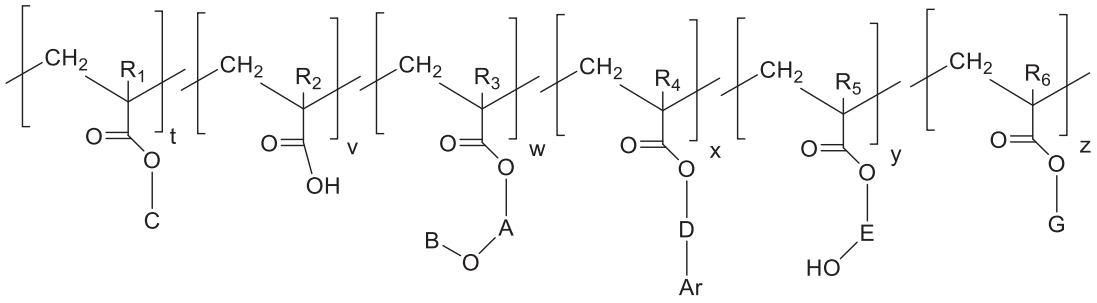
What is claimed is:

1. A positive working photosensitive composition comprising:

a) at least one photoacid generator;

b) at least one Novolak polymer;

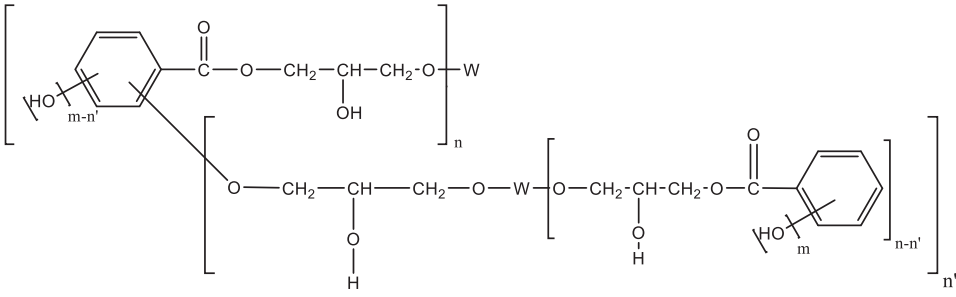
c) at least one acrylate polymer, comprising a component having structure (I),



(I)

wherein R_1 to R_6 are, independently, -H, or $-CH_3$, A is a linear or branched C_2 to C_{10} alkylene group, B is a C_1 to C_{12} primary or secondary unsubstituted linear, branched, cyclic or alicyclic alkyl group, C is a C_1 to C_{12} primary or secondary unsubstituted linear, branched, cyclic or alicyclic alkyl group, D is a linking group that is a direct valence bond, or a linear or branched C_2 to C_{10} alkylene group, Ar is a substituted or unsubstituted aromatic group or heteroaromatic group, E is a linear or branched C_2 to C_{10} alkylene group, G is an acid cleavable group, t is 0 mole% to about 40 mole%, v is 0 mole% to about 15 mole%, w is 0 mole% to about 45 mole%, x is 0 mole% to about 80 mole%, y is about 20 mole% to about 50 mole% and z is about 20 mole% to about 50 mole%, and further wherein the sum of t, v, w, x, y and z equals 100 mole%;

d) at least one glycidyl hydroxy benzoic acid condensate material comprising one or more compounds having structure (II),



(II),

wherein,

W is an organic moiety having a molecular weight of 600 or less, wherein W forms an ether bond with the oxygen to which it is bound,

m is an integer from 1 to 3 and

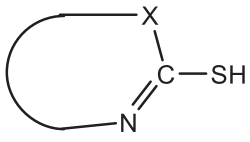
n is an integer from 1 to 4, and further provided that

when m is 1, n is 3 or 4,

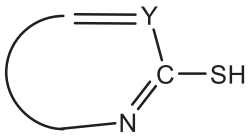
and when m is 2 or 3, n is an integer from 1 to 4,

n' is 0 or 1,

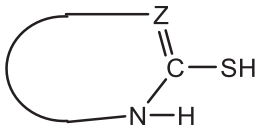
e) at least one heterocyclic thiol compound comprising a ring structure chosen from the general structures (III), (IIIa) or (IIIb), or tautomers thereof; and



(III)



(IIIa)



(IIIb),

wherein,

said ring structure is a single ring structure having from 4 to 8 atoms, or a multi ring structure having from 5 to 20 atoms; and wherein the single ring structure, or the multi ring structure comprises an aromatic, non-aromatic, or heteroaromatic ring, and

in said structure (III), X is selected from the group consisting of $C(Rt_1)(Rt_2)$, O, S, Se, and Te;

in said structure (IIIa), Y is selected from the group consisting of $C(Rt_3)$ and N;

in said structure (IIIb), Z is selected from the group consisting of $C(Rt_3)$ and N; and

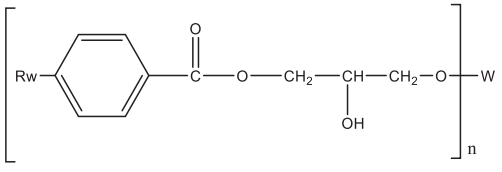
Rt_1, Rt_2, and Rt_3 are independently selected from the group consisting of H, a substituted alkyl group having 1 to 8 carbon atoms, an unsubstituted alkyl group having 1 to 8 carbon atoms, a substituted alkenyl group having 2 to 8 carbon atoms, unsubstituted alkenyl group having 2 to 8 carbon atoms, a substituted alkynyl group having 2 to 8 carbon atoms, unsubstituted alkynyl group having 2 to 8 carbon atoms, a substituted aromatic group having 6 to 20 carbon atoms, a substituted heteroaromatic group having 3 to 20 carbon atoms, unsubstituted aromatic group having 6 to 20 carbon atoms and unsubstituted heteroaromatic group having 3 to 20 carbon atoms;

f) at least one solvent.

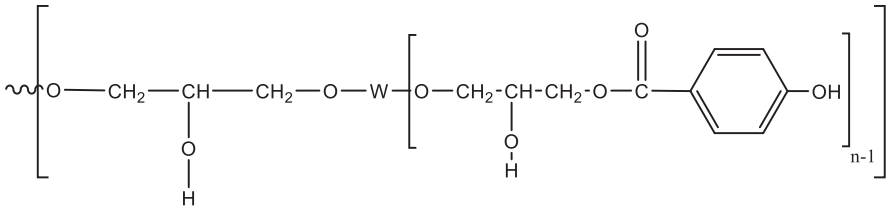
2. The positive working photosensitive composition of Claim 1, wherein said glycidyl hydroxy benzoic acid condensate material having structure (II) is one wherein the moiety W is an aliphatic moiety selected from the group consisting an aliphatic hydrocarbon, an aliphatic alkyl ether, a bis(alkyl) sulfone, and a bis(alkyl)ketone.

3. The positive working photosensitive composition of Claim 1, wherein glycidyl hydroxy benzoic acid condensate material having structure (II) is one wherein the moiety W is an aromatic moiety selected from an arene, a polycyclic arene, an bis(aryl)ether, a biphenyl, a bis(aryl) sulfone, bis(phenyl)alkylene, an (alkyl)(aryl)ketone, a bis(aryl)ketone, a bis(aryl) sulfone, and an (alkyl)(aryl) sulfone.

4. The positive working photosensitive composition of any one of Claims 1 to 3 wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound having structure (IVa-1), wherein n is 3 to 4, and Rw is OH or the moiety (IVb-1), wherein ∿∿ represents the point of attachment in this moiety;

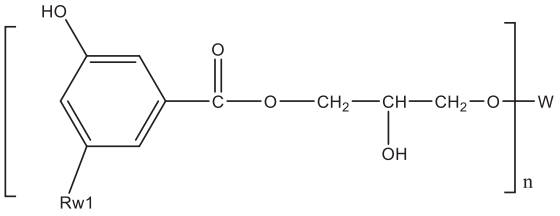


(IVa-1),

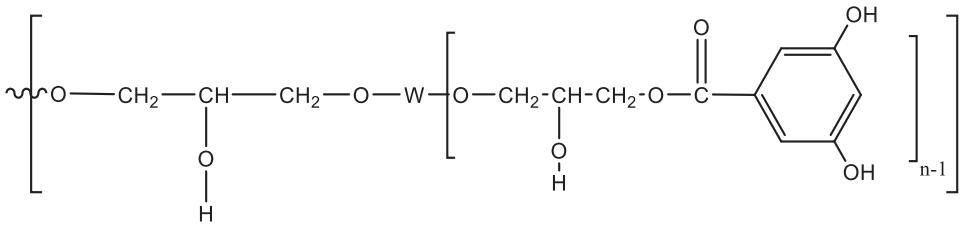


(IVb-1).

5. The positive working photosensitive composition of any one of Claims 1 to 3 wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound having structure (IVa-2), wherein n is 1 to 4, and Rw1 is OH or the moiety (IVb-2), wherein ∿∿ represents the point of attachment in this moiety;

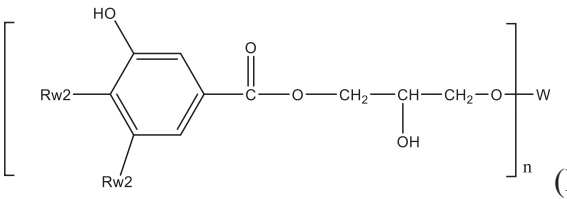


(IVa-2),

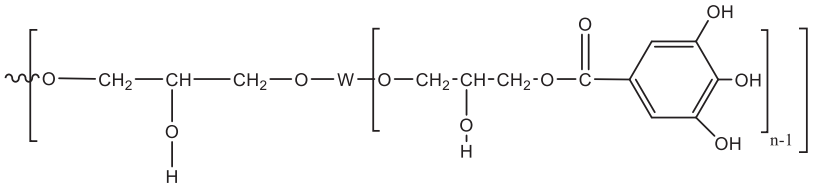


(IVb-2).

6. The positive working photosensitive composition of any one of Claims 1 to 3 wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound having structure (IVa-3), wherein n is 1 to 4, and Rw2 is OH or the moiety (IVa), provided that no more than one Rw2 is the moiety (IVb-3), wherein ∿∿ represents the point of attachment in this moiety;



(IVa-3),



(IVb-3).

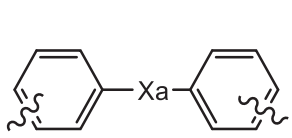
7 The positive working photosensitive composition of any one of Claims 1 to 3 wherein said organic moiety W is selected from the group consisting of moieties of structures (Wa), (Wb), (Wc), (Wd), (We) and (Wf); wherein

~~~ represents an attachment point within each of these organic moieties, where it forms an ether bond with the oxygen in said glycidyl hydroxy benzoic acid condensate material of structure (II);

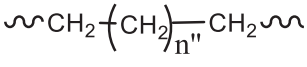
Xa is a moiety selected from the group consisting of a direct valence bond, alkylene, $-SO_2-$ $-C(=O)-$ and $-O-$;

Ra1, Rb1 and Rc are independently selected from a C_1 to C_5 alkyl or C_2 to C_5 alkyleneoxyalkyl;

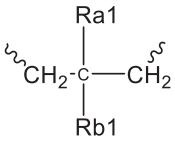
Ra2 is selected from a C_1 to C_5 alkyl an C_2 to C_5 alkyleneoxyalkyl, a C_1 to C_5 alkyloxy, a halide, a C_1 to C_5 alkylsulfonyl a C_1 to C_5 alkylcarbonyl, and a C_1 to C_5 alkylcarbonyloxy, and n'' ranges from 0 to 12;



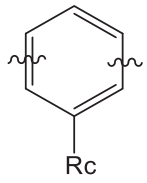
(Wa),



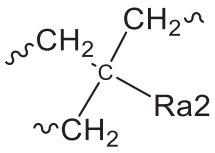
(Wb),



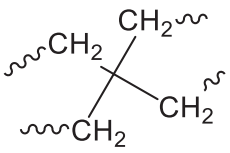
(Wc),



(Wd),



(We),



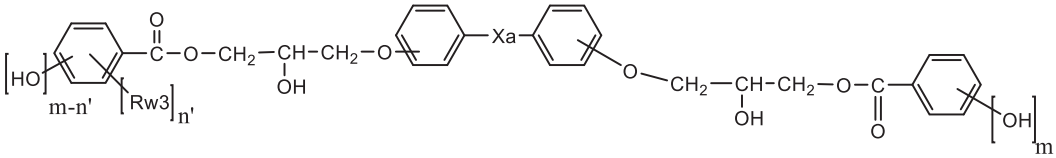
(Wf).

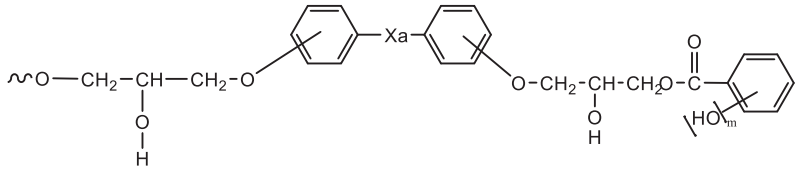
8. The positive working photosensitive composition of any one of Claims 1 to 3 wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound having structure (Va-1), wherein Rw3 is OH, or a moiety of structure (Vb-1), wherein ~~~ represents the point of attachment in this moiety, provided

m is 2 to 3,

n' is 1 or 0; and
~~~

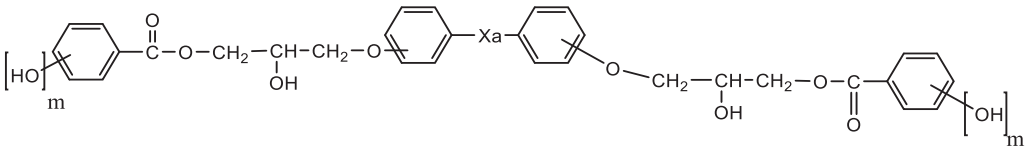
Xa is selected from the group consisting of a direct valence bond, alkylene, -SO_2- -C(=O)- and -O- ;


(Va-1),


(Vb-1).

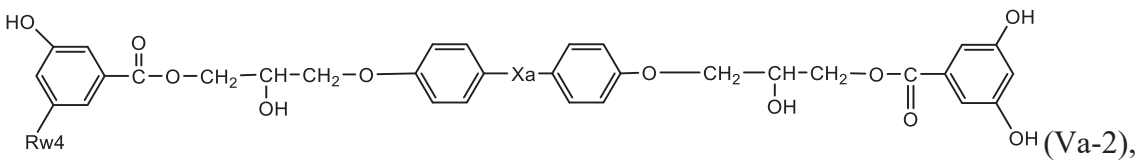
9. The positive working photosensitive composition of any one of Claims 1 to 3 wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound having structure (V-1), wherein m is 2 to 3, and further wherein,

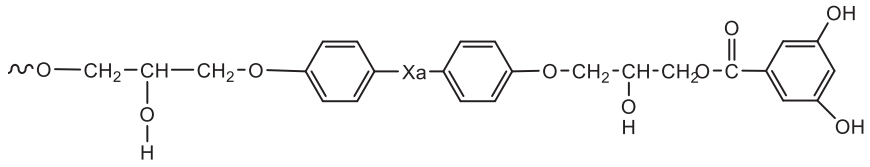
Xa is selected from the group consisting of a direct valence bond, alkylene, -SO_2- -C(=O)- and -O-.


(V-1).

10. The positive working photosensitive composition of any one of Claims 1 to 3, wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound having structure (Va-2), wherein Rw4 is OH or a moiety of structure (Vb-2), wherein ∿∿ represents the point of attachment in this moiety, and further wherein,

Xa is selected from the group consisting of a direct valence bond, alkylene, -SO_2-, -C(=O)- and -O-,

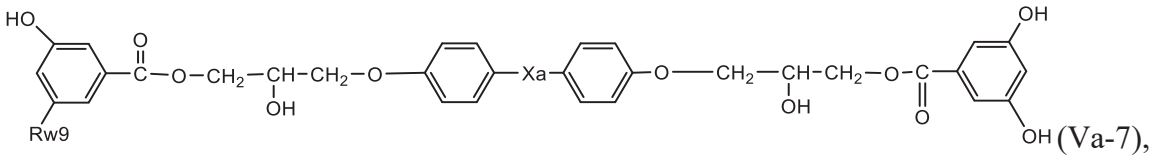

(Va-2),



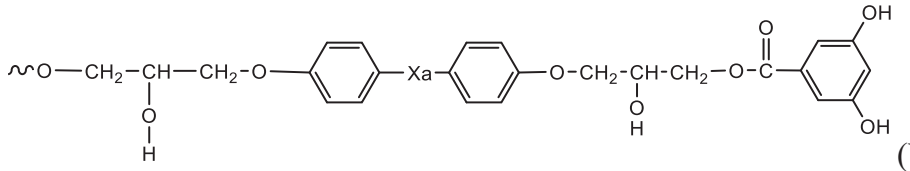
(Vb-2).

11. The positive working photosensitive composition of any one of Claims 1 to 3, wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound having structure (Va-7), wherein Rw9 is OH or a moiety of structure (Vb-7), wherein ∿∿ represents the point of attachment in this moiety, and further wherein

Xa is an alkylene moiety,

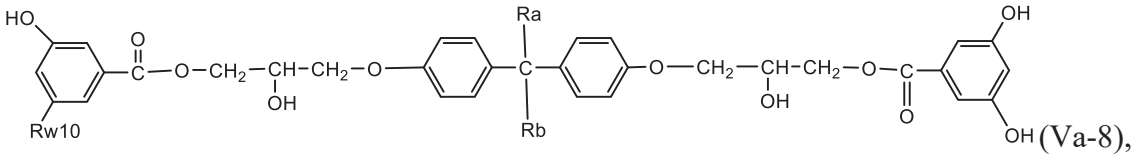


(Va-7),

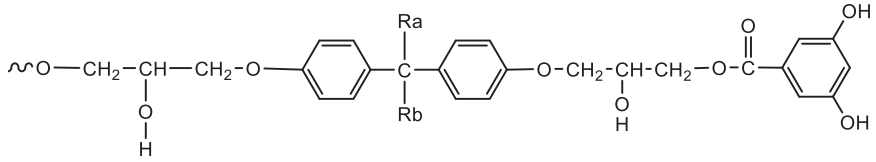


(Vb-7).

12. The positive working photosensitive composition of any one of Claims 1 to 3, wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound having structure (Va-8), wherein Ra and Rb are independently a C_1 to C_5 alkyl moiety, or a C_2 to C_5 -alkylene-O-alkyl moiety, and Rw10 is OH or a moiety of structure (Vb-8), wherein ∿∿ represents the point of attachment in this moiety,



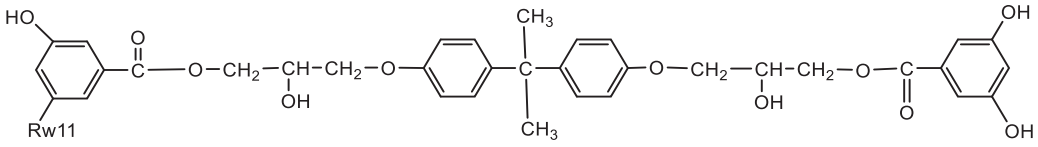
(Va-8),

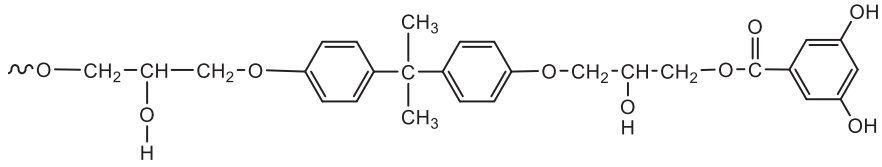


(Vb-8).

13. The positive working photosensitive composition of any one of Claims 1 to 3, wherein said

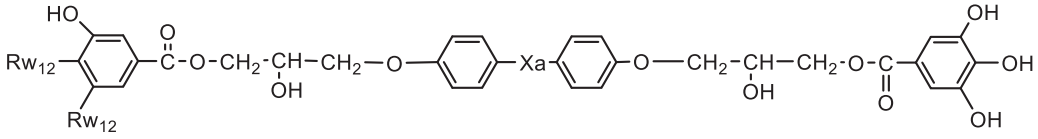
glycidyl hydroxy benzoic acid condensate material comprises at least one compound having structure (Va-9), wherein Rw11 is OH or a moiety of structure (Vb-9), wherein ∿∿ represents the point of attachment in this moiety

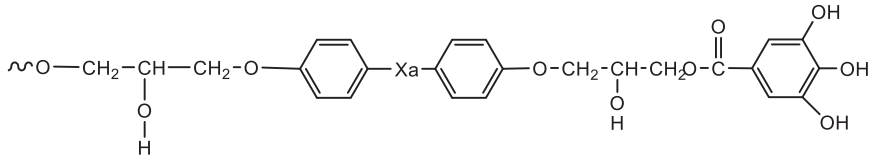

(Va-9),


(Vb-9).

14. The positive working photosensitive composition of any one of Claims 1 to 3 wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound of structure (Va-10), wherein Rw12 is OH or the moiety (Vb-10), wherein ∿∿ represents the point of attachment in this moiety, provided that no more than one Rw12 is the moiety (Vb-10), and further wherein,

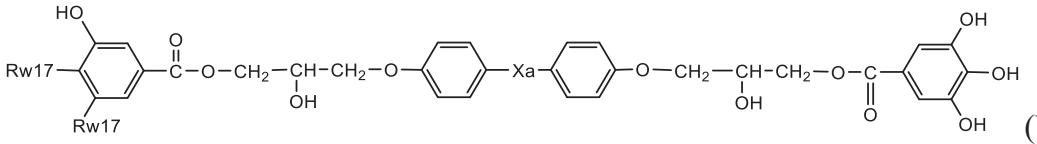
Xa is selected from the group consisting of a direct valence bond, alkylene, -SO_2-, -C(=O)- and -O-;

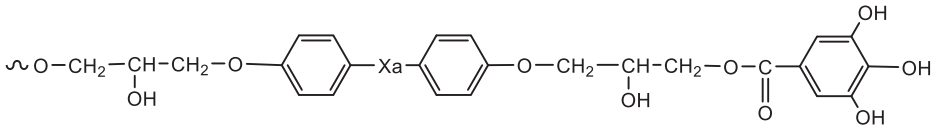

(Va-10),


(Vb-10).

15. The positive working photosensitive composition of any one of Claims 1 to 3 wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound of structure (Va-15), wherein Rw17 is OH or the moiety (Vb-15), wherein ∿∿ represents the point of attachment in this moiety, provided that no more than one Rw17 is the moiety (Vb-15), and further wherein

Xa is an alkylene moiety,


(Va-15),

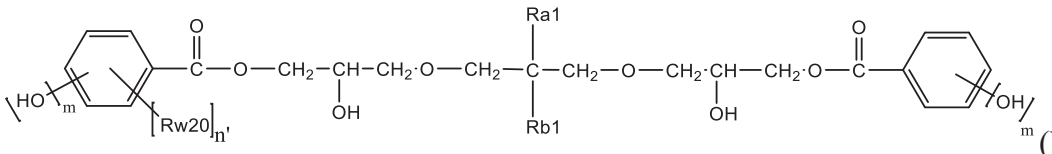

(Vb-15).

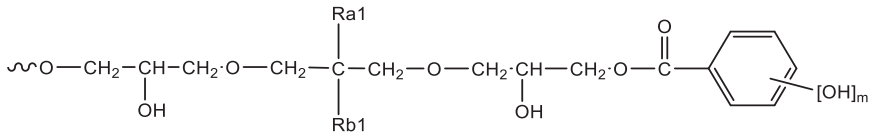
16. The positive working photosensitive composition of any one of Claims 1 to 3, wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound having structure (VIa-1), wherein Rw20 is OH, or a moiety of structure (VIb-1), wherein ∿∿ represents the point of attachment in this moiety, provided that

m is 2 to 3,

n' is 0 or 1, and further wherein,

Ra1 and Rb1 are independently selected from a C_1 to C_5 alkyl or a C_2 to C_5 -alkylene-O-alkyl moiety,

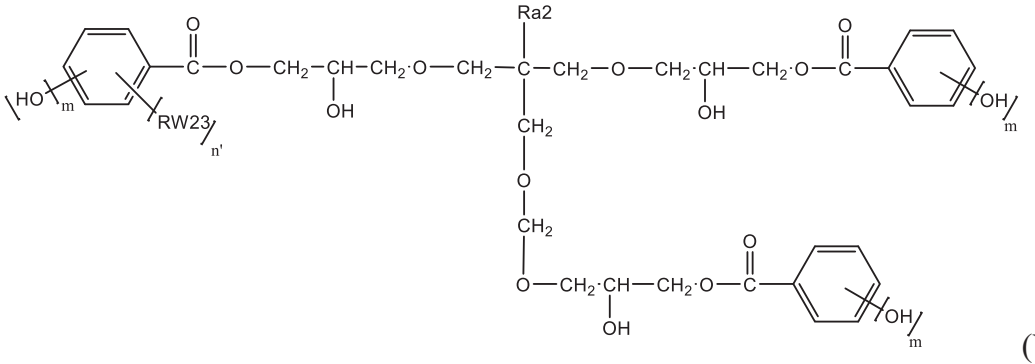

(VIa-1),


(VIb-1).

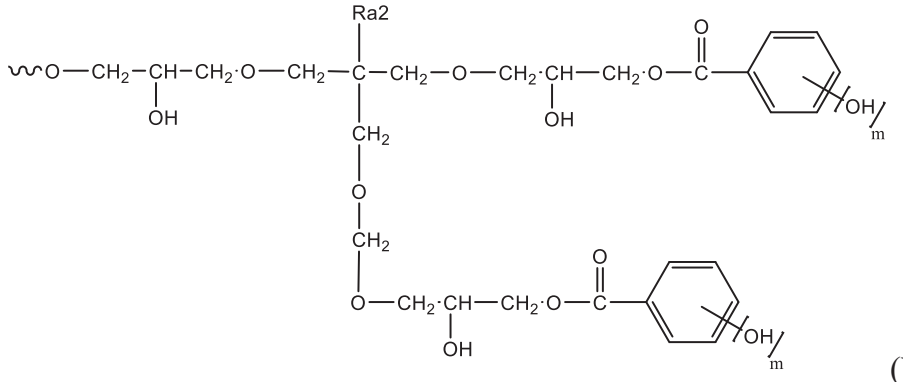
17. The positive working photosensitive composition of any one of Claims 1 to 3 wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound of structure (VIIa-1), wherein Rw23 is OH, or a moiety of structure (VIIb-1), wherein ∿∿ represents the point of attachment in this moiety, provided

m is 1, 2 or 3, and n' is 0 or 1, and further wherein,

Ra2 is selected from a C_1 to C_5 alkyl or a C_2 to C_5 -alkylene-O-alkyl moiety;



(VIIa-1),



(VIIb-1).

18. The positive working photosensitive composition of any one of Claims 1 to 3, wherein, said acrylate polymer, is one wherein A is a methylene group, an ethylene group or a 1,2-propylene group, B is a methyl group, an ethyl group, a propyl group, or a butyl group, C is a methyl group, an ethyl group, a propyl group, a butyl group, a cyclohexyl group, an isobornyl group or a tetrahydrodicyclopentadienyl group, D is a direct valence bond, a methylene or an ethylene group, E is a methylene group, an ethylene group or a 1,2-propylene group.

19. The positive working photosensitive composition of any one of Claims 1 to 3, wherein, said acrylate polymer is one wherein G is a high activation energy acid labile group selected from a tertiary alkyl which has at least one vicinal hydrogen to the tertiary attachment point of the oxygen of the carboxylate in the repeat unit designated by z forming a tertiary ester, or a low activation energy protection group selected from an acetal or ketal formed with the oxygen of the carboxylate in the repeat unit designated by z.

20. The positive working photosensitive composition of any one of Claims 1 to 3 wherein the composition further comprises a basic quencher.

21. A method of forming a positive relief image comprising:

a) forming a photosensitive layer by applying the positive working photosensitive composition of any one of Claims 1 to 20 to a substrate, thus forming a film and then baking the film;

b) image-wise exposing the photosensitive layer to actinic radiation to form a latent image;

c) developing the latent image in a developer.

22. A method of forming a positive relief image comprising:

a') forming a photosensitive layer by applying the positive working photosensitive composition of any one of Claims 1 to 20 to a substrate thus forming a film and then baking the film;

b') image-wise exposing the photosensitive layer to actinic radiation to form a latent image;

c') thermally treating the image-wise exposed photosensitive layer forming a baked latent image.

d') developing the baked latent image in a developer.

23. A method of forming a metal pattern on a substrate comprising:

a'') forming a photosensitive layer by applying the positive working photosensitive composition of any one of Claims 1 to 20 to a substrate thus forming a film, and then baking the film;

b'') image-wise exposing the photosensitive layer to actinic radiation to form a latent image;

c'') developing the latent image in a developer to form a resist pattern on the substrate.

d'') selectively electroplating on the substrate using the resist pattern as a barrier

e'') stripping the resist pattern leaving behind the selectively electroplated metal, thereby creating a metal pattern on the substrate.

24. A method of forming a metal pattern on a substrate comprising:

a''') forming a photosensitive layer by applying the positive working photosensitive composition of any one of Claims 1 to 20 to a substrate thus forming a film and then baking the film;

b''') image-wise exposing the photosensitive layer to actinic radiation to form a latent image;

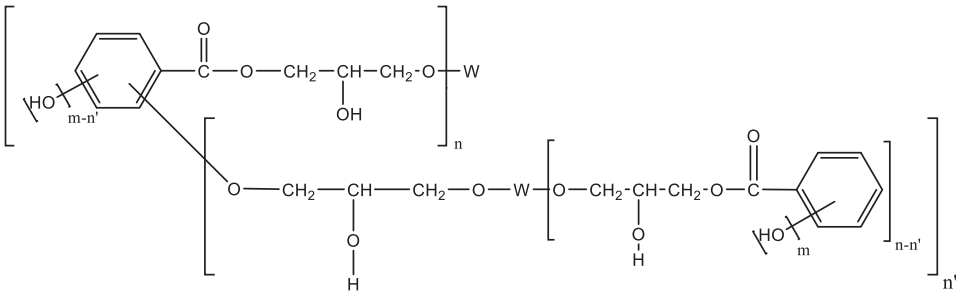
c''') thermally treating the image-wise exposed photosensitive layer forming a baked latent image.

d''') developing the baked latent image in a developer to form a resist pattern on the substrate.

e''') selectively electroplating on the substrate using the resist pattern as a barrier

f''') stripping the resist pattern leaving behind the selectively electroplated metal, thereby creating a metal pattern on the substrate.

25. A glycidyl hydroxy benzoic acid condensate material comprising one or more compounds having structure (II),



(II),

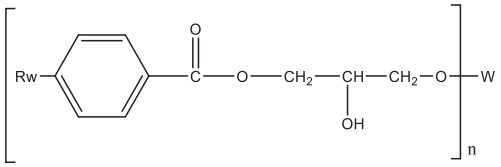
wherein,

W is an organic moiety having a molecular weight of 600 or less, wherein W forms an ether bond with the oxygen to which it is bound,
m is an integer from 1 to 3 and
n is an integer from 1 to 4, and further provided that
when m is 1, n is 3 or 4,
and when m is 2 or 3, n is an integer from 1 to 4,
n' is 0 or 1.

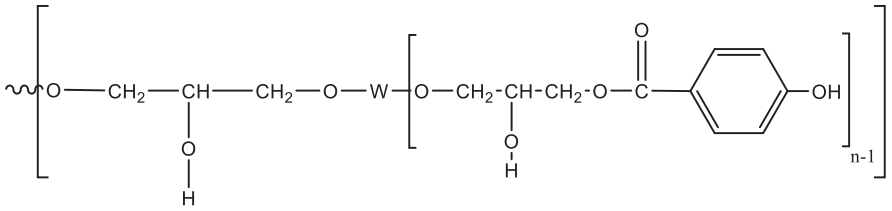
26. The glycidyl hydroxy benzoic acid condensate material of Claim 25, wherein said glycidyl hydroxy benzoic acid condensate material having structure (II) is one wherein the moiety W is an aliphatic moiety selected from the group consisting an aliphatic hydrocarbon, an aliphatic alkyl ether, a bis(alkyl) sulfone, and a bis(alkyl)ketone.

27. The glycidyl hydroxy benzoic acid condensate material of Claim 25 or 26, wherein said glycidyl hydroxy benzoic acid condensate material having structure (II) is one wherein the moiety W is an aromatic moiety selected from an arene, a polycyclic arene, an bis(aryl)ether, a biphenyl, a bis(aryl) sulfone, bis(phenyl)alkylene, an (alkyl)(aryl)ketone, a bis(aryl)ketone, a bis(aryl) sulfone, and an (alkyl)(aryl) sulfone.

28. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound having structure (IVa-1), wherein n is 3 to 4, and Rw is OH or the moiety (IVb-1), wherein ∿∿ represents the point of attachment in this moiety;

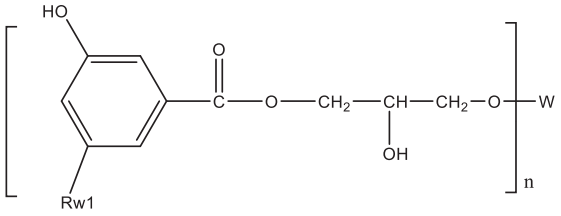


(IVa-1),

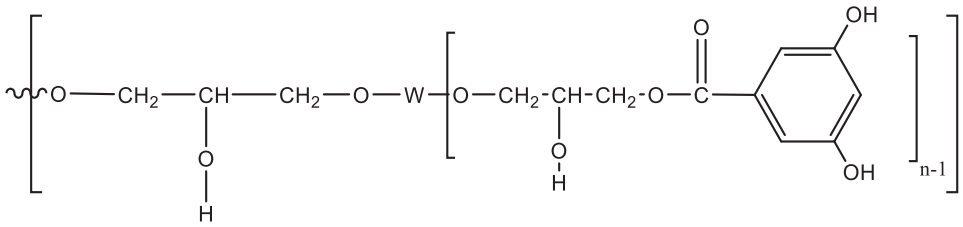


(IVb-1).

29. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound having structure (IVa-2), wherein n is 1 to 4, and Rw1 is OH or the moiety (IVb-2), wherein ∿∿ represents the point of attachment in this moiety;

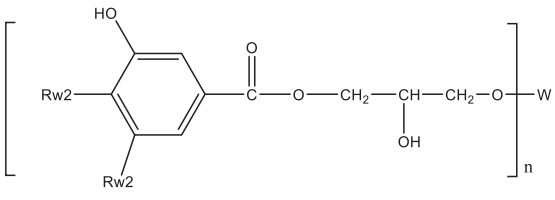


(IVa-2),

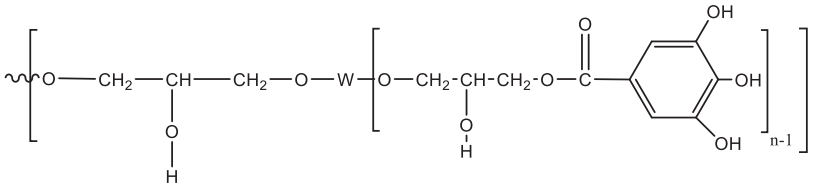


(IVb-2).

30. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound having structure (IVa-3), wherein n is 1 to 4, and Rw2 is OH or the moiety (IVa), provided that no more than one Rw2 is the moiety (IVb-3), wherein ∿∿ represents the point of attachment in this moiety;



(IVa-3),



(IVb-3).

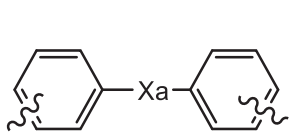
31. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said organic moiety W is selected from the group consisting of moieties of structures (Wa), (Wb), (Wc), (Wd), (We) and (Wf); wherein

~~~ represents an attachment point within each of these organic moieties, where it forms an ether bond with the oxygen in said glycidyl hydroxy benzoic acid condensate material of structure (II);

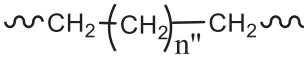
Xa is a moiety selected from the group consisting of a direct valence bond, alkylene, -SO_2- -C(=O)- and -O-;

Ra1, Rb1 and Rc are independently selected from a C_1 to C_5 alkyl or C_2 to C_5 alkyleneoxyalkyl;

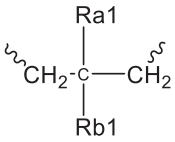
Ra2 is selected from a C_1 to C_5 alkyl an C_2 to C_5 alkyleneoxyalkyl, a C_1 to C_5 alkyloxy, a halide, a C_1 to C_5 alkylsulfonyl a C_1 to C_5 alkylcarbonyl, and a C_1 to C_5 alkylcarbonyloxy, and n'' ranges from 0 to 12;



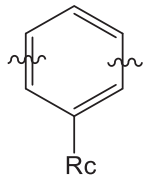
(Wa),



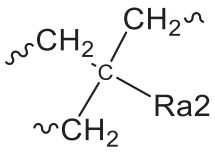
(Wb),



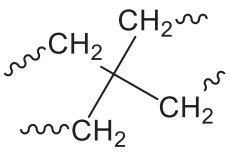
(Wc),



(Wd),



(We),



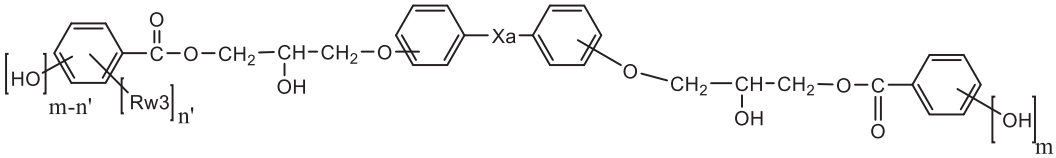
(Wf).

32. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound having structure (Va-1), wherein Rw3 is OH, or a moiety of structure (Vb-1), wherein ~~~ represents the point of attachment in this moiety, provided

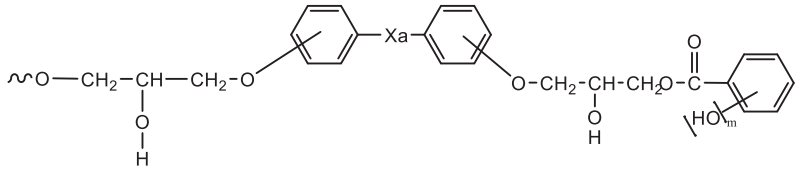
m is 2 to 3,

n' is 1 or 0; and
~~~

Xa is selected from the group consisting of a direct valence bond, alkylene, -SO_2- -C(=O)- and -O- ;



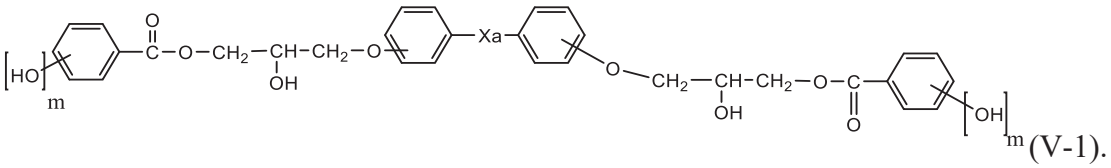
(Va-1),



(Vb-1).

33. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound having structure (V-1), wherein m is 2 to 3, and further wherein,

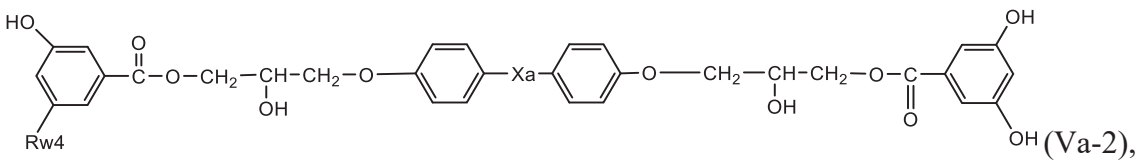
Xa is selected from the group consisting of a direct valence bond, alkylene, -SO_2- -C(=O)- and -O-.



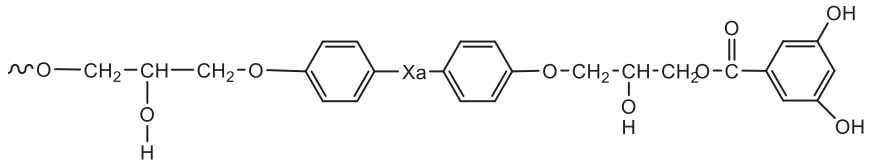
(V-1).

34. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound having structure (Va-2), wherein Rw4 is OH or a moiety of structure (Vb-2), wherein ∿∿ represents the point of attachment in this moiety, and further wherein,

Xa is selected from the group consisting of a direct valence bond, alkylene, -SO_2-, -C(=O)- and -O-,

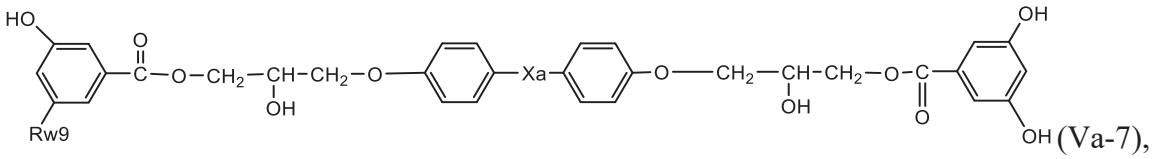


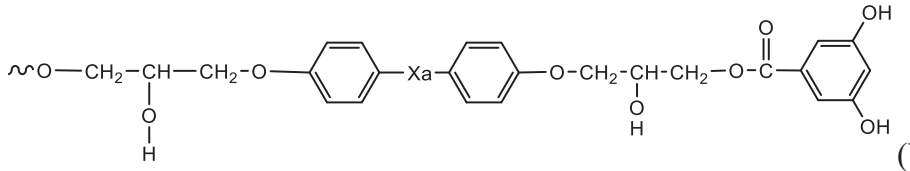
(Va-2),


(Vb-2).

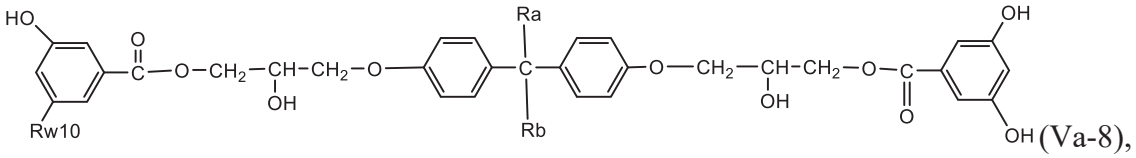
35. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound having structure (Va-7), wherein Rw9 is OH or a moiety of structure (Vb-7), wherein ∿∿ represents the point of attachment in this moiety, and further wherein

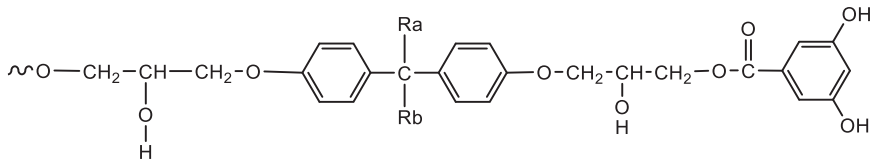
Xa is an alkylene moiety,


(Va-7),


(Vb-7).

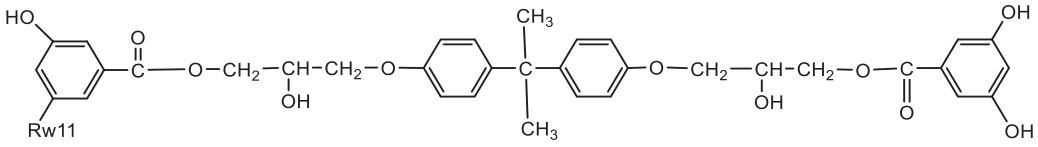
36. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound having structure (Va-8), wherein Ra and Rb are independently a C_1 to C_5 alkyl moiety, or a C_2 to C_5 -alkylene-O-alkyl moiety, and Rw10 is OH or a moiety of structure (Vb-8), wherein ∿∿ represents the point of attachment in this moiety,

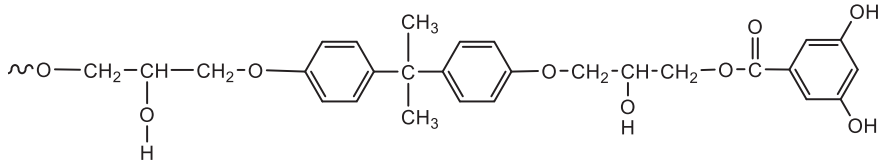

(Va-8),


(Vb-8).

37. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27,

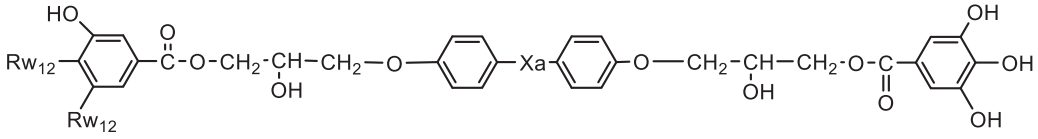
wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound having structure (Va-9), wherein Rw11 is OH or a moiety of structure (Vb-9), wherein ∿∿ represents the point of attachment in this moiety

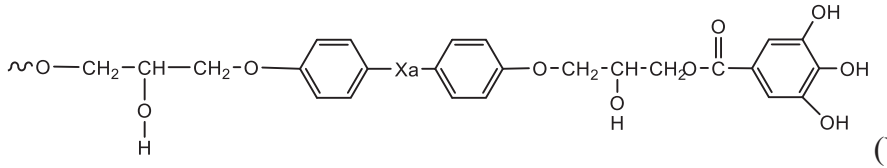

(Va-9),


(Vb-9).

38. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound of structure (Va-10), wherein Rw12 is OH or the moiety (Vb-10), wherein ∿∿ represents the point of attachment in this moiety, provided that no more than one Rw12 is the moiety (Vb-10), and further wherein,

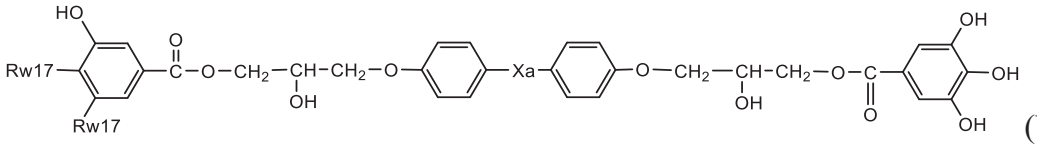
Xa is selected from the group consisting of a direct valence bond, alkylene, -SO_2-, -C(=O)- and -O-;

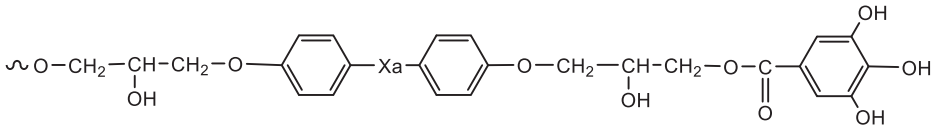

(Va-10),


(Vb-10).

39. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound of structure (Va-15), wherein Rw17 is OH or the moiety (Vb-15), wherein ∿∿ represents the point of attachment in this moiety, provided that no more than one Rw17 is the moiety (Vb-15), and further wherein

Xa is an alkylene moiety,


(Va-15),

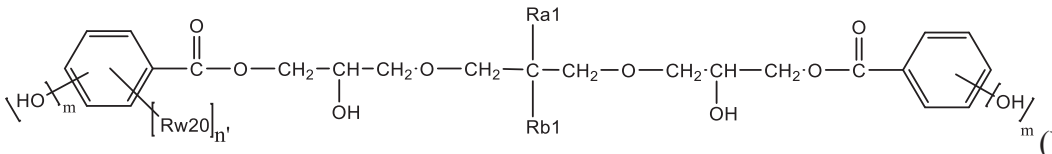

(Vb-15).

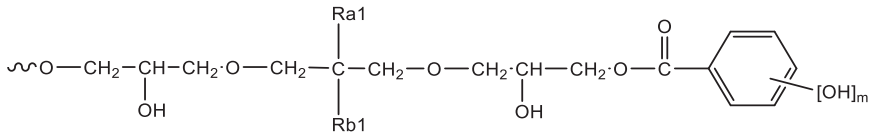
40. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound having structure (VIa-1), wherein Rw20 is OH, or a moiety of structure (VIb-1), wherein ∿∿ represents the point of attachment in this moiety, provided that

m is 2 to 3,

n' is 0 or 1, and further wherein,

Ra1 and Rb1 are independently selected from a C_1 to C_5 alkyl or a C_2 to C_5 -alkylene-O-alkyl moiety,

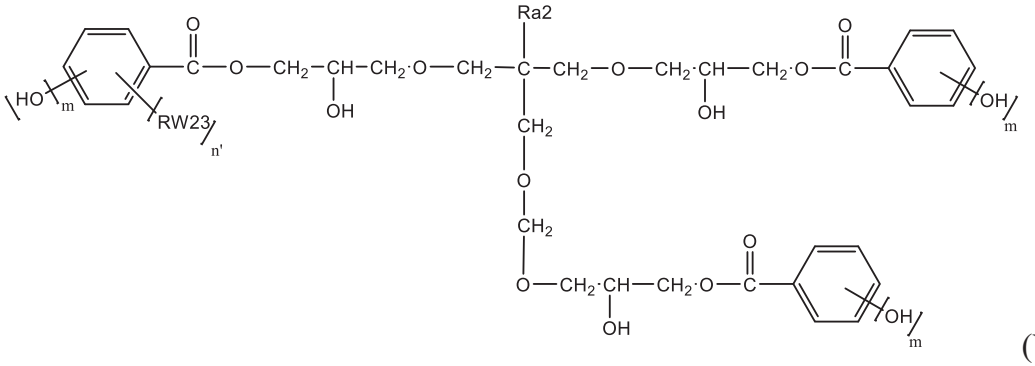

(VIa-1),


(VIb-1).

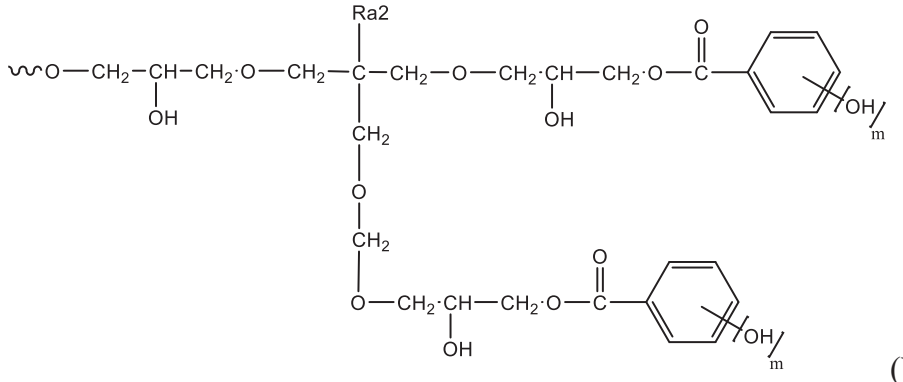
41. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate comprises at least one compound of structure (VIIa-1), wherein Rw23 is OH, or a moiety of structure (VIIb-1), wherein ∿∿ represents the point of attachment in this moiety, provided

m is 1, 2 or 3, and n' is 0 or 1, and further wherein,

Ra2 is selected from a C_1 to C_5 alkyl or a C_2 to C_5 -alkylene-O-alkyl moiety;

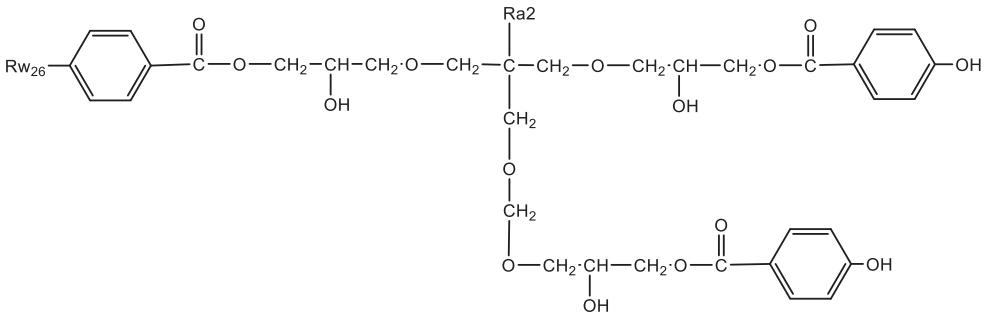


(VIIa-1),

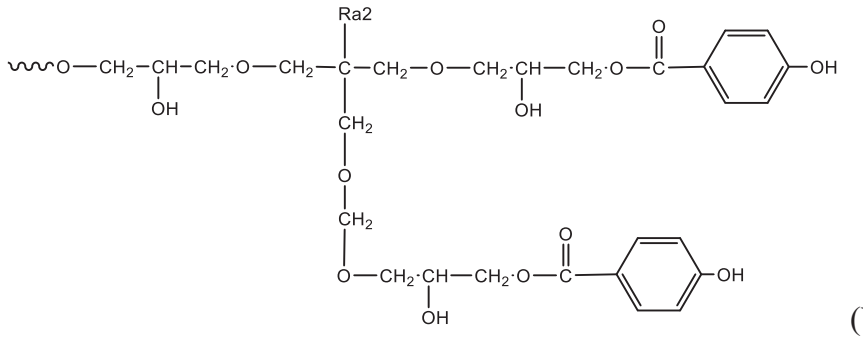


(VIIb-1).

42. The glycidyl hydroxy benzoic acid condensate material of any one of claims 25, 26 and 27, wherein said glycidyl hydroxy benzoic acid condensate material comprises at least one compound of structure (VIIa-4), wherein Rw26 is OH or the moiety (VIIb-4), wherein ∿∿ represents the point of attachment in this moiety, provided that no more than one Rw26 is the moiety (VIIb-4), and further wherein, Ra2 is a C_1 to C_5 alkyl or a C_2 to C_5 -alkylene-O-alkyl moiety,



(VIIa-4),



(VIIb-4).