry was filtered and
15 solvent removed from the filtrate *in vacuo* to yield yellow, sticky solid (33.8 g,
92%).

EXAMPLE J.

Preparation of "Bis(*m*-maleimidobenzyl carbamate) of DDI 1410"



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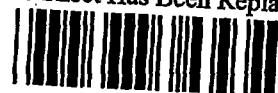


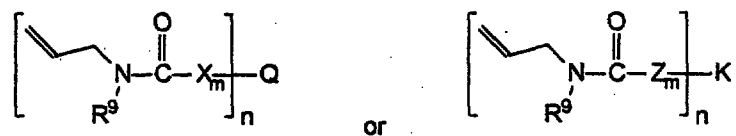
"Bis(*m*-maleimidobenzyl carbamate) of DDI 1410" (and cyclic isomers)

Maleic anhydride (15.4 g, 1.57×10^{-2} mols) was dissolved in acetone (300 mL) in a 2 L four-necked flask equipped with mechanical stirrer, internal
5 temperature probe and addition funnel under nitrogen. This solution was cooled to -4°C on an ice bath. A solution of the diamine prepared in Example I (63.4 g, 7.48×10^{-2} mols) in acetone (70 mL) was charged to the addition funnel and added to the maleic anhydride solution over a period of 30 minutes maintaining an internal temperature of $<10^{\circ}\text{C}$. The resulting solution was
10 stirred for 1 h and subsequently allowed to warm to room temperature and stir for 2 h.

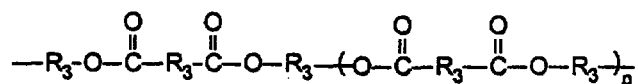
To this solution of amic acid was added acetic anhydride (24.7 mL, 2.62×10^{-1} mols), triethylamine (6.25 mL, 4.48×10^{-2} mols) and manganese acetate tetrahydrate (0.37 g, 1.50×10^{-3} mols). This solution was heated to
15 light reflux for 6.5 h, then allowed to cool to room temperature. Bulk solvent was removed *in vacuo*, and the resulting dark liquid was dissolved in diethyl ether (500 mL). This solution was washed with dist. H_2O (500 mL). The isolated organic layer was then washed with saturated NaHCO_3 aq. (500 mL) and again with dist. H_2O (500 mL). The organics were isolated, dried over
20 anhyd. MgSO_4 , and solvent removed *in vacuo* to yield a viscous orange oil. This material exhibited FT-IR, ^1H NMR and ^{13}C NMR spectral features consistent with the expected bismaleimide product.

Another embodiment of this invention includes the circuit component compositions containing the allylated amide compounds having the
25 structures:

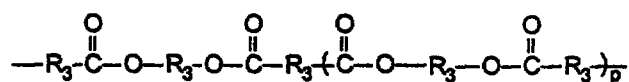




as described herein, in which Q and Z can be an ester having the structure



5 or the structure



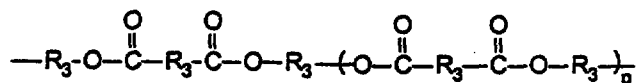
in which p is 1 to 100,

each R³ can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents, or

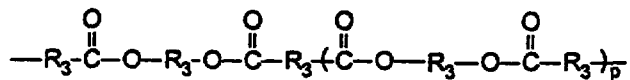
10 a siloxane having the structure $-(\text{CR}^1_2)_e-[\text{SiR}^4_2-\text{O}]_f-\text{SiR}^4_2-(\text{CR}^1_2)_g-$

in which the R¹ substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R⁴ substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10 and f is 1 to 50.

15 Another embodiment of this invention includes the maleimides having the formulae $[\text{M}-\text{X}_m]_n - \text{Q}$ and $[\text{M}-\text{Z}_m]_n - \text{K}$ as described herein in which Q and Z can be an ester having the structure



or the structure



20



in which p is 1 to 100,

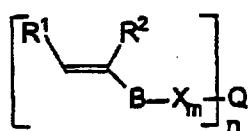
each R³ can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents, or

a siloxane having the structure $-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$

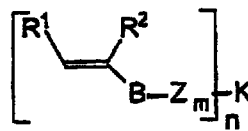
- 5 in which the R¹ substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R⁴ substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10 and f is 1 to 50.

Another embodiment of this invention includes the vinyl compounds

- 10 having the structures



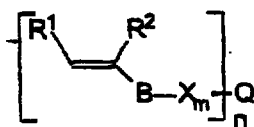
and



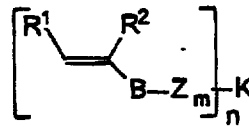
as described herein in which B is C, S, N, O, C(O), C(O)NH or C(O)N(R⁵), in which R⁵ is C₁ to C₆ alkyl.

Another embodiment of this invention includes the vinyl compounds

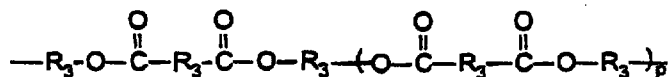
- 15 having the structures



and



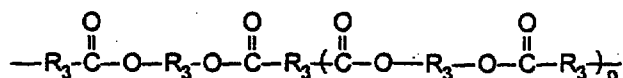
as described herein in which Q and Z can be an ester having the structure



- 20 or the structure

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in which p is 1 to 100,

each R³ can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,

5 or a siloxane having the structure



in which the R¹ substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R⁴ substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to

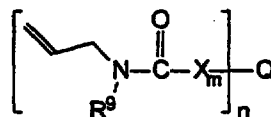
10 10, and f is 1 to 50.

Another embodiment of this invention includes the circuit component composition as described herein containing an anionic or cationic curing initiator. The types and useful amounts of such initiators are well known in the art.

15 Other embodiments of this invention include those described in the following numbered paragraphs:

1. A circuit component composition comprising an allylated amide compound; a curing initiator selected from the group consisting of a
20 free-radical initiator, a photoinitiator, and a combination of those; optionally, one or more fillers; optionally, one or more adhesion promoters;

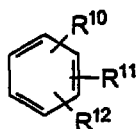
the allylated amide compound having the formula



in which m is 0 or 1, n is 1 to 6, and



(a) R^9 is H, an alkyl group having 1 to 18 carbon atoms, an alkyleneoxy group having 1 to 18 carbon atoms, an allyl group, an aryl group, or a substituted aryl group having the structure

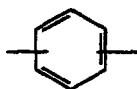


in which R^{10} , R^{11} , and R^{12} are independently

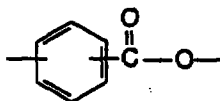
5 H or an alkyl or alkyleneoxy group having 1 to 18 carbon atoms;

(b) X is an aromatic group selected from the group of aromatic groups having the structures:

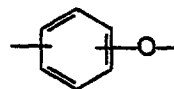
(I)



(II)

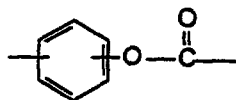


(III)

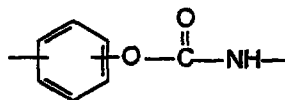


10

(IV)



(V)



, and

;

(c) Q is a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteroatom present may or may not be directly attached to X.

20

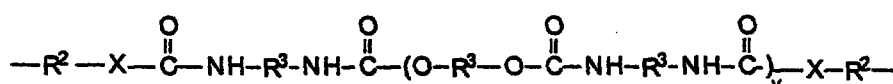
2. The circuit component composition comprising an allylated amide compound according to paragraph 1, in which Q is a linear or branched



chain alkyl species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteroatom present may or may not be directly attached to X.

5

3. The circuit component composition comprising an allylated amide compound according to paragraph 1 in which Q is a urethane having the structure:



10 in which each R² independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R³ is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; X is O, S, N, or P; and v is 0 to 50.

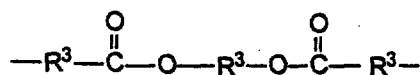
15 4. The circuit component composition comprising an allylated amide compound according to paragraph 1 in which Q is a siloxane having the structure (CR¹₂)_e—[SiR⁴₂—O]_f—SiR⁴₂—(CR¹₂)_g—

20 in which the R¹ substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R⁴ substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to 50.

25 5. The circuit component composition comprising an allylated amide compound according to paragraph 1 in which Q is an ester having the structure:

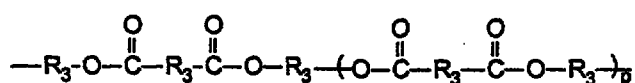
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in which R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents.

- 5 6. The circuit component composition comprising an allylated amide compound according to paragraph 1 in which Q is an ester having the structure:

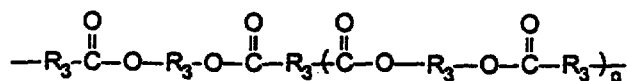


- 10 in which p is 1 to 100,
each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,
or a siloxane having the structure



- 15 independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to 50.

- 20 7. The circuit component composition comprising an allylated amide compound according to paragraph 1 in which Q is an ester having the structure:



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in which p is 1 to 100,

each R³ can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,

or a siloxane having the structure

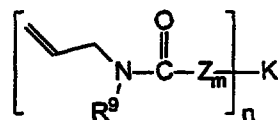
- 5 $-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R¹ substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R⁴ substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to 50.

10

8. A circuit component composition comprising an allylated amide compound; a curing initiator selected from the group consisting of a free-radical initiator, a photoinitiator, and a combination of those; optionally, one or more fillers; optionally, one or more adhesion promoters;

- 15 the allylated amide compound having the formula

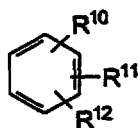
the allylated amide compound having the formula



in which m is 0 or 1, n is 1-6, and

- (a) R⁹ is H, an alkyl or alkyleneoxy group having 1 to 18 carbon atoms, allyl, aryl, or substituted aryl having the structure

20



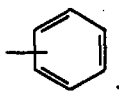
in which R¹⁰, R¹¹, and R¹² are independently

H or an alkyl or alkyleneoxy group having 1 to 18 carbon atoms;



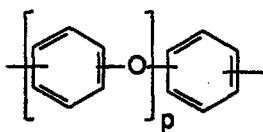
(b) K is an aromatic group selected from group of aromatic groups having the structures:

(VI)



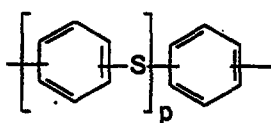
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(VII)



in which p is 1 to 100;

(VIII)



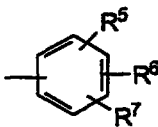
10

in which p is 1 to 100;

(IX)



15 (X)



in which R^5 , R^6 , and R^7 are a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to

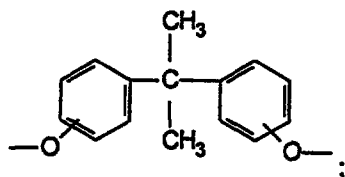
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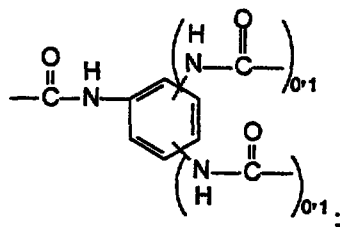
about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the backbone in the chain, and in which any heteratom present may or may not be directly attached to the aromatic ring; or

- 5 R^5 , R^6 , and R^7 are a siloxane having the structure $-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CH_3)_g-$ in which the R^1 substituent is H or an alkyl group having 1 to 5 carbon atoms and the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e is 1 to 10 and f is 1 to 50;

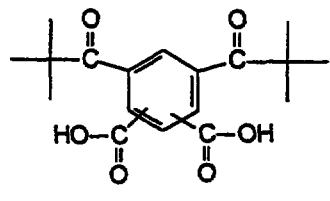
10 (XI)



(XII)



15 and (XIII)



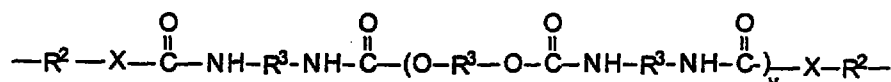
and



(c) Z is a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteroatom present may or may not be directly attached to K.

9. The circuit component composition comprising an allylated amide compound according to paragraph 8 in which Z is a linear or branched chain alkyl species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteroatom present may or may not be directly attached to K.

10. The circuit component composition comprising an allylated amide compound according to paragraph 8 in which Z is a urethane having the structure:



in which each R^2 independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; X is O, S, N, or P; and v is 0 to 50.

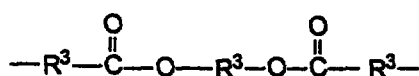
11. The circuit component composition comprising an allylated amide compound according to paragraph 8 in which Z is a siloxane having the structure: $-(CR^1_2)_6-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$



in which the R¹ substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, and the R⁴ substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e and g are independently 1 to 10 and f is 1 to 50.

5

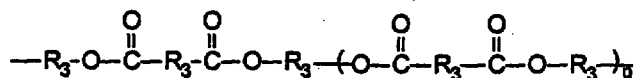
12. The circuit component composition comprising an allylated amide compound according to paragraph 8 in which Z is an ester having the structure:



10 in which R³ is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents.

13. The circuit component composition comprising an allylated amide compound according to paragraph 8 in which Z is an ester having the structure:

15



in which p is 1 to 100,

each R³ can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,

20

or a siloxane having the structure

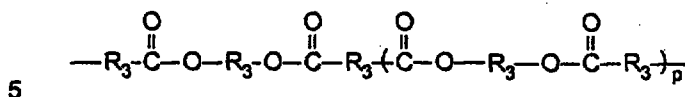


in which the R¹ substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R⁴ substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to

25 10, and f is 1 to 50.



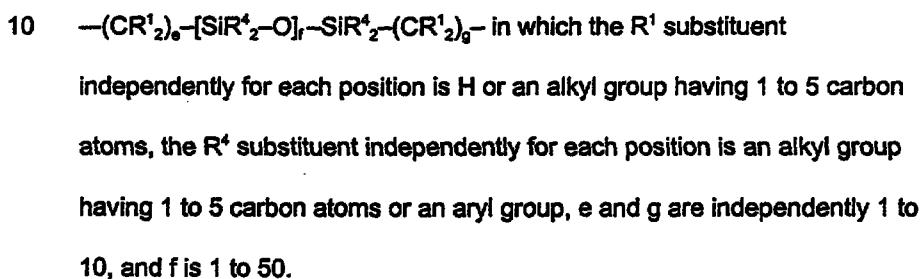
14. The circuit component composition comprising an allylated amide compound according to paragraph 8 in which Z is an ester having the structure:



in which p is 1 to 100,

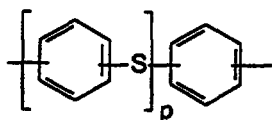
each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,

or a siloxane having the structure



15

15. The circuit component composition comprising an allylated amide compound according to any one of paragraphs 8 to 14 in which K is



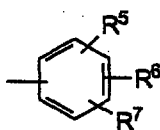
in which p is 1 to 100.

20

16. The circuit component composition comprising an allylated amide compound according to any one of paragraphs 8 to 14 in which K is

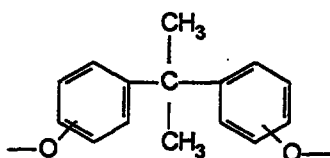
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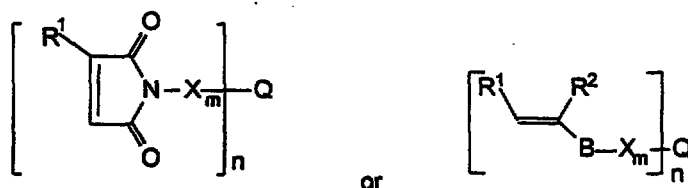
in which R^5 , R^6 , and R^7 are a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteroatom present may or may not be directly attached to the aromatic ring.

17. The circuit component composition comprising an allylated amide compound according to any one of paragraphs 8 to 14 in which K is



18. A circuit component composition according to any one of paragraphs 1 through 17 in which the curing initiator is selected from the group consisting of an anionic and a cationic initiator.

19. A circuit component composition according to any one of paragraphs 1 to 18 further comprising a compound having the structure



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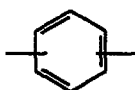
in which m is 0 or 1 and n is 1 to 6, and

(a) R^1 and R^2 are H or an alkyl group having 1 to 5 carbon atoms, or together form a 5 to 9 membered ring with the carbons forming the vinyl group;

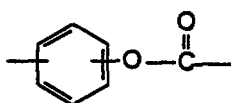
5 (b) B is C, S, N, O, C(O), C(O)NH or C(O)N(R^8), in which R^8 is an alkyl group having 1 to 5 carbon atoms;

(c) X is an aromatic group selected from the group of aromatic groups having the structures:

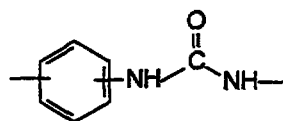
(I)



(II)



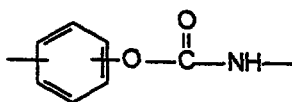
(III)



10

and

(IV)

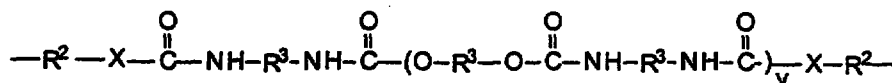


and

15 (d) Q is a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteratom present may or may not be directly

20 attached to X; or

(d) Q is a urethane having the structure:



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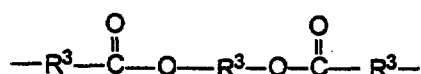
in which each R^2 independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; X is O, S, N, or P; and v is 0 to 50; or

5 (e) Q is a siloxane having the structure:

$-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, and the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e and g are

10 independently 1 to 10 and f is 1 to 50; or

(f) Q is an ester having the structure:

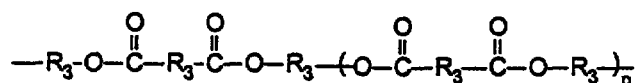


in which R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents.

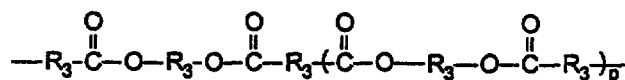
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20. The circuit component composition according to paragraph

19 in which Q is an ester having the structure:



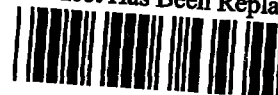
or the structure:



20

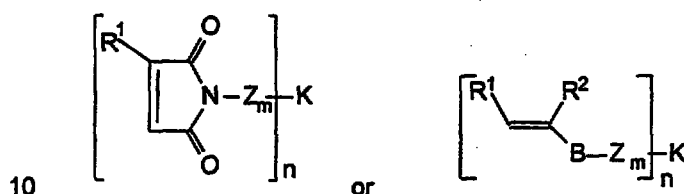
in which p is 1 to 100, and

each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; or



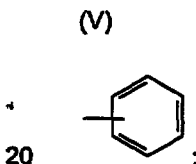
each R^3 can independently be a siloxane having the structure —
 $(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R^1 substituent independently
 for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4
 substituent independently for each position is an alkyl group having 1 to 5
 5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to
 50.

21. A circuit component composition according to any one of
 paragraphs 1 to 18 further comprising a compound having the structure



in which m is 0 or 1 and n is 1-6; and

- (a) R^1 and R^2 are H or an alkyl group having 1 to 5 carbon
 atoms, or together form a 5 to 9 membered ring with the carbons forming the
 vinyl group;
- 15 (b) B is C, S, N, O, C(O), C(O)NH or C(O)N(R^6), in which R^6 is
 an alkyl group having 1 to 5 carbon atoms;
- (c) K is an aromatic group selected from the group of aromatic
 groups having the structures:

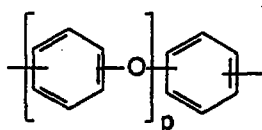


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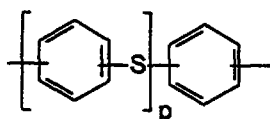


(VI)



in which p is 1 to 100;

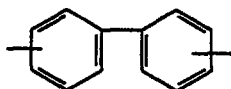
(VII)



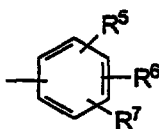
in which p is 1 to 100;

5

(VIII)



(IX)



in which R⁵, R⁶, and R⁷ are a linear or branched

10 chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the backbone in the chain, and in which any heteratom present may or may not be directly attached to the aromatic ring; or

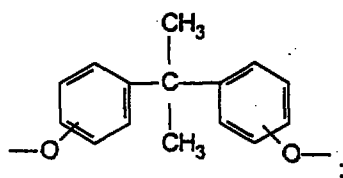
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R⁵, R⁶, and R⁷ are a siloxane having the structure

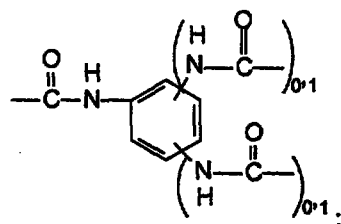
—(CR¹₂)_e—[SiR⁴₂—O]_f—SiR⁴₂—(CH₃)_g— in which the R¹ substituent is H or an alkyl group having 1 to 5 carbon atoms and the R⁴ substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e is 1 to 10 and f is 1 to 50;



(X)

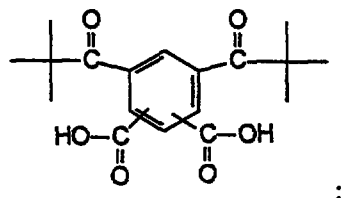


(XI)



5

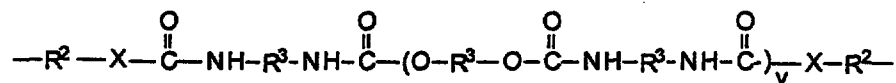
and (XII)



and

- (d) Z is a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteratom present may or may not be directly attached to K; or

- 15 (e) Z is a urethane having the structure:





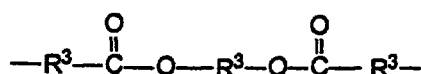
in which each R^2 independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; X is O, S, N, or P; and v is 0 to 50; or

5 (f) Z is a siloxane having the structure:

$-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, and the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e and g are

10 independently 1 to 10 and f is 1 to 50; or

(g) Z is an ester having the structure:

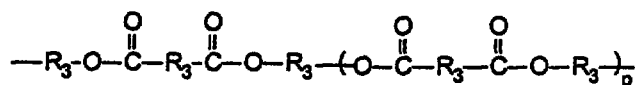


in which R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents.

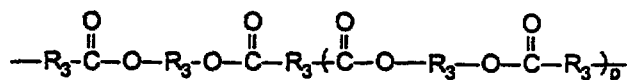
15

22. The curable adhesive composition according to paragraph 21

in which Z is an ester having the structure:



or the structure:



20

in which p is 1 to 100, and

each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; or

each R³ can independently be a siloxane having the structure —
(CR¹₂)_e—[SiR⁴₂—O]_f—SiR⁴₂—(CR¹₂)_g— in which the R¹ substituent independently
for each position is H or an alkyl group having 1 to 5 carbon atoms, the R⁴
substituent independently for each position is an alkyl group having 1 to 5
5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to
50.

23. A method for making a printed circuit board comprising a
circuit component prepared by curing a composition according to any one of
10 paragraphs 1 through 22 comprising:

- (a) depositing the curable circuit component composition on the
printed circuit board; and
- (b) curing the composition *in situ*.

15 24. An electronic assembly prepared by the method according to
paragraph 23.

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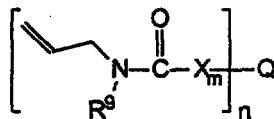




What is claimed is:

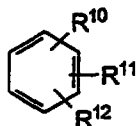
1. A circuit component composition comprising an allylated amide compound; a curing initiator selected from the group consisting of a free-radical initiator, a photoinitiator, and a combination of those; optionally, one or more fillers; optionally, one or more adhesion promoters;

the allylated amide compound having the formula



in which m is 0 or 1, n is 1 to 6, and

- (a) R^9 is H, an alkyl group having 1 to 18 carbon atoms, an alkyleneoxy group having 1 to 18 carbon atoms, an allyl group, an aryl group, or a substituted aryl group having the structure

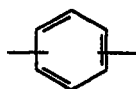


in which R^{10} , R^{11} , and R^{12} are independently

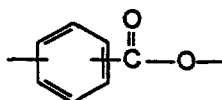
H or an alkyl or alkyleneoxy group having 1 to 18 carbon atoms;

- (b) X is an aromatic group selected from the group of aromatic groups having the structures:

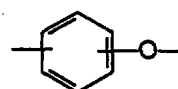
(I)



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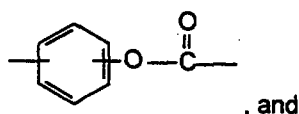


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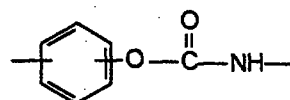




(IV)



(V)

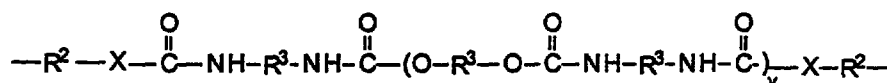


, and

(c) Q is a linear or branched chain alkyl, alkyloxy, alkyl amine,

5 alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteroatom present may or may not be directly attached to X; or

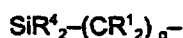
10 (d) Q is a urethane having the structure:



in which each R^2 independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents;

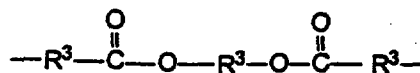
15 X is O, S, N, or P; and v is 0 to 50; or

(e) Q is a siloxane having the structure $(\text{CR}^1_2)_e \text{---} [\text{SiR}^4_2 \text{---} \text{O}]_f \text{---}$



in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4 substituent independently for
20 each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to 50.

(f) Q is an ester having the structure:



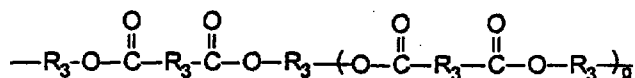
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in which R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; or

(g) Q is an ester having the structure:



5 in which p is 1 to 100,

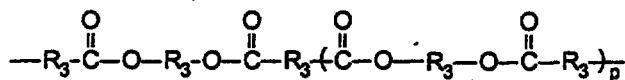
each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,

or a siloxane having the structure



10 independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to 50; or

(h) Q is an ester having the structure:



15

in which p is 1 to 100,

each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,

or a siloxane having the structure

20 $-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R^1 substituent

independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to 50.

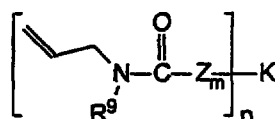
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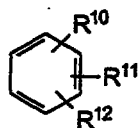
2. A circuit component composition comprising an allylated amide compound; a curing initiator selected from the group consisting of a free-radical initiator, a photoinitiator, and a combination of those; optionally,
- 5 one or more fillers; optionally, one or more adhesion promoters; the allylated amide compound having the formula

the allylated amide compound having the formula



in which m is 0 or 1, n is 1-6, and

- 10 (a) R^9 is H, an alkyl or alkyleneoxy group having 1 to 18 carbon atoms, allyl, aryl, or substituted aryl having the structure

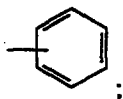


in which R^{10} , R^{11} , and R^{12} are independently

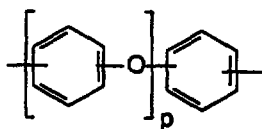
H or an alkyl or alkyleneoxy group having 1 to 18 carbon atoms;

- (b) K is an aromatic group selected from group of aromatic groups having the structures:
- 15

(VI)



(VII)

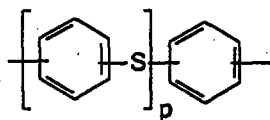


in which p is 1 to 100;



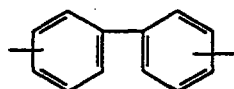


(VIII)



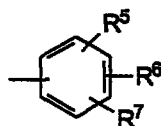
in which p is 1 to 100;

(IX)



5

(X)



in which R^5 , R^6 , and R^7 are a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the backbone in the chain, and in which any heteratom present may or may not be directly attached to the aromatic ring; or

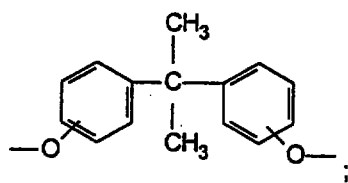
15

R^5 , R^6 , and R^7 are a siloxane having the structure $-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CH_3)_g-$ in which the R^1 substituent is H or an alkyl group having 1 to 5 carbon atoms and the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e is 1 to 10 and f is 1 to 50;

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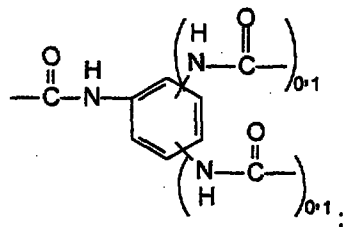
(XI)



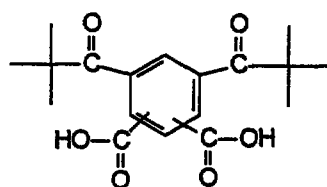
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(XII)



and (XIII)

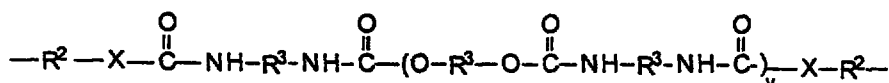


5

and

- (c) Z is a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species having up to about 100 atoms in the chain, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteroatom present may or may not be directly attached to K; or
- 10

(d) Z is a urethane having the structure:

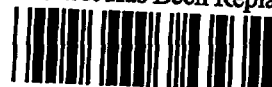


15

in which each R^2 independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; X is O, S, N, or P; and v is 0 to 50; or.

(e) Z is a siloxane having the structure:

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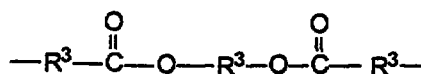




$-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, and the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e and g are

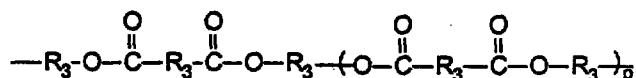
5 independently 1 to 10 and f is 1 to 50; or

(f) Z is an ester having the structure:



in which R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; or

10 (g) Z is an ester having the structure:



in which p is 1 to 100,

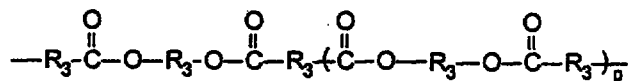
each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,

15 or a siloxane having the structure

$-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to

20 10, and f is 1 to 50; or

(i) Z is an ester having the structure:



in which p is 1 to 100,

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each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,

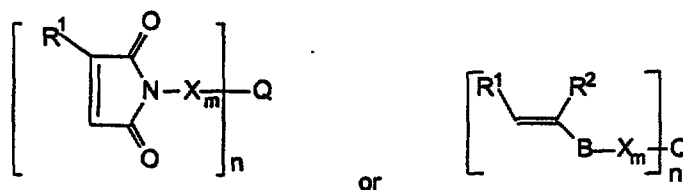
or a siloxane having the structure



- 5 independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to 50.

- 10 3. A circuit component composition according to claim 1 or claim 2 in which the curing initiator is selected from the group consisting of an anionic and a cationic initiator.

- 15 4. A circuit component composition according to any one of claims 1 to 3 further comprising a compound having the structure

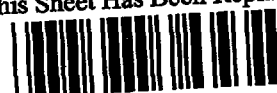


in which m is 0 or 1 and n is 1 to 6, and

- (a) R^1 and R^2 are H or an alkyl group having 1 to 5 carbon atoms, or together form a 5 to 9 membered ring with the carbons forming the vinyl group;

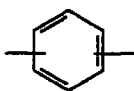
(b) B is C, S, N, O, C(O), C(O)NH or C(O)N(R^6), in which R^6 is an alkyl group having 1 to 5 carbon atoms;

(c) X is an aromatic group selected from the group of aromatic groups having the structures:

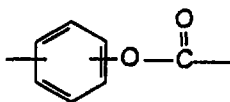




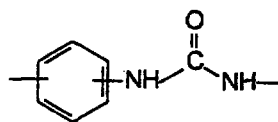
(I)



(II)

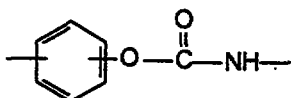


(III)



and

(IV)

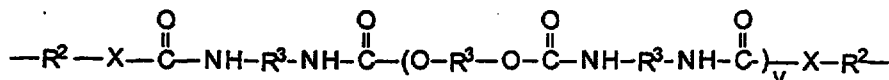


5

and

- (d) Q is a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteratom present may or may not be directly attached to X; or

(d) Q is a urethane having the structure:



- 15 in which each R^2 independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; X is O, S, N, or P; and v is 0 to 50; or

(e) Q is a siloxane having the structure:

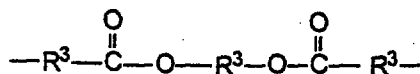
- 20 $-(CR^1_2)_a-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, and the R^4 substituent independently for each position is an alkyl





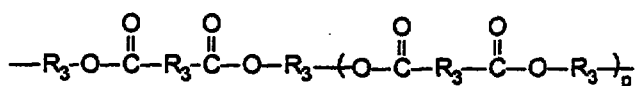
group having 1 to 5 carbon atoms or an aryl group, and e and g are independently 1 to 10 and f is 1 to 50; or

(f) Q is an ester having the structure:



5 in which R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; or

(g) Q is an ester having the structure:



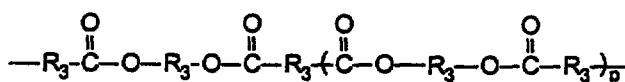
in which p is 1 to 100,

10 each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,
or a siloxane having the structure



15 in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to 50; or

(h) Q is an ester having the structure;



20 in which p is 1 to 100, and
each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; or

each R^3 can independently be a siloxane having the structure —

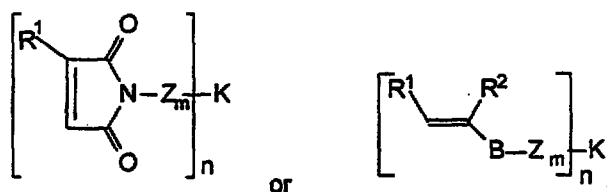




for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to 50.

5

5. A circuit component composition according to any one of claims 1 to 4 further comprising a compound having the structure



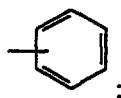
in which m is 0 or 1 and n is 1-6; and

10 (a) R^1 and R^2 are H or an alkyl group having 1 to 5 carbon atoms, or together form a 5 to 9 membered ring with the carbons forming the vinyl group;

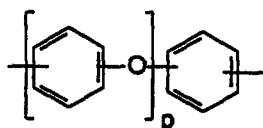
(b) B is C, S, N, O, C(O), C(O)NH or C(O)N(R^8), in which R^8 is an alkyl group having 1 to 5 carbon atoms;

15 (c) K is an aromatic group selected from the group of aromatic groups having the structures:

(V)



(VI)



20

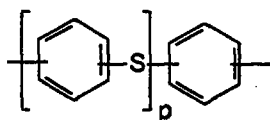
in which p is 1 to 100;

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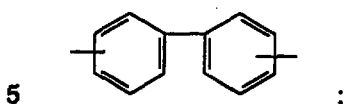


(VII)

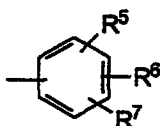


in which p is 1 to 100;

(VIII)



(IX)



in which R^5 , R^6 , and R^7 are a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species, which may

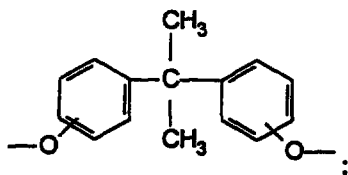
10 contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the backbone in the chain, and in which any heteratom present may or may not be directly attached to the aromatic ring; or

R^5 , R^6 , and R^7 are a siloxane having the structure

$-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CH_3)_g-$ in which the R^1 substituent is H or an

15 alkyl group having 1 to 5 carbon atoms and the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e is 1 to 10 and f is 1 to 50;

(X)

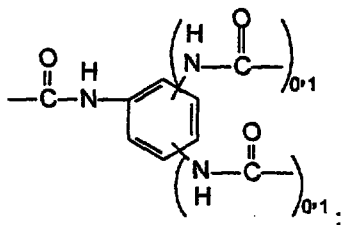


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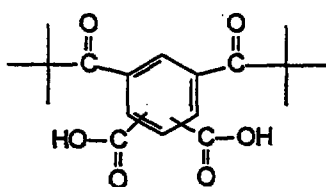




(XI)



and (XII)

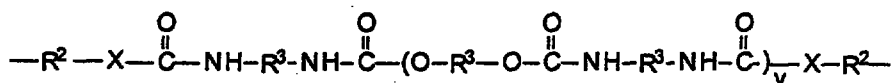


5

and

- (d) Z is a linear or branched chain alkyl, alkyloxy, alkyl amine, alkyl sulfide, alkylene, alkyleneoxy, alkylene amine, alkylene sulfide, aryl, aryloxy, or aryl sulfide species, which may contain saturated or unsaturated cyclic or heterocyclic substituents pendant from the chain or as part of the chain, and in which any heteratom present may or may not be directly attached to K; or

- (e) Z is a urethane having the structure:



- 15 in which each R^2 independently is an alkyl, aryl, or arylalkyl group having 1 to 18 carbon atoms; R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; X is O, S, N, or P; and v is 0 to 50; or

- (f) Z is a siloxane having the structure:

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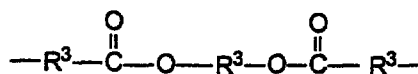




$-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, and the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, and e and g are

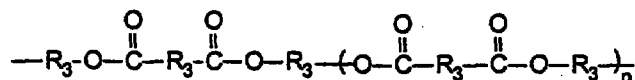
5 independently 1 to 10 and f is 1 to 50; or

(g) Z is an ester having the structure:



in which R^3 is an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; or

10 (h) Z is an ester having the structure:



in which p is 1 to 100,

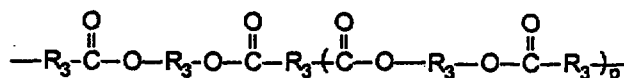
each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents,

15 or a siloxane having the structure

$-(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R^1 substituent independently for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4 substituent independently for each position is an alkyl group having 1 to 5 carbon atoms or an aryl group, e and g are independently 1 to

20 10, and f is 1 to 50; or

(i) Z is an ester having the structure:



in which p is 1 to 100, and





each R^3 can independently be an alkyl or alkyloxy chain having up to 100 atoms in the chain, which chain may contain aryl substituents; or

each R^3 can independently be a siloxane having the structure —
 $(CR^1_2)_e-[SiR^4_2-O]_f-SiR^4_2-(CR^1_2)_g-$ in which the R^1 substituent independently
5 for each position is H or an alkyl group having 1 to 5 carbon atoms, the R^4
substituent independently for each position is an alkyl group having 1 to 5
carbon atoms or an aryl group, e and g are independently 1 to 10, and f is 1 to
50.

10 6. A method for making a printed circuit board comprising a
circuit component prepared by curing a composition according to any one of
claims 1 through 5 comprising:

- (a) depositing the curable circuit component composition on the
printed circuit board; and
- 15 (b) curing the composition *in situ*.

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