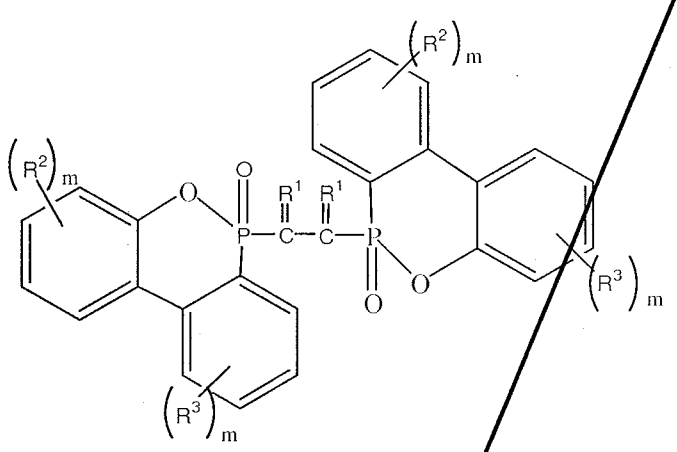
CLAIMS:

Claim 1 A compound having the following structure:



wherein R^1 is $C(R^4)_2$;

each R^2 and R^3 are independently hydrogen, C_1-C_{15} alkyl, C_6-C_{12} aryl, C_7-C_{15} aralkyl or C_7-C_{15} alkaryl; or R^2 and R^3 taken together can form a saturated or unsaturated cyclic ring, wherein said saturated or unsaturated cyclic ring may be optional substituted by a C_1-C_6 alkyl;

each R^4 is independently hydrogen, C_1-C_6 alkyl, C_6-C_{12} aryl or C_3-C_{12} cycloalkyl;

and each m is independently 1, 2, 3 or 4.

Claim 2 The compound of Claim 1, wherein R^2 and R^3 are independently hydrogen or a C_1-C_6 alkyl.

Claim 3 The compound of claim 2, wherein all R^4 substituents are hydrogen.

Claim 4 The compound of claims 3, wherein R^2 and R^3 are hydrogen.

Claim 5 A flame-retardant polymer composition comprising a polymer and the compound of Claim 1 or 4.

Claim 6 The composition of Claim 5, wherein said polymer is polyolefins, polyesters, polyethers, polyketones, polyamides, natural and synthetic rubbers, polyurethanes, polystyrenes, poly(meth)acrylates, phenolic resins, polyacetals, polyacrylonitriles, polybutadienes, polystyrenes, polyimides, polyamideimides,

polyetherimides, polyphenylsulfides, polyphenylene oxide, polycarbonates, polyketones, cellulose, cellulose derivatives, epoxy resins or mixtures thereof.

Claim 7 The composition of claim 6, wherein said polymer is polyesters, phenolic resins, polyamides, polyurethanes, polystyrene, epoxy resins or mixtures thereof.

Claim 8 The composition of claim 6, wherein said polymer is a phenolic resin or an epoxy resin, and wherein said composition further contains a curing or polymer initiation agent.

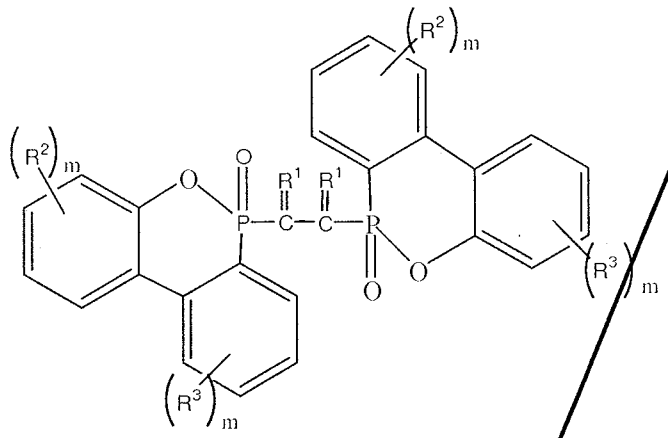
Claim 9 A prepreg or laminate comprising an organic or inorganic reinforcing material and the composition of claim 8.

Claim 10 The composition of claim 6, wherein the amount of the compound is about 0.1 to about 100 parts by weight per 100 parts by weight of polymer.

Claim 11 The composition of claim 6, wherein the organic phosphorous content of the composition is about 0.5wt% to about 10wt%, based on the total weight of the composition.

Claim 12 The composition of claim 6, further comprising heat stabilizers, light stabilizers, ultra-violet light absorbers, anti-oxidants, anti-static agents, preservatives, adhesion promoters, fillers, pigments, dyes, lubricants, mold releasers, blowing agents, fungicides, plasticizers, processing aids, acid scavengers, dyes, pigments, stabilizers, blowing agents, nucleating agents, wetting agents, dispersing agents, synergists, mineral fillers, reinforcing agents, whiskers, inorganic fillers, other fire-retardant additives, smoke suppressants or mixtures thereof.

Claim 13 A thermoset composition comprising: (a) 0-50 parts by weight of at least one cyanate ester, (b) 0-50 parts by weight of at benzoxazine monomer; (c) 0-50 parts by weight of at least one bismaleimide, (d) 10-100 parts by weight of at least one epoxy compound; and (e) 5-60 parts by weight of the phosphorus compound having the formula:



wherein R^1 is $C(R^4)_2$;

each R^2 and R^3 are independently hydrogen, C_1-C_{15} alkyl, C_6-C_{12} aryl, C_7-C_{15} aralkyl or C_7-C_{15} alkaryl; or R^2 and R^3 taken together can form a saturated or unsaturated cyclic ring, wherein said saturated or unsaturated cyclic ring may be optional substituted by a C_1-C_6 alkyl;

each R^4 is independently hydrogen, C_1-C_6 alkyl, C_6-C_{12} aryl or C_3-C_{12} cycloalkyl;

and each m is independently 1, 2, 3 or 4.

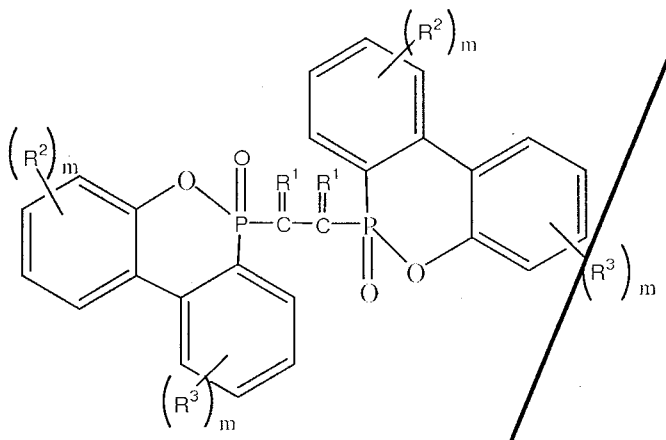
Claim 14 The compound of Claim 13, wherein R^2 and R^3 are independently hydrogen or a C_1-C_6 alkyl.

Claim 15 The compound of claim 13, wherein all R^4 substituents are hydrogen and wherein R^2 and R^3 are hydrogen.

Claim 16 The composition of claim 15 wherein the composition comprises (a) 10-50 parts by weight of at least one cyanate ester, (b) 10-50 parts by weight of at benzoxazine monomer; (c) 10-50 parts by weight of at least one bismaleimide, (d) 10-100 parts by weight of at least one epoxy compound; and (e) 5-60 parts by weight of the phosphorus compound having formula I.

Claim 17 A thermoset composition comprising: (a) 30-100 parts by weight of at least styrene-butadiene (SB) rubber, (b) 0-50 parts by weight of a styrene-butadiene-styrene (SBS) rubber; (c) 0-50 parts by weight of at least one bismaleimide, (d) 0-50 parts by weight of a maleic anhydride grafted styrene-butadiene polymer; (e) 0-50 parts of an ethylene propylene diene monomer liquid rubber. (f) 0-50 parts of a vinyl-terminated polybutadiene

rubber and (g) 0-50 parts of a polyphenylene oxide resin and (h) 5-60 parts of the phosphorus compound



wherein R^1 is $C(R^4)_2$;

each R^2 and R^3 are independently hydrogen, C_1-C_{15} alkyl, C_6-C_{12} aryl, C_7-C_{15} aralkyl or C_7-C_{15} alkaryl; or R^2 and R^3 taken together can form a saturated or unsaturated cyclic ring, wherein said saturated or unsaturated cyclic ring may be optional substituted by a C_1-C_6 alkyl;

each R^4 is independently hydrogen, C_1-C_6 alkyl, C_6-C_{12} aryl or C_3-C_{12} cycloalkyl;

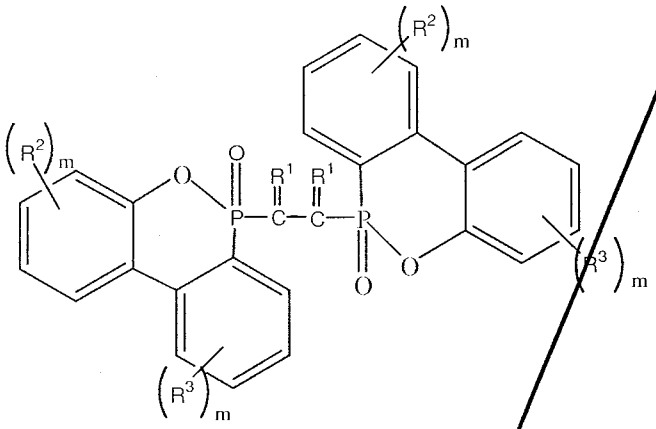
and each m is independently 1, 2, 3 or 4.

Claim 18 The compound of Claim 17, wherein R^2 and R^3 are independently hydrogen or a C_1-C_6 alkyl.

Claim 19 The compound of claim 17, wherein all R^4 substituents are hydrogen and wherein R^2 and R^3 are hydrogen.

Claim 20 The composition of claim 19 wherein the composition comprises (a) 10-50 parts by weight of at least one cyanate ester, (b) 10-50 parts by weight of at benzoxazine monomer; (c) 10-50 parts by weight of at least one bismaleimide, (d) 10-100 parts by weight of at least one epoxy compound; and (e) 5-60 parts by weight of the phosphorus compound having formula I.

Claim 21 A process for preparing the compound of Formula I:



Formula I

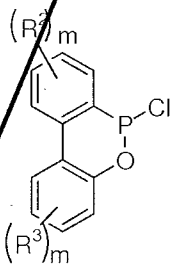
wherein R^1 is $C(R^4)_2$;

each R^2 and R^3 are independently hydrogen, C_1-C_{15} alkyl, C_6-C_{12} aryl, C_7-C_{15} aralkyl or C_7-C_{15} alkaryl; or R^2 and R^3 taken together can form a saturated or unsaturated cyclic ring, wherein said saturated or unsaturated cyclic ring may be optional substituted by a C_1-C_6 alkyl;

each R^4 is independently hydrogen, C_1-C_6 alkyl, C_6-C_{12} aryl or C_3-C_{12} cycloalkyl;

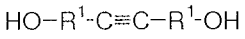
and each m is independently 1, 2, 3 or 4.

comprising reacting a compound of Formula A



Formula A

with a compound of Formula B:

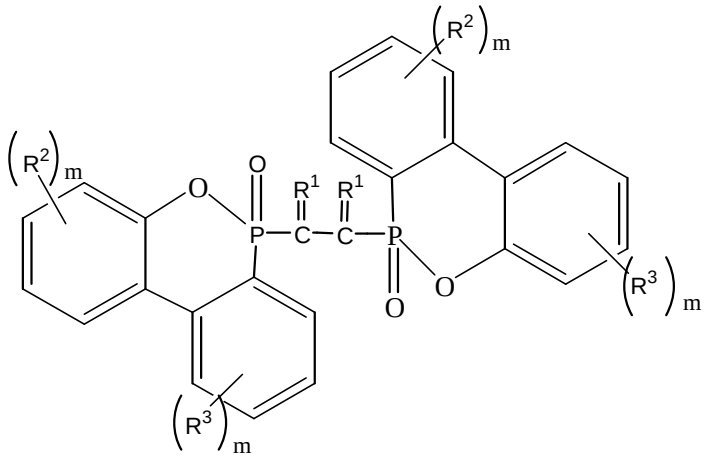


Formula B

in the presence of an optional base and an optional solvent wherein m, and R^1 to R^3 are defined above.

CLAIMS

1. A compound having the following structure:



wherein R^1 is $C(R^4)_2$;
each R^2 and R^3 are independently hydrogen, C_1-C_{15} alkyl, C_6-C_{12} aryl, C_7-C_{15} aralkyl or C_7-C_{15} alkaryl; or R^2 and R^3 taken together can form a saturated or unsaturated cyclic ring, wherein said saturated or unsaturated cyclic ring may be optional substituted by a C_1-C_6 alkyl;
each R^4 is independently hydrogen, C_1-C_6 alkyl, C_6-C_{12} aryl or C_3-C_{12} cycloalkyl;
and each m is independently 1, 2, 3 or 4.

2. The compound of Claim 1, wherein R^2 and R^3 are independently hydrogen or a C_1-C_6 alkyl.

3. The compound of claim 2, wherein all R^4 substituents are hydrogen.

4. The compound of claims 3, wherein R^2 and R^3 are hydrogen.

5. A flame-retardant polymer composition comprising a polymer and the compound of Claim 1.

6. The composition of Claim 5, wherein said polymer is polyolefins, polyesters, polyethers, polyketones, polyamides, natural and synthetic rubbers, polyurethanes, polystyrenes, poly(meth)acrylates, phenolic resins, polyacetals, polyacrylonitriles, polybutadienes, polystyrenes, polyimides, polyamideimides, polyetherimides,

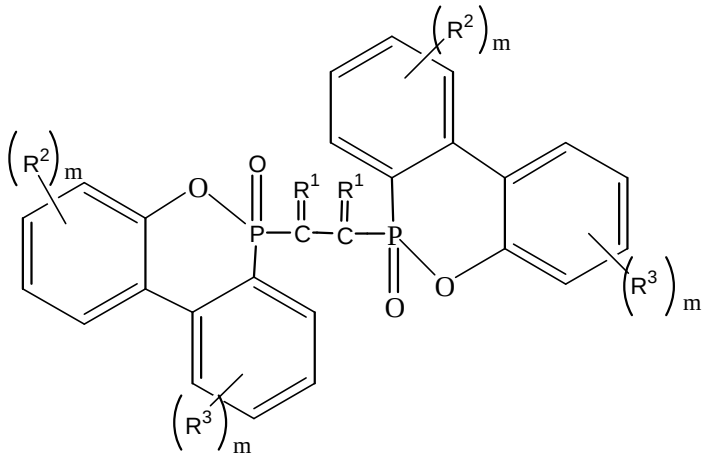
polyphenylsulfides, polyphenylene oxide, polycarbonates, polyketones, cellulose, cellulose derivatives, epoxy resins or mixtures thereof.

7. The composition of claim 6, wherein said polymer is a phenolic resin or an epoxy resin, and wherein said composition further contains a curing or polymer initiation agent.

8. A prepreg or laminate comprising an organic or inorganic reinforcing material and the composition of claim 7.

9. The composition of claim 6, wherein the amount of the compound is about 0.1 to about 100 parts by weight per 100 parts by weight of polymer.

10. A thermoset composition comprising: (a) 0-50 parts by weight of at least one cyanate ester, (b) 0-50 parts by weight of at benzoxazine monomer; (c) 0-50 parts by weight of at least one bismaleimide, (d) 10-100 parts by weight of at least one epoxy compound; and (e) 5-60 parts by weight of the phosphorus compound having the formula:



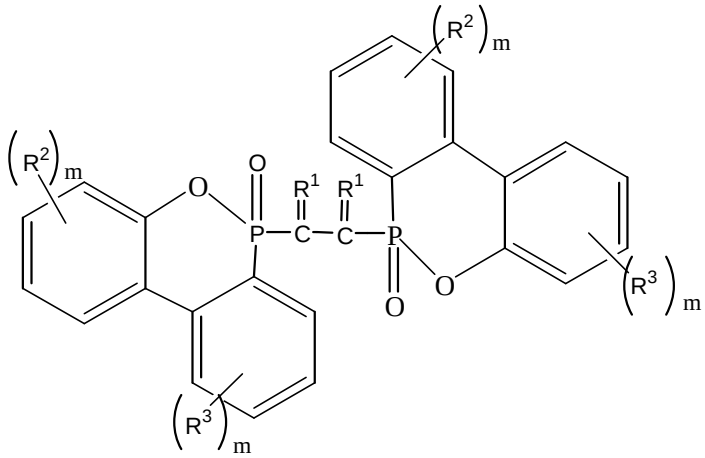
wherein R^1 is $C(R^4)_2$;
each R^2 and R^3 are independently hydrogen, C_1-C_{15} alkyl, C_6-C_{12} aryl, C_7-C_{15} aralkyl or C_7-C_{15} alkaryl; or R^2 and R^3 taken together can form a saturated or unsaturated cyclic ring, wherein said saturated or unsaturated cyclic ring may be optional substituted by a C_1-C_6 alkyl;
each R^4 is independently hydrogen, C_1-C_6 alkyl, C_6-C_{12} aryl or C_3-C_{12} cycloalkyl;
and each m is independently 1, 2, 3 or 4.

11. The compound of Claim 10, wherein R^2 and R^3 are independently hydrogen or a C_1-C_6 alkyl.

12. The compound of claim 10, wherein all R^4 substituents are hydrogen and wherein R^2 and R^3 are hydrogen.

13. The composition of claim 12 wherein the composition comprises (a) 10-50 parts by weight of at least one cyanate ester, (b) 10-50 parts by weight of at benzoxazine monomer; (c) 10-50 parts by weight of at least one bismaleimide, (d) 10-100 parts by weight of at least one epoxy compound; and (e) 5-60 parts by weight of the phosphorus compound having formula I.

14. A thermoset composition comprising: (a) 30-100 parts by weight of at least styrene-butadiene (SB) rubber, (b) 0-50 parts by weight of a styrene-butadiene-styrene (SBS) rubber; (c) 0-50 parts by weight of at least one bismaleimide, (d) 0-50 parts by weight of a maleic anhydride grafted styrene-butadiene polymer; (e) 0-50 parts of an ethylene propylene diene monomer liquid rubber, (f) 0-50 parts of a vinyl-terminated polybutadiene rubber and (g) 0-50 parts of a polyphenylene oxide resin and (h) 5-60 parts of the phosphorus compound



wherein R^1 is $C(R^4)_2$;
each R^2 and R^3 are independently hydrogen, C_1-C_{15} alkyl, C_6-C_{12} aryl, C_7-C_{15} aralkyl or C_7-C_{15} alkaryl; or R^2 and R^3 taken together can form a saturated or unsaturated cyclic ring, wherein said saturated or unsaturated cyclic ring may be optional substituted by a C_1-C_6 alkyl;

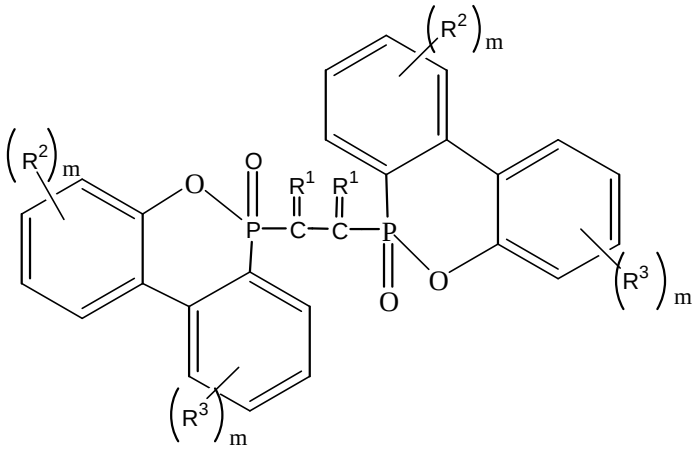
each R^4 is independently hydrogen, C_1-C_6 alkyl, C_6-C_{12} aryl or C_3-C_{12} cycloalkyl;
and each m is independently 1, 2, 3 or 4.

15. The compound of Claim 14, wherein R^2 and R^3 are independently hydrogen or a C_1-C_6 alkyl.

16. The compound of claim 14, wherein all R^4 substituents are hydrogen and wherein R^2 and R^3 are hydrogen.

17. The composition of claim 16 wherein the composition comprises (a) 10-50 parts by weight of at least one cyanate ester, (b) 10-50 parts by weight of at benzoxazine monomer; (c) 10-50 parts by weight of at least one bismaleimide, (d) 10-100 parts by weight of at least one epoxy compound; and (e) 5-60 parts by weight of the phosphorus compound having formula I.

18. A process for preparing the compound of Formula I:

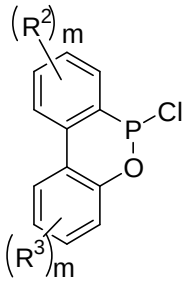


Formula I

wherein R^1 is $C(R^4)_2$;
each R^2 and R^3 are independently hydrogen, C_1-C_{15} alkyl, C_6-C_{12} aryl, C_7-C_{15} aralkyl or C_7-C_{15} alkaryl; or R^2 and R^3 taken together can form a saturated or unsaturated cyclic ring, wherein said saturated or unsaturated cyclic ring may be optional substituted by a C_1-C_6 alkyl;
each R^4 is independently hydrogen, C_1-C_6 alkyl, C_6-C_{12} aryl or C_3-C_{12} cycloalkyl;

and each m is independently 1, 2, 3 or 4.

comprising reacting a compound of Formula A



Formula A

with a compound of Formula B:

$$HO-R^{1}-C\equiv C-R^{1}-OH$$

Formula B

in the presence of an optional base and an optional solvent wherein m, and R^1 to R^3 are defined above.