CLAIMS

We claim:

1. A method of coating an insulation component with a crosslinked aromatic polymer for use in a high temperature, high voltage and/or corrosive environments, comprising:

providing a composition comprising at least one crosslinkable aromatic polymer and at least one crosslinking compound in an amount of 1% to 24% by weight based on the total weight of an unfilled composition of the crosslinkable aromatic polymer and the crosslinking compound, wherein the at least one crosslinkable aromatic polymer is selected from polyarylenes, polysulfones, polyethersulfones, polyphenylene sulfides, polyphenylene oxides, polyimides, polyetherimides, thermoplastic polyimides, polybenzamide, polyamide-imide, polyurea, polyurethane, polyphthalamide, polybenzimidazole, polyaramid, and blends, co-polymers, and alloys thereof;

heat processing the composition;

applying a coating of the composition to an exterior surface of an insulation component; and

crosslinking the aromatic polymer in the composition to provide a coated insulation component.

2. The method according to claim 1, wherein crosslinking is initiated by application of heat.

3. The method according to claim 1, wherein crosslinking is initiated after coating the insulation component.

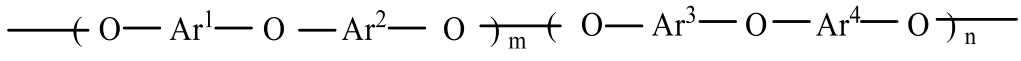
4. The method according to claim 1, wherein the crosslinkable aromatic polymer is at least partially crosslinked during the coating of the insulation component.

5. The method according to claim 1, wherein the crosslinking occurs generally simultaneously with the coating of the insulation component.

6. The method according to claim 1, wherein the aromatic polymer comprises one or more functionalized groups for crosslinking.

7. The method according to claim 1, wherein the aromatic polymer is a polyarylene selected from polyetherketone, polyetheretherketone, polyetherdiphenylether ketone, polyetherketone ketone, and blends, co-polymers and alloys thereof.

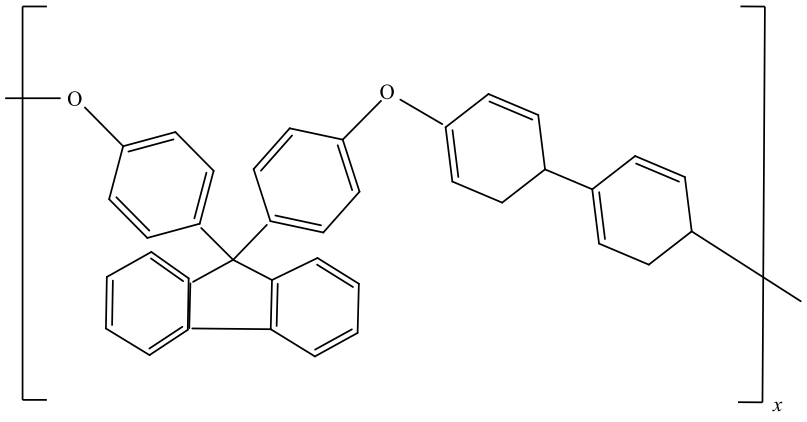
8. The method according to claim 1, wherein the at least one crosslinkable polymer is a polyarylene ether having repeating units along its backbone according to the structure of formula (I):



(I)

wherein Ar^1, Ar^2, Ar^3 and Ar^4 are identical or different aryl radicals, m = 0 to 1, and n = 1-m.

9. The method according to claim 1, wherein the at least one crosslinkable aromatic polymer has repeating units along its backbone having the structure of formula (II):



(II)

10. The method according to claim 1, wherein the at least one crosslinkable aromatic polymer comprises a blend of at least two different polymers, each having at least one reaction kinetics property that is different from the other, wherein the at least one reaction kinetics property comprises one or more selected from a crosslinking reaction, a crosslinking reaction rate, and a thermal property.

11. The method according to claim 10, wherein the at least one reaction kinetics property is the crosslinking reaction rate.

12. The method according to claim 10, wherein the blend is selected from the group of polyphenylene sulfide and polyetherether ketone; polyphenylene oxide and polyphenylene sulfide; and polyetherimide and polyphenylene sulfide.

13. The method according to claim 10, wherein the blend comprises at least one first crosslinkable aromatic polymer that has a crosslinking reaction rate that is slower than at least one second crosslinkable aromatic polymer.

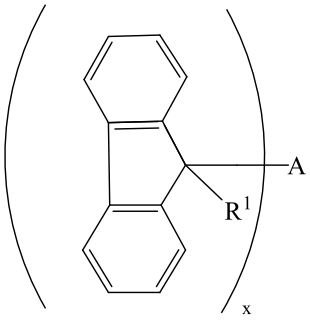
14. The method according to claim 13, further comprising slowing the crosslinking reaction rate of the second crosslinkable aromatic polymer by incorporating the first crosslinkable aromatic polymer into the second crosslinkable aromatic polymer in an amount that is 1 to 50 percent by weight based on the total weight of the first and the second

crosslinkable aromatic polymers to provide a degree of crosslinking for the blend that facilitates melt processing and post-curing of the blend.

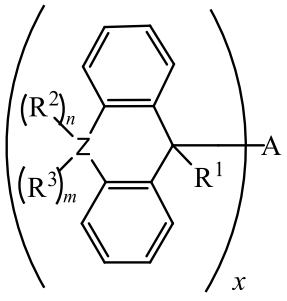
15. The method according to claim 13, further comprising accelerating the crosslinking reaction rate of the first crosslinkable aromatic polymer by incorporating the second crosslinkable aromatic polymer into the first crosslinkable aromatic polymer in an amount that is about 1 to about 50 percent by weight based on the total weight of the first and the second crosslinkable aromatic polymers to provide a degree of crosslinking for the blend that facilitates melt processing and post-curing of the blend

16. The method according to claim 13, wherein the at least one first crosslinkable polymer is polyphenylene sulfide and wherein the at least one second crosslinkable polymer is selected from the group consisting of (i) one or more polyarylene selected from polyetherketone, polyetheretherketone, polyetherdiephenylether ketone, polyetherketone ketone, and blends, co-polymers and alloys thereof; (ii) one or more of polysulfone, polyphenylsulfone, polyethersulfone, co-polymers and allows thereof; and (iii) one or more of polyimide, thermoplastic polyimide, polyetherimide, and blends, co-polymers and allows thereof.

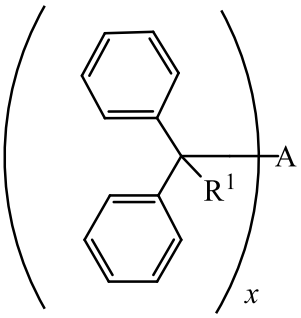
17. The method according to claim 1, wherein the composition further comprises at least one crosslinking compound that has a structure according to one of the following formulae:



(IV) ,



(V) , and

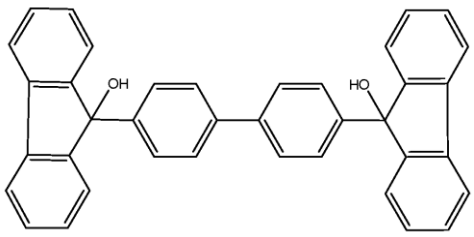


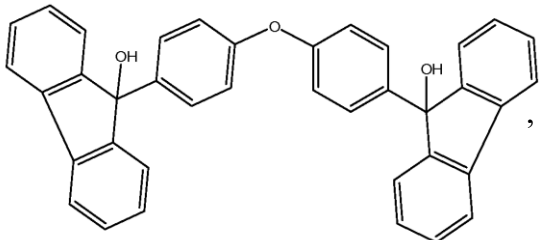
(VI) ,

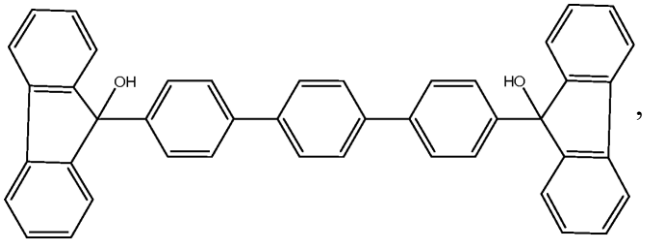
wherein A is a bond, an alkyl, an aryl, or an arene moiety having a molecular weight less than 10,000 g/mol; wherein R^1, R^2, and R^3 are the same or different and are independently selected from the group consisting of hydrogen, hydroxyl (-OH), amine (NH_2), halide, ester,

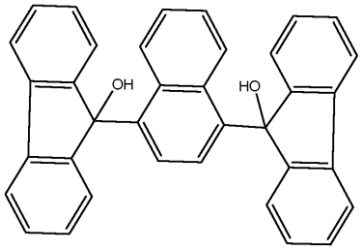
ether, amide, aryl, arene, or a branched or straight chain, saturated or unsaturated alkyl group of one to about six carbon atoms; wherein *m* is from 0 to 2, *n* is from 0 to 2, and *m* + *n* is greater than or equal to zero and less than or equal to two; wherein *Z* is selected from the group of oxygen, sulfur, nitrogen, and a branched or straight chain, saturated or unsaturated alkyl group of one to about six carbon atoms; and wherein *x* is 1 to 6.

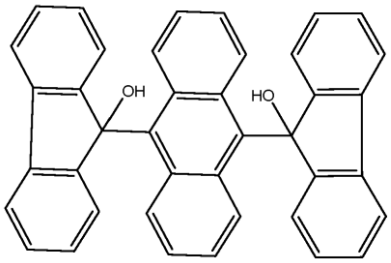
18. The method according to claim 17, wherein the at least one crosslinking compound has a structure according to formula (IV) and is selected from the group consisting of

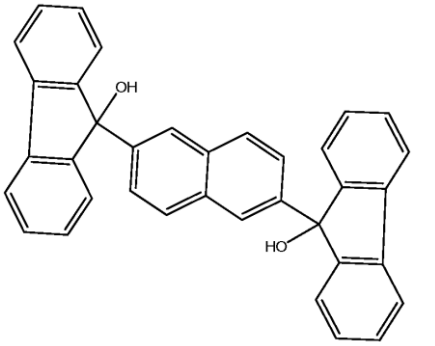


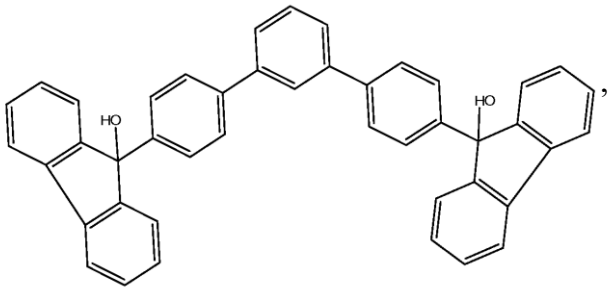
,


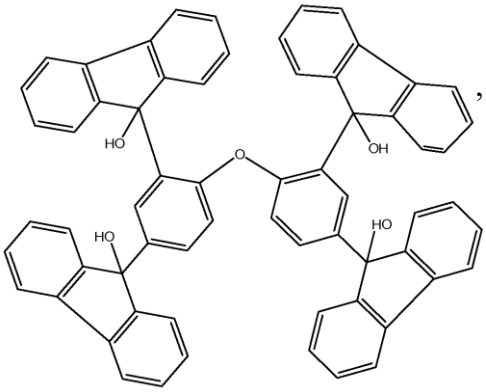
,


,


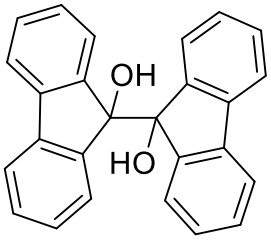
,


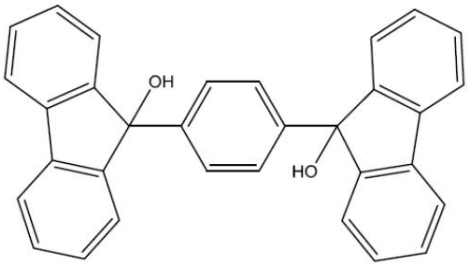
,


,


,


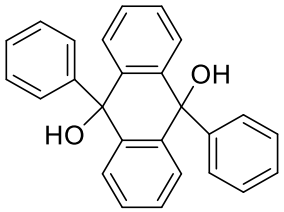
,

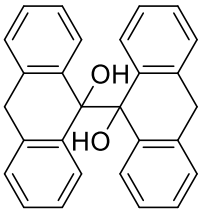


, and 

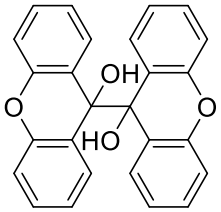
.

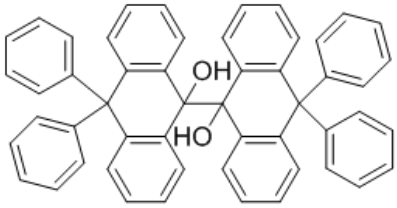
19. The method according to claim 17, wherein the at least one crosslinking compound has a structure according to formula (V) and is selected from a group consisting of:



, 

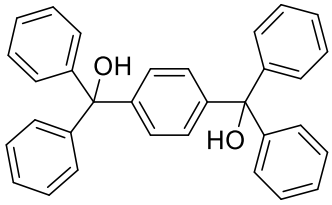
,

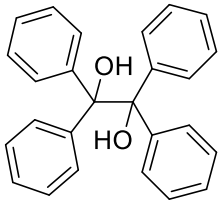


, and 

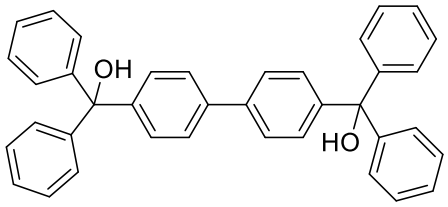
.

20. The method according to claim 17, wherein the at least one crosslinking compound has a structure according to formula (VI) and is selected from the group consisting of:



, 

, and



.

21. The method according to claim 17, wherein A has a molecular weight of 1,000 g/mol to 9,000 g/mol.

22. The method according to claim 21, wherein A has a molecular weight of 2,000 g/mol to 7,000 g/mol.

23. The method according to claim 17, wherein a weight ratio of the aromatic polymer to the crosslinking compound in the composition is 1:1 to 100:1.

24. The method according to claim 17, wherein the composition further comprises a crosslinking reaction control additive selected from a cure inhibitor or a cure accelerator.

25. The method according to claim 24, wherein the crosslinking reaction control additive is present in the composition in an amount of 0.01% to 15% by weight of the crosslinking compound.

26. The method according to claim 24, wherein the crosslinking reaction control additive is a cure inhibitor comprising lithium acetate.

27. The method according to claim 24, wherein the crosslinking reaction control additive is a cure accelerator comprising magnesium chloride.

28. The method according to claim 1, wherein the composition comprises one or more additives selected from continuous or discontinuous, long or short, reinforcing fibers selected from carbon fibers, glass fibers, woven glass fibers, woven carbon fibers, aramid fibers, boron fibers, polytetrafluoroethylene fibers, ceramic fibers, polyamide fibers; and/or one or more fillers selected from carbon black, silicate, fiberglass, glass beads, glass spheres, milled glass, calcium sulfate, boron, ceramic, polyamide, asbestos, fluorographite, aluminum hydroxide, barium sulfate, calcium carbonate, magnesium carbonate, silica, aluminum nitride, aluminum oxide, borax (sodium borax), activated carbon, pearlite, zinc terephthalate, graphite, graphene, talc, mica, silicon carbide whiskers or platelets, nanofillers, molybdenum disulfide, fluoropolymer fillers, carbon nanotubes and fullerene tubes.

29. The method according to claim 28, wherein the composition comprises 0.5% by weight to 65% by weight of the one or more additives and/or one or more fillers.

30. The method according to claim 1, wherein the heat processing of the composition further comprises extruding the composition for coating the insulation component.

31. The method according to claim 30, wherein the composition is extruded through a cross-head die.

32. The method according to claim 30, wherein the extruder comprises is a twin-screw extruder.

33. The method according to claim 30, wherein curing occurs at least partially in an oven.

34. The method according to claim 33, wherein the oven is an infrared or convection oven.

35. The method according to claim 33, further comprising curing and/or post-curing the crosslinkable aromatic polymer after coating in the oven.

36. The method according to claim 33, wherein the residence time in the oven and/or the cross-linking rate are controlled.

37. The method according to claim 1, further comprising preparing the exterior surface of the insulation component to enhance bonding.

38. The method according to claim 37, wherein the exterior surface is prepared by at least one of cleaning, roughening and/or chemically modifying the surface.

39. The method according to claim 37, wherein the exterior surface is prepared by chemically modifying the exterior surface using a primer and/or a coupling agent.

40. The method according to claim 1, wherein applying a coating to the exterior surface of the insulation component comprises applying the composition directly to the exterior surface of the insulation component.

41. The method according to claim 40, wherein the exterior surface is prepared by at least one of cleaning the surface, roughening the surface and/or chemically modifying the surface.

42. The method according to claim 1, further comprising applying at least one intermediate layer to the exterior surface of the insulation product prior to applying the coating of the composition.

43. The method according to claim 42, wherein the at least one intermediate layer comprises the ability to enhance bonding with the exterior surface of the insulation component.

44. The method according to claim 42, wherein the coating of the composition encapsulates the insulation component.

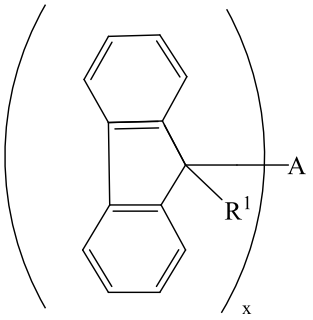
45. The method according to claim 1, further comprising applying a release agent to the coating prior to the coating contacting another surface.

46. The method according to claim 1, wherein the insulation component is selected from wire, metallic and/or fiber optic cable, hybrid cables, telemetry cables, sensors, RFID chips, piezoelectric sensors, cables or wires for logging while drilling, motor windings, motor rotors, motor stators, chemical pumps, electronic actuators for aircraft, and 5G transmission cables.

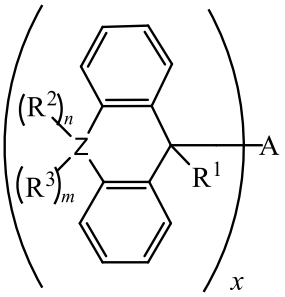
47. A composition for coating an insulation component, comprising:

a first crosslinkable aromatic polymer and a second crosslinkable aromatic polymer, wherein the first crosslinkable aromatic polymer has at least one reaction kinetics property that is different from the same reaction kinetics property in the second

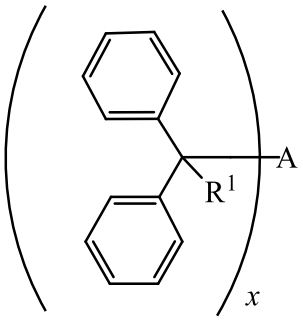
crosslinkable aromatic polymer, wherein the at least one reaction kinetics property comprises one or more selected from a crosslinking reaction, a crosslinking reaction rate, and a thermal property and wherein the composition further comprises at least one crosslinking compound that has a structure according to one of the following formulae:



(IV) ,



(V) , and



(VI) ,

wherein A is a bond, an alkyl, an aryl, or an arene moiety having a molecular weight less than 10,000 g/mol; wherein R^1, R^2, and R^3 are the same or different and are independently selected from the group consisting of hydrogen, hydroxyl (-OH), amine (NH_2), halide, ester, ether, amide, aryl, arene, or a branched or straight chain, saturated or unsaturated alkyl group of one to about six carbon atoms; wherein m is from 0 to 2, *n* is from 0 to 2, and $m + n$ is greater than or equal to zero and less than or equal to two; wherein Z is selected from the group of oxygen, sulfur, nitrogen, and a branched or straight chain, saturated or unsaturated alkyl group of one to about six carbon atoms; and wherein *x* is 1 to 6.

48. The composition according to claim 47, wherein the first crosslinkable polymer and the second crosslinkable polymer are selected from polyarylenes, polysulfones, polyethersulfones, polyphenylene sulfides, polyphenylene oxides, polyimides, polyetherimides, thermoplastic polyimides, polybenzamide, polyamide-imide, polyurea, polyurethane, polyphthalamide, polybenzimidazole, polyaramid, and blends, co-polymers, and alloys thereof.

49. The composition according to claim 47, wherein the aromatic polymer comprises one or more functionalized groups for crosslinking.

50. The composition according to claim 47, wherein the second crosslinkable aromatic polymer is at least one polyarylene selected from polyetherketone, polyetheretherketone, polyetherdiephenylether ketone, polyetherketone ketone, and blends, co-polymers and alloys thereof.

51. The composition according to claim 47, wherein the at least one reaction kinetics property is the crosslinking reaction rate.

52. The composition according to claim 51, wherein the first crosslinkable aromatic polymer has a crosslinking reaction rate that is slower than the second crosslinkable aromatic polymer.

53. The composition according to claim 51, wherein the blend comprises from 1 percent to 50 percent by weight of the first crosslinkable aromatic polymer and 50 percent by weight to 1 percent by weight of the second crosslinkable polymer and a range of the weight percentage ratio of the first crosslinkable aromatic polymer to the second crosslinkable aromatic polymer is 1:50 to 50:1 to provide a degree of crosslinking for the blend to facilitate melt processing and post-curing of the blend.

54. The composition according to claim 52, wherein the at least one first crosslinkable polymer is polyphenylene sulfide and wherein the at least one second crosslinkable polymer is selected from the group consisting of (i) one or more polyarylene selected from polyetherketone, polyetheretherketone, polyetherdiephenylether ketone, polyetherketone ketone, and blends, co-polymers and alloys thereof; (ii) one or more of polysulfone, polyphenylsulfone, polyethersulfone, co-polymers and allows thereof; and (iii) one or more of polyimide, thermoplastic polyimide, polyetherimide, and blends, co-polymers and allows thereof.

55. The composition according to claim 54, wherein the second crosslinkable aromatic polymer is selected from the group of polyetherether ketone; polyphenylene oxide, and polyetherimide

56. The composition according to claim 47, wherein the composition further comprises one or more additional aromatic crosslinkable polymers, different from the first and the second aromatic crosslinkable polymers.

57. The composition according to claim 47, wherein the at least one crosslinking compound is present in the composition in an amount of 1% by weight to 50% by weight of an unfilled weight of the composition.

58. The composition according to claim 47, wherein a weight ratio of the total weight of the crosslinkable aromatic polymers to the crosslinking compound in the composition is 1:1 to 100:1.

59. The composition according to claim 47, wherein the composition further comprises a crosslinking reaction control additive selected from a cure inhibitor or a cure accelerator.

60. The composition according to claims 47, wherein the first crosslinkable aromatic polymer, the second crosslinkable aromatic polymer or both of the first and the second crosslinkable polymers are self-crosslinkable, thermally crosslinkable, chemically crosslinkable or thermally and chemically crosslinkable.