POLYMER AND COMPOSITIONS THEREOF FOR FORMING PATTERNED LAYERS AFTER IMAGE-WISE EXPOSURE TO ACTINIC RADIATION

~~A Self-Imageable Layer Forming Polymer and Compositions Thereof~~

CROSS-REFERENCE TO RELATED PATENT APPLICATION

[0001] The present patent application is entitled to and claims the benefit of priority, under 35 U.S.C. §119 of United States Provisional Patent Application Serial No. 61/507685 filed July14, 2011, and United States Provisional Patent Application Serial No. 61/548832 filed October 19, 2011, both of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

[0002] The present invention relates generally to copolymers and compositions thereof that encompass both norbornene-type repeating units and non-norbornene-type repeating units that are useful for forming self-imageable layers, and more specifically to such copolymers and compositions thereof that encompass both repeating units derived from norbornene-type monomers with repeating units derived from maleic anhydride-type monomers for providing self-imageability to layers made therefrom when such layers are image-wise exposed to actinic radiation.

BACKGROUND

[0003] The microelectronic, such as semiconductor and optoelectronic, industries have seen the requirement for smaller and smaller device geometries over the past several years. While in some areas of device fabrication sub-micron device geometries have been common place for a number of years, in other areas, such as liquid crystal displays (LCDs), organic light emitting diodes (OLEDs) and a variety of radio frequency (Rf) and microwave devices (e.g. RFICs/MMICs, switches, couplers, phase shifters, SAW filters and SAW duplexers), such device geometries are only recently approaching sub 10 micron levels.

[0004] With such smaller geometries comes a requirement for dielectric materials with low dielectric constants to reduce or eliminate any cross-talk between adjacent signal lines or between a signal line and a device feature (e.g. a pixel electrode) due to capacitive coupling. Although many low dielectric (low-K) materials are available for microelectronic devices, for optoelectronic devices such materials must also be broadly transparent in the visible light spectrum, not require high temperature processing (greater than 300°C.) that would be

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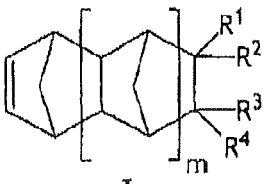
Claims:

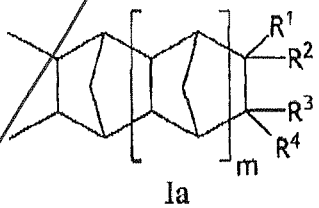
1. A layer forming polymer composition comprising:

(i) a self-imageable polymer consisting of norbornene-type repeating units and maleic anhydride-type repeating units where

(a) such norbornene-type repeating units are represented by Formula Ia, which are derived from norbornene-type monomers represented by Formula I:



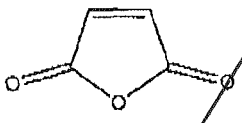
I



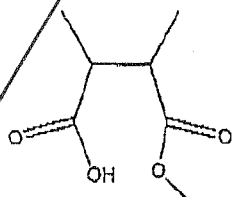
Ia

where m is 0, 1 or 2, each R^1, R^2, R^3 and R^4 for the said first type of repeating unit is independently a hydrogen or a hydrocarbyl pendent group having high transparency in the visible light spectrum; and

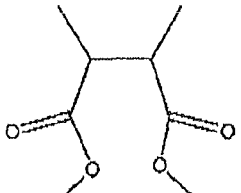
(b) such maleic anhydride-type repeating units are represented by one or more of Formulae IIa, IIb and IIc, which are derived from maleic anhydride monomer represented by Formula II:



II



IIa



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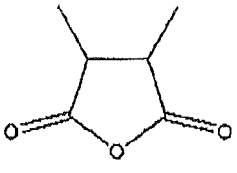
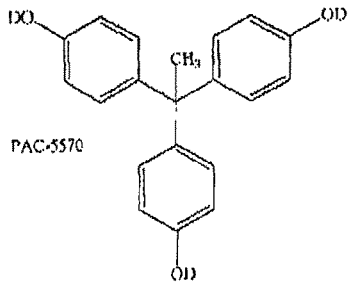


IIc

where R^5 and R^6 are each independently one of hydrogen, methyl, ethyl, a fluorinated or perfluorinated methyl or ethyl, a linear or branched C_3-C_9 hydrocarbyl group; a linear or branched fluorinated or perfluorinated C_3-C_9 hydrocarbyl group; a C_6-C_{18} substituted or unsubstituted cyclic or polycyclic hydrocarbyl group,

where R^5 and R^6 are the same or different hydrocarbyl;

(ii) a photo active compound (PAC) selected from:



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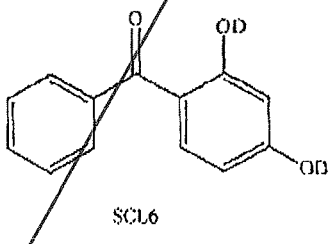

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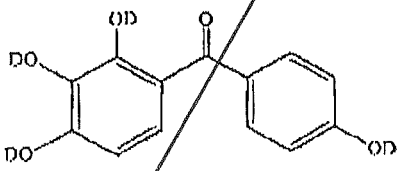

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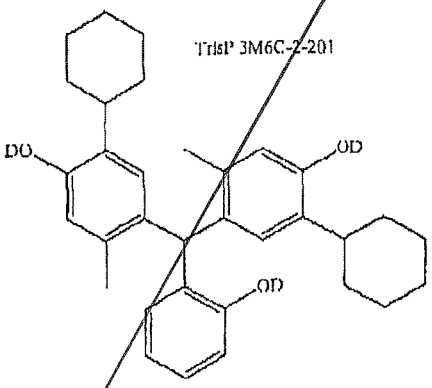
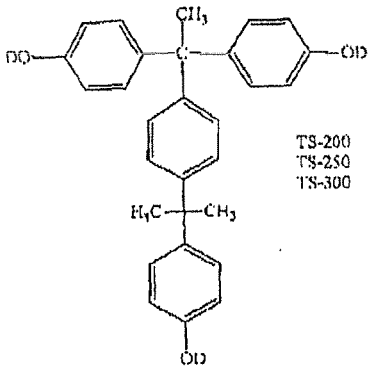
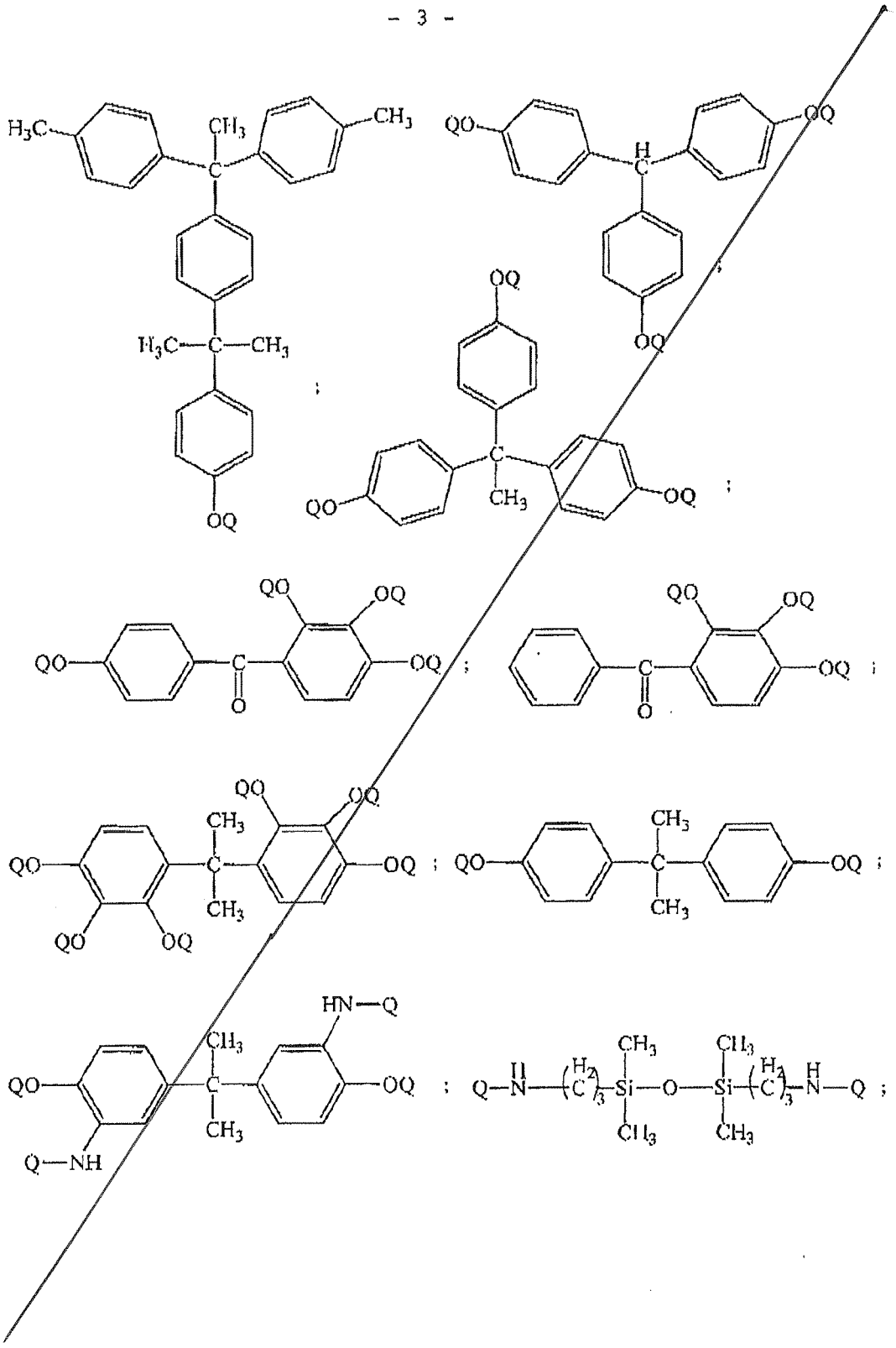
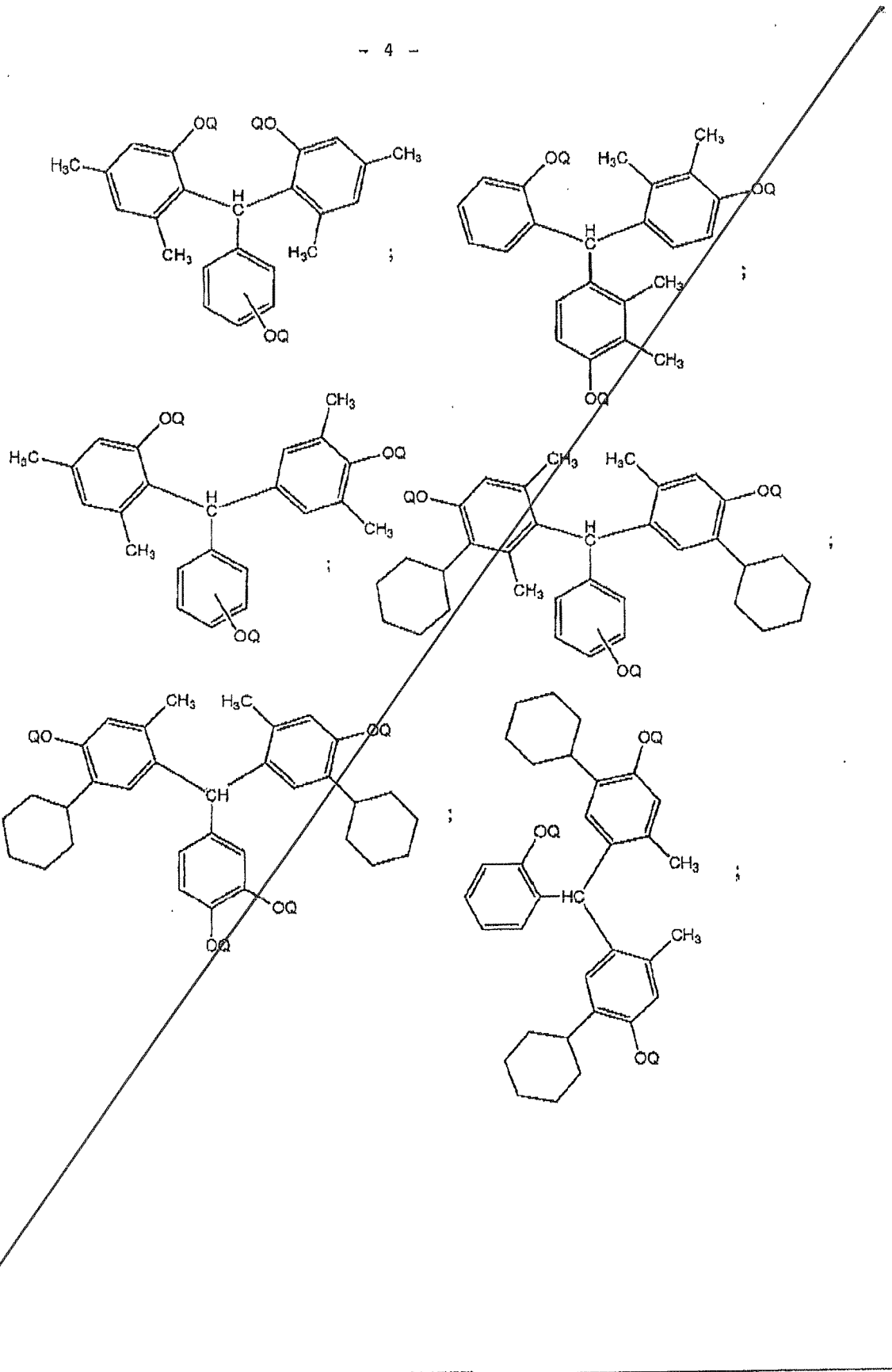


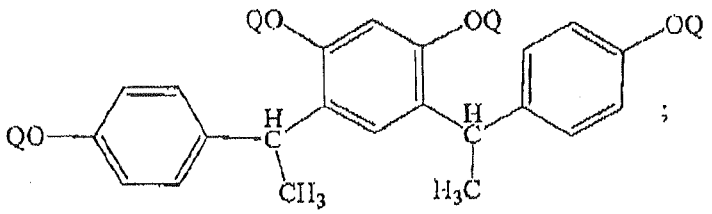
TrisP 3M6C-2-201 ;



TS-200
TS-250
TS-300 ;







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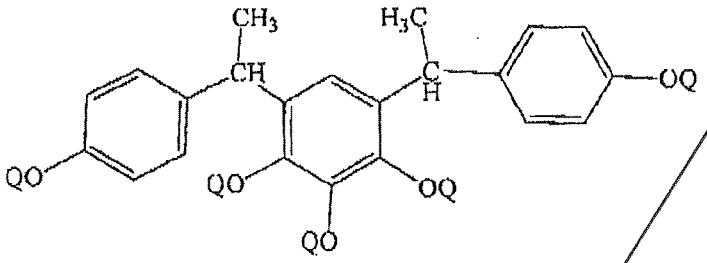

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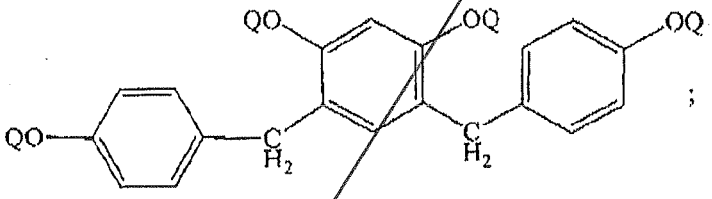

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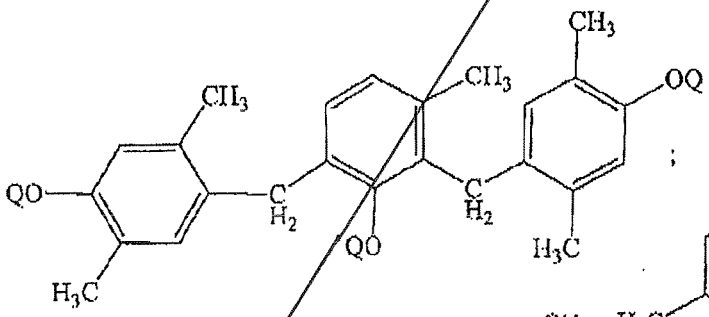

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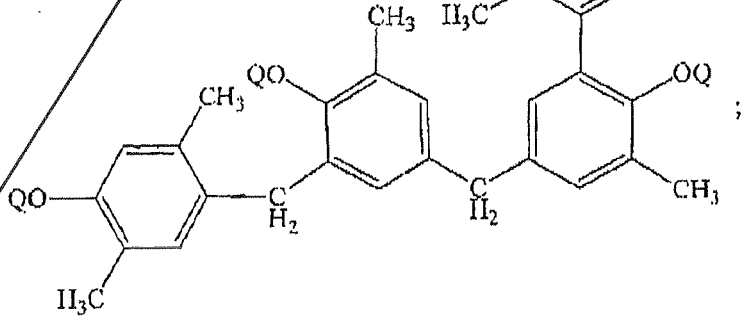

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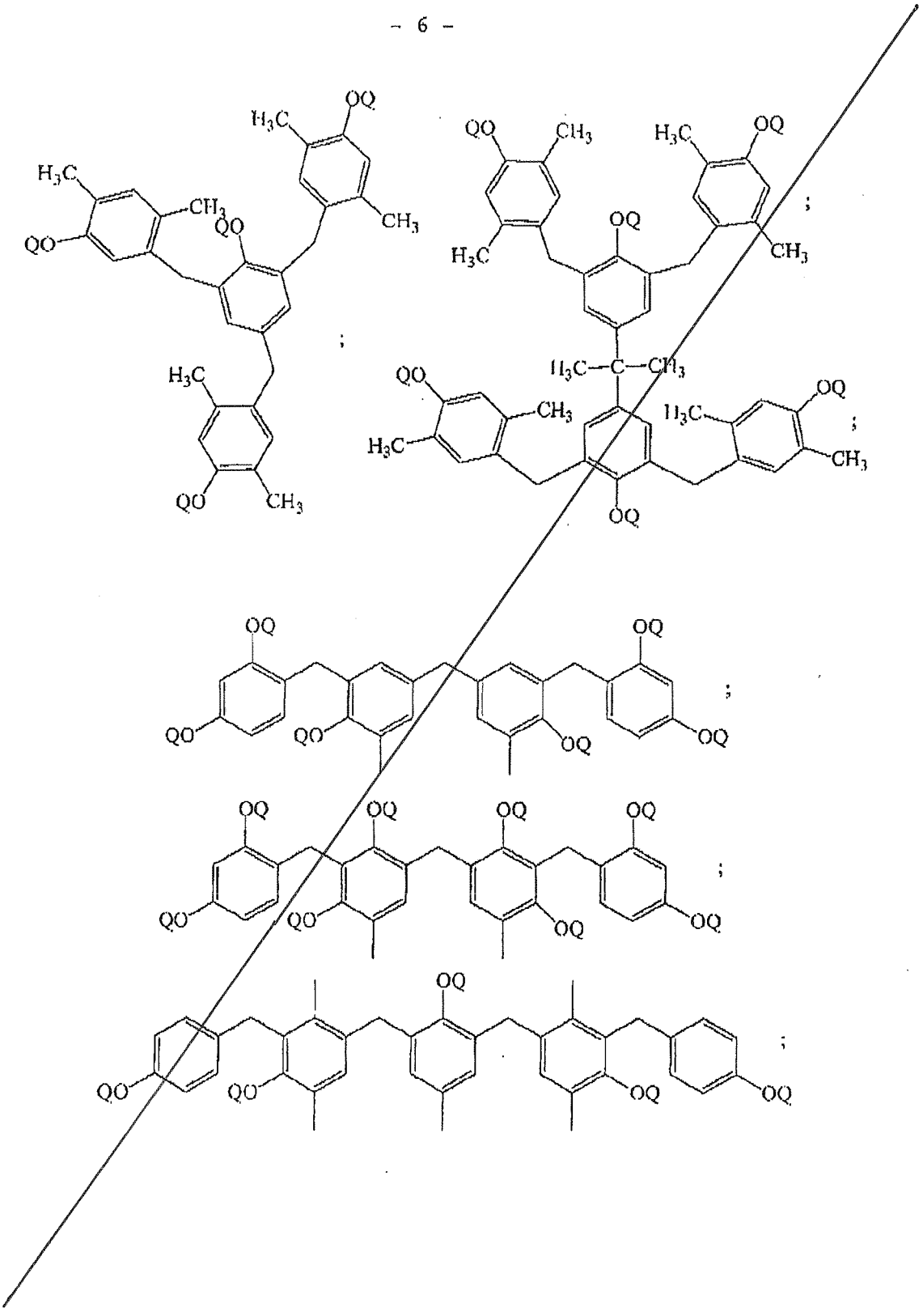

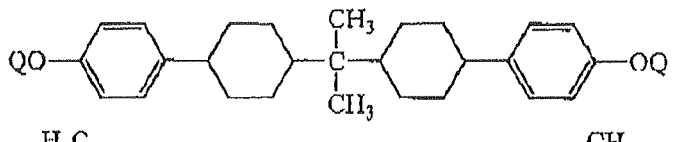

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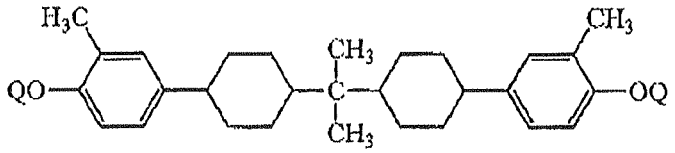

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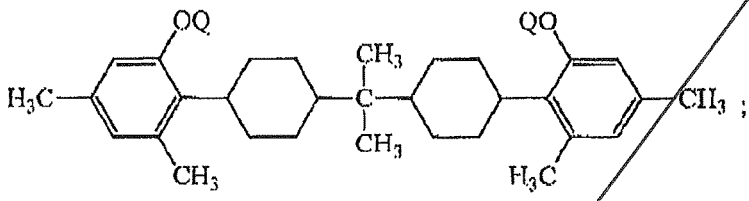

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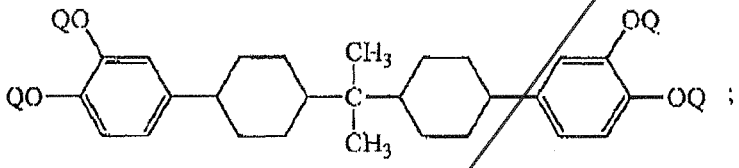

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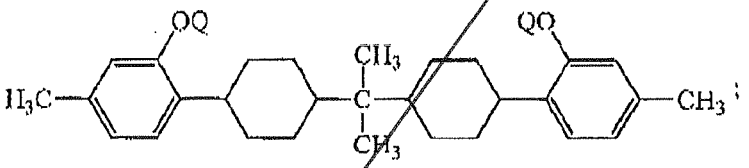

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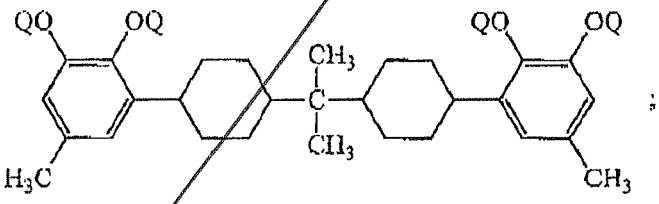

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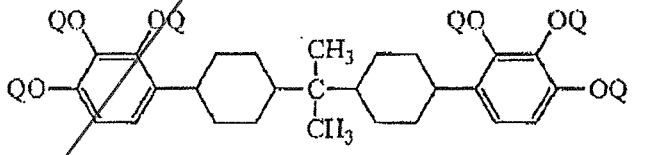

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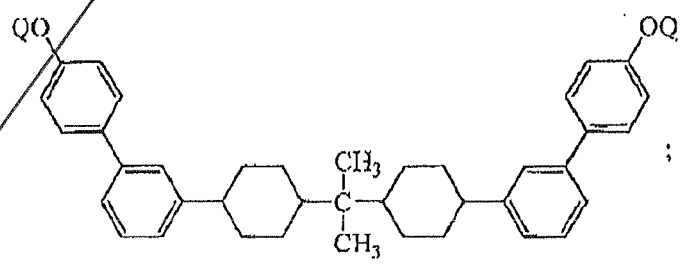

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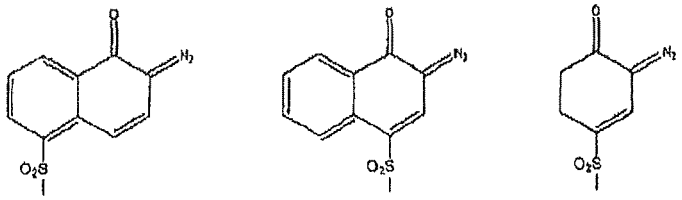
where D and Q are selected from

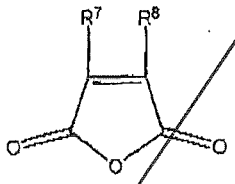


, or a hydrogen atom;

(iii) an epoxy resin comprising at least two epoxy groups; and

(iv) a solvent.

2. The layer forming polymer composition of claim 1, where the self-imageable polymer further comprises maleic anhydride-type repeating units derived from maleic anhydride-type monomers represented by Formula III:



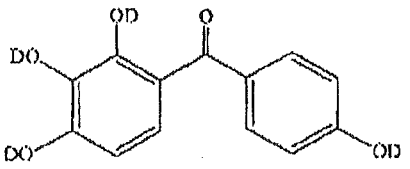
III

where R^7 and R^8 are the same or different and are selected from hydrogen, methyl and ethyl.

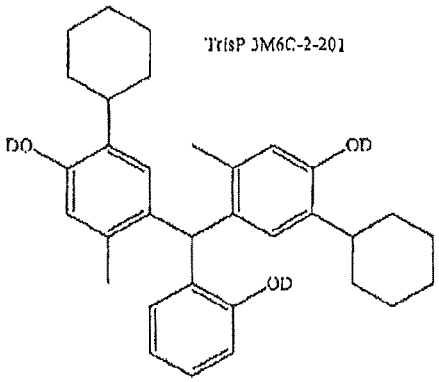
3. The polymer composition of claim 1, where R^5 is one of methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl or tert-butyl.

4. The polymer composition of claim 1, where the epoxy resin comprises three epoxy groups.

5. The polymer composition of claim 1 or 2, where the PAC is selected from:



4NT-300 ;



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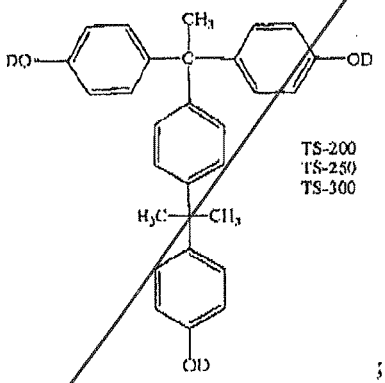
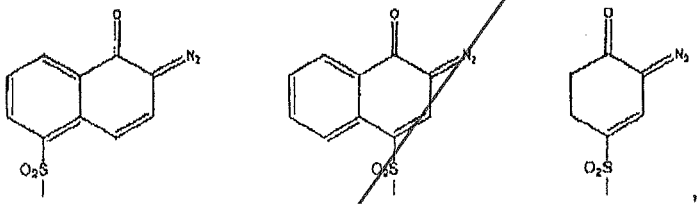


TS-200
TS-250
TS-300

or ;

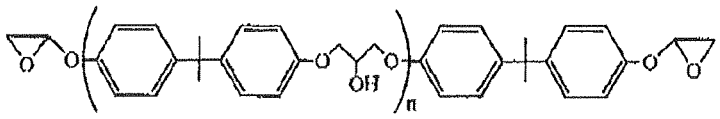
where D is selected from



, or a hydrogen atom.

6. The polymer composition of claim 5 where the solvent is propylene glycol monomethyl ether acetate (PGMEA), ethyl lactate, methyl n-amyl ketone (MAK) or mixtures thereof.

7. The polymer composition of claim 5, where R^1-R^4 is hydrogen, butyl, hexyl, perfluorobutyl, phenethyl, R^5 is butyl and the epoxy resin is selected from:



LX-01

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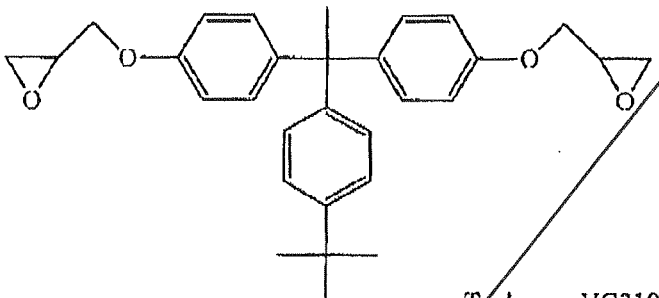

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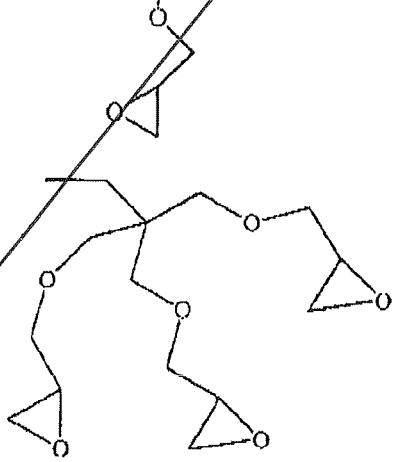
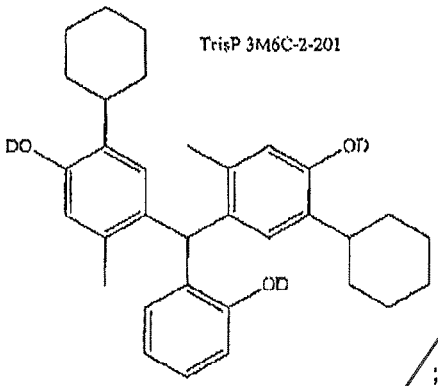


; and

TMPTGE

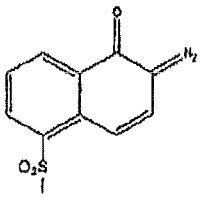
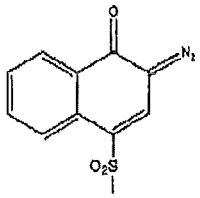
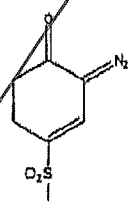
8. The polymer composition of claim 6,

where the PAC is:



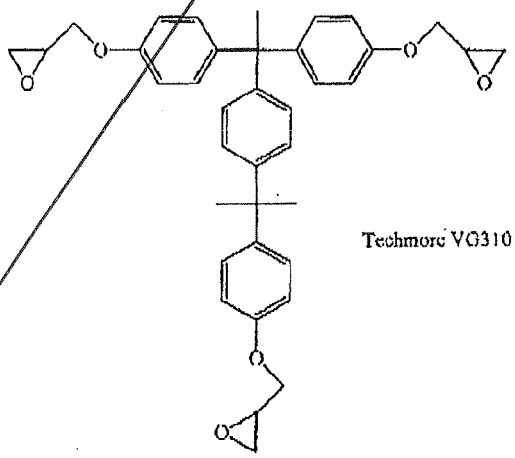
;

where D is selected from

, or a hydrogen atom;

the epoxy resin is:



;

and the solvent is propylene glycol monomethyl ether acetate (PGMEA).

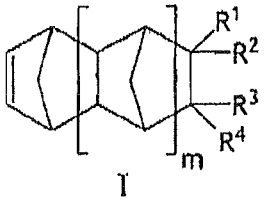
9. A polymer layer formed from the polymer composition of any of claims 1 to 8.

10. The polymer layer of claim 9 having a dielectric constant of 3.2 or less at 1 MHz.

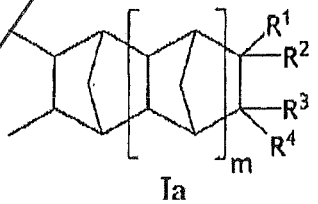
11. The polymer layer of Claim 9 or 10 having a transparency at 400 nm of more than 85 % after curing at 250 °C for 30 minutes.

12. A polymer comprising:

(a) norbornene-type repeating units represented by Formula Ia, which are derived respectively from one or more norbornene-type monomers represented by Formula I:



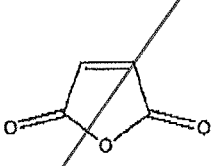
I



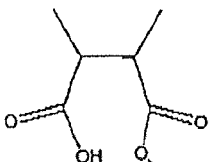
Ia

where m is 0, 1 or 2, each R^1, R^2, R^3 and R^4 for the said first type of repeating unit is independently a hydrogen or a hydrocarbyl pendent group having high transparency in the visible light spectrum; and

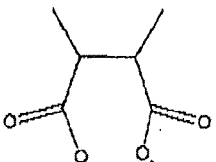
(b) maleic anhydride-type repeating units represented by one or more of Formulae IIa, IIb and IIc, which are derived from maleic anhydride monomer represented by Formula II:



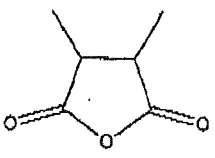
II



IIa



IIb



IIc

where R^5 and R^6 are each independently one of hydrogen, methyl, ethyl, a fluorinated or perfluorinated methyl or ethyl, a linear or branched C_3-C_9 hydrocarbyl group; a linear or branched fluorinated or perfluorinated C_3-C_9 hydrocarbyl group; a C_6-C_{18} substituted or unsubstituted cyclic or polycyclic hydrocarbyl group,

where R^5 and R^6 are the same or different hydrocarbyl.

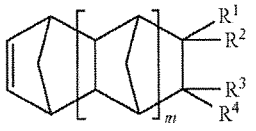
13. Use of the polymer composition of any of claims 1 to 8 for forming positive tone self-imageable films.

Claims:

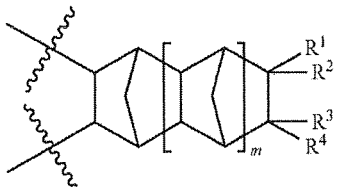
1. A layer forming polymer composition, comprising:

a self-imageable polymer including norbornene-type repeating units and maleic anhydride-type repeating units, where:

such norbornene-type repeating units are represented by Formula Ia, which are derived from norbornene-type monomers represented by Formula I:



I

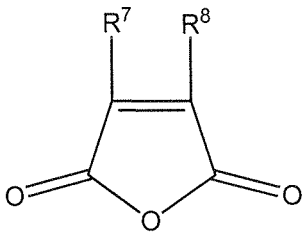


Ia

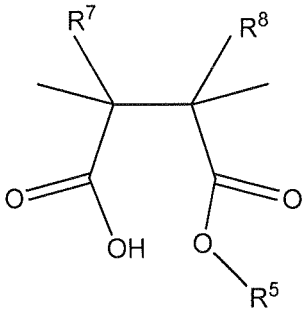
where m is 0, 1 or 2, each R^1, R^2, R^3 and R^4 for the said norbornene-type repeating unit is independently a hydrogen or a hydrocarbyl pendent group;

such maleic anhydride-type of repeating units are represented by one or more of Formulae IIIa and IIIb, which are derived from maleic anhydride monomers represented

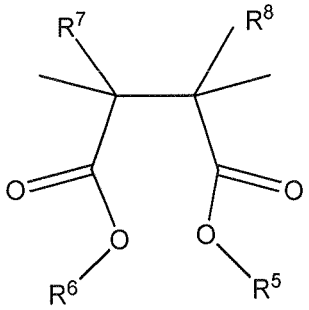
by Formula III:



III



IIIa



IIIb

where R^5 and R^6 are each independently one of hydrogen, methyl, ethyl, a fluorinated or perfluorinated methyl or ethyl, a linear or branched C_3-C_9 hydrocarbyl group, a linear or branched fluorinated or perfluorinated C_3-C_9 hydrocarbyl group or a C_6-C_{18} substituted or unsubstituted cyclic or polycyclic hydrocarbyl group; R^7 and R^8 are the same or different and are selected from hydrogen, methyl and ethyl;

a photo active compound;

an epoxy resin comprising at least two epoxy groups; and

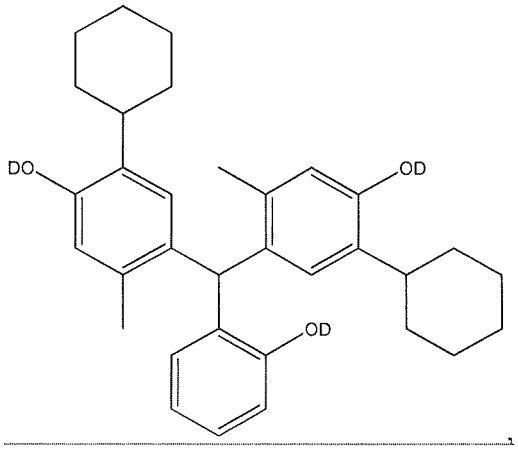
a solvent.

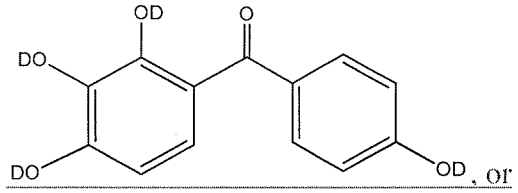
2. The layer forming polymer composition of Claim 1, wherein R^7 and R^8 are hydrogen.

3. The polymer composition of Claim 1, where R^5 is one of methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl or tert-butyl.

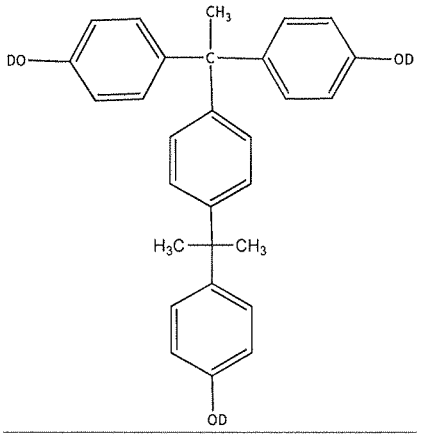
4. The polymer composition of Claim 1, where the epoxy resin comprises three epoxy groups.

5. The polymer composition of Claim 1 or 2, where the photo active compound is selected from:

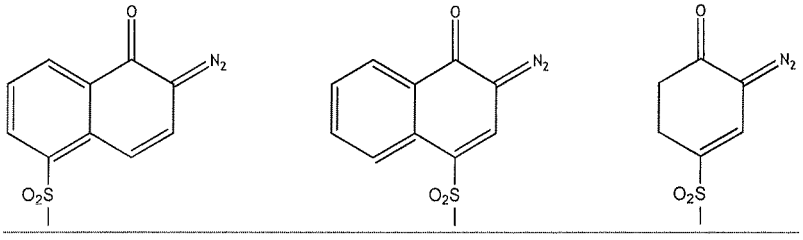




, or



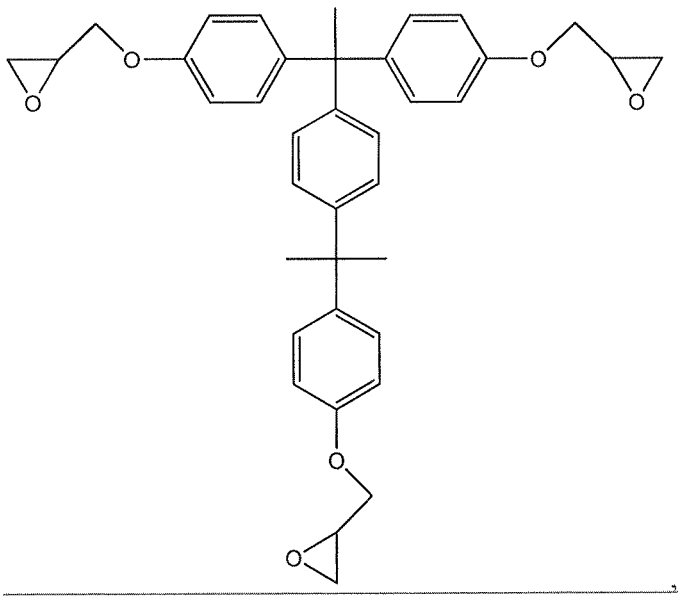
wherein at least one of D is :



and remaining D is hydrogen.

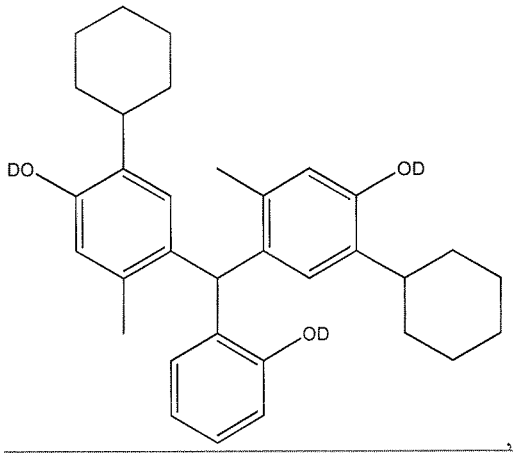
6. The polymer composition of Claim 5 where the solvent is propylene glycol monomethyl ether acetate, ethyl lactate, methyl n-amyl ketone or mixtures thereof.

7. The polymer composition of Claim 5, where R^1-R^4 are each hydrogen, R^5 is butyl and the epoxy resin is

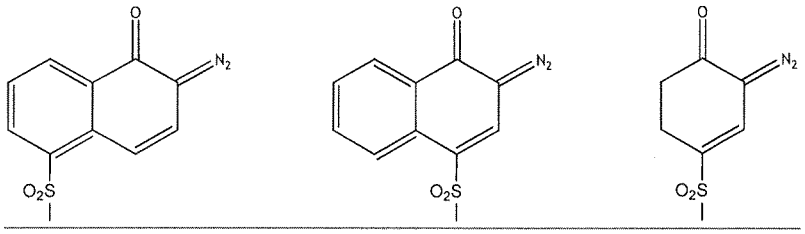


trimethylolpropane triglycidylether or bisphenol A epoxy resin.

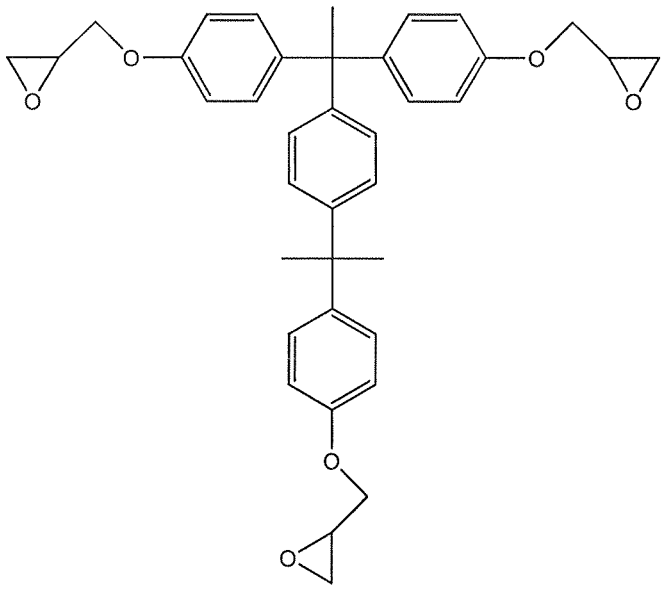
8. The polymer composition of Claim 6, where the photo active compound is



wherein at least one of D is :



and remaining D is hydrogen, the epoxy resin is

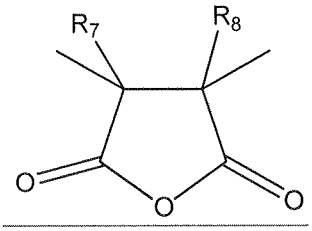


and the solvent is propylene glycol monomethyl ether acetate.

9. A polymer layer formed from the polymer composition of Claim 1 having a dielectric constant of 3.2 or less at 1MHz.

10. A polymer layer formed from the polymer composition of Claim 1 having a transparency at 400 nm of more than 85% after curing at 250°C for 30 minutes.

11. The polymer composition of Claim 1, wherein the polymer further comprises maleic anhydride-type repeating units represented by Formula IIIc:



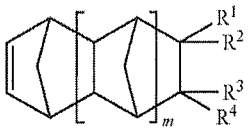
IIIc

where R^7 and R^8 are the same or different and are selected from hydrogen, methyl and ethyl.

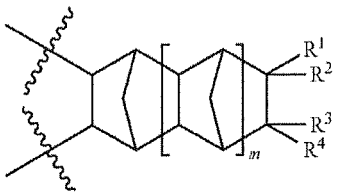
12. A layer forming polymer composition, comprising:

a self-imageable polymer consisting of norbornene-type repeating units and maleic anhydride-type repeating units, where:

such norbornene-type repeating units are represented by Formula Ia, which are derived from norbornene-type monomers represented by Formula I:



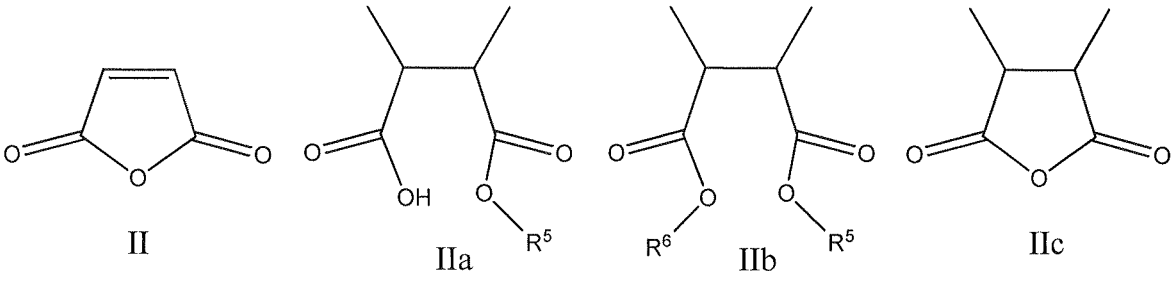
I



Ia

where m is 0, 1 or 2, each R^1, R^2, R^3 and R^4 for the said norbornene-type repeating unit is independently a hydrogen or a hydrocarbyl pendent group selected from C_1 to C_{30} aryl, aralkyl or alkaryl groups or a perfluorinated alkyl group or a perfluorinated aryl group;

such maleic anhydride-type of repeating units include one or more repeating units of Formulae IIa and IIb, and optionally include repeating units of Formula IIc which are derived from maleic anhydride monomers represented by Formula II:



II IIa IIb IIc

where R^5 and R^6 are each independently one of hydrogen, methyl, ethyl, a fluorinated or perfluorinated methyl or ethyl, a linear or branched C_3-C_9 hydrocarbyl group; a linear or branched fluorinated or perfluorinated C_3-C_9 hydrocarbyl group; a C_6-C_{18} substituted or unsubstituted cyclic or polycyclic hydrocarbyl group;

a photo active compound;

an epoxy resin comprising at least two epoxy groups; and

a solvent.