CLAIMS

What is claimed is:

1. A process for preparing a functionalized graphitic material, comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first group, a first spacer, and a second group, wherein the first group comprises at least one of hydroxyl, thiol, amino, epoxy, carboxyl, and silyl, wherein the second group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol;

providing a second molecule comprising a third group, a second spacer, and a fourth group, wherein said third group is a different group from said first group, wherein said third group comprises at least one of thiol, carboxyl, trialkoxysilyl, phosphoryl ester, crown ether, cryptand, dioxime, and N-heterocycle, wherein the fourth group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol; and

bonding said second group and said fourth group to said graphitic material.

2. The process of Claim 1, wherein said graphitic material comprises at least one material of a carbon nanotube and graphene, wherein the first and second spacers are less than 1 nm.

3. The process of Claim 1, wherein said first molecule comprises at least one molecule of diamino compound, diepoxy compound, and amino alcohol compound.

4. The process of Claim 1, wherein said second molecule comprises at least one molecule of a diester of O-phosphorylethanolamine and aminopropyl trialkoxysilane, wherein the first and second spacers are less than 1 nm.

5. The process of Claim 1, wherein said bonding is provided by at least one method of mechanical milling, ultrasonic vibration, and high pressure microfluidic injection.

6. The process of Claim 1, further comprising the step of:

polymerizing said first group.

7. The process of Claim 1, further comprising the step of:

polymerizing said third group.

8. The process of Claim 1, further comprising the step of:

binding a sacrificial metal particle to said third group.

9. The process of Claim 8, wherein said sacrificial metal particle comprise at least one metal of zinc, magnesium, nickel, aluminum, and cobalt.

10. The process of Claim 8, wherein an electrical contact is made between said sacrificial metal particle and said functionalized graphitic material.

11. The process of Claim 8, further comprising the step of:

transferring a cation of said sacrificial metal particle by ionic conductance.

12. The process of Claim 1, further comprising the step of:

incorporating said functionalized graphitic material into a plastic composite.

13. The process of Claim 12, wherein said plastic composite is thermoset.

14. A tunable material composition comprising:

a thermoset plastic; and

a functionalized graphitic material prepared by the method comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first group, a first spacer, and a second group, wherein the first group comprises at least one of hydroxyl, thiol, amino, epoxy, carboxyl, and silyl, wherein the second group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol;

providing a second molecule comprising a third group, a second spacer, and a fourth group, wherein said third group is a different group from said first group, wherein said third group comprises at least one of thiol, carboxyl, trialkoxysilyl, phosphoryl ester, crown ether, cryptand, dioxime, and N-heterocycle, wherein the

fourth group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol; and

bonding said second group and said fourth group to said graphitic material.

15. The composition of Claim 14, wherein said thermoset plastic is at least one plastic of an epoxy, a polyacrylate, a polyurethane, and a phenolformaldehyde.

16. The composition of Claim 14, wherein said graphitic material is at least one material of carbon nanotubes and graphene, wherein the first and second spacers are less than 1 nm.

17. The composition of Claim 14, wherein said graphitic material is functionalized with at least one hardener of diaminobenzene, diamino polyethyleneoxide, diamino polypropyleneoxide, diamine cyclohexane derivatives, and aminated tall oil.

18. The composition of Claim 14, further comprising at least one particle of macroparticles, microparticles, and nanoparticles.

19. The composition of Claim 18, wherein said macroparticles comprise at least one macroparticle of sand, glass, basalt, alumina, silica, titanium dioxide, ceramic, and graphite fibers.

20. The composition of Claim 18, wherein said microparticles comprise at least one microparticle of titanium dioxide, silica, ceramic, graphite, iron phosphate, alumina, nickel, cobalt, zinc, aluminum, and magnesium.

21. The composition of Claim 18, wherein said nanoparticles comprise at least one nanoparticle of titanium dioxide, copper oxide, iron phosphate, silver, silica, and alumina.

22. The composition of Claim 14, wherein said tunable material composition is used in anticorrosion coatings for electromagnetic interference shields, magnetic shields, conductors, super capacitors, and pre-impregnated composites.

23. A process for preparing a functionalized graphitic material, comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first amino group, a first spacer, and a

trialkoxysiloxane group;

providing a second molecule comprising a second amino group, a second spacer, and a third amino group, wherein the first and second spacers are less than 1 nm; and

bonding said first amino group and said second amino group to said graphitic material.

24. The process of Claim 23, wherein said graphitic material comprises at least one material of a carbon nanotube and graphene.

25. The process of Claim 23, wherein said bonding is provided by at least one method of mechanical milling, ultrasonic vibration, and high pressure microfluidic injection.

26. The process of Claim 23, further comprising the step of:

polymerizing said third amino group with an epoxy monomer or epoxy oligomer.

27. The process of Claim 23, further comprising the step of:

polymerizing said third amino group with urethane monomer or urethane oligomer.

28. The process of Claim 23, further comprising the step of:

polymerizing said trialkoxysiloxane group with silicone monomer.

29. The process of Claim 23, further comprising the step of:

binding aluminum oxide to said trialkoxysiloxane group.

30. The process of Claim 23, further comprising the step of:

binding silica to said trialkoxysiloxane group.

31. The process of Claim 23, further comprising the step of:

binding a sacrificial metal particle to said trialkoxysiloxane group.

32. The process of Claim 31, wherein said sacrificial metal particle comprise at least one metal of zinc, magnesium, nickel, aluminum, and cobalt.

33. The process of Claim 31, wherein an electrical contact is made between said sacrificial metal particle and said functionalized graphitic material.

34. The process of Claim 23, further comprising the step of:

incorporating said functionalized graphitic material into a plastic composite.

35. The process of Claim 34, wherein said plastic composite is thermoset.

36. The process of Claim 34, wherein said plastic composite comprises at least one resin of epoxy, polyacrylate, polyurethane, and phenolformaldehyde.

37. A tunable material composition comprising:

a thermoset plastic;

silicone; and

a functionalized graphitic material prepared by the method comprising the steps of:

providing said graphitic material;

providing a first molecule comprising a first amino group, a first spacer, and a trialkoxysiloxane group;

providing a second molecule comprising a second amino group, a second spacer, and a third amino group, wherein the first and second spacers are less than 1 nm; and

bonding said first amino group and said second amino group to said graphitic material.

38. The composition of Claim 37, wherein said thermoset plastic is at least one plastic of an epoxy, polyacrylate, polyurethane, and phenolformaldehyde.

39. The composition of Claim 37, wherein said graphitic material is at least one material of carbon nanotubes and graphene.

40. The composition of Claim 37, wherein said graphitic material is functionalized with at least one hardener of diaminobenzene, diamino polyethyleneoxide, diamino polypropyleneoxide, diamine cyclohexane derivatives, and aminated tall oil.

41. The composition of Claim 37, further comprising at least one particle of macroparticles, microparticles, and nanoparticles.

42. The composition of Claim 41, wherein said macroparticles comprise at least one macroparticle of sand, glass, basalt, alumina, silica, titanium dioxide, ceramic, and graphite fibers.

43. The composition of Claim 41, wherein said microparticles comprise at least one microparticle of titanium dioxide, silica, ceramic, graphite, iron phosphate, alumina, nickel, cobalt, zinc, aluminum, and magnesium.

44. The composition of Claim 41, wherein said nanoparticles comprise at least one nanoparticle of titanium dioxide, copper oxide, iron phosphate, silver, silica, and alumina.

45. The composition of Claim 37, wherein said tunable material composition is used in electromagnetic interference shields, magnetic shields, conductors, super capacitors, and pre- impregnated composites.

46. A process of making a corrosion resistant coating system, comprising the steps of:

providing a substrate;

applying to said substrate a first layer of a tunable material composition comprising a thermoset plastic; and at least one functionalized graphitic material of

carbon nanotubes and graphene prepared by the method comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first group, a first spacer, and a second group, wherein the first group comprises at least one of hydroxyl, thiol, amino, epoxy, carboxyl, and silyl, wherein the second group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol;

providing a second molecule comprising a third group, a second spacer, and a fourth group, wherein said third group is a different group from said first group, wherein said third group comprises at least one of thiol, carboxyl, trialkoxysilyl, phosphoryl ester, crown ether, cryptand, dioxime, and N-heterocycle, wherein the fourth group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol, wherein the first and second spacers are less than 1 nm;

binding a sacrificial metal particle to said third group; and

bonding said second group and said fourth group to said graphitic material;

applying a second layer comprising an electrically insulating material to said first layer; and

applying to said second layer a third layer of a tunable material composition comprising a thermoset plastic; and at least one functionalized graphitic material of carbon nanotubes and graphene prepared by the method comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first group, a first spacer, and a second group, wherein the first group comprises at least one of hydroxyl, thiol, amino, epoxy, carboxyl, and silyl, wherein the second group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol;

providing a second molecule comprising a third group, a second spacer, and a fourth group, wherein said third group is a different group from said first group, wherein said third group comprises at least one of thiol, carboxyl, trialkoxysilyl, phosphoryl ester, crown ether, cryptand, dioxime, and N-heterocycle, wherein the fourth group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol, wherein the first and second spacers are less than 1 nm; and

bonding said second group and said fourth group to said graphitic material.

47. A process of making a corrosion resistant coating system, comprising the steps of:

providing a substrate;

applying to said substrate a first layer of a tunable material composition comprising a thermoset plastic; silicone; and at least one functionalized graphitic material of carbon nanotubes and graphene prepared by the method comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first amino group, a first spacer, and a trialkoxysiloxane group;

providing a second molecule comprising a second amino group, a second spacer, and a third amino group, wherein the first and second spacers are less than 1 nm; and

bonding said first amino group and said second amino group to said graphitic material;

applying a second layer comprising an electrically insulating material to said first layer; and

applying to said second layer a third layer of a tunable material composition comprising a thermoset plastic; silicone; a sacrificial metal particle; and at least one functionalized graphitic material of carbon nanotubes and graphene prepared by the method comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first amino group, a first spacer, and a trialkoxysiloxane group;

providing a second molecule comprising a second amino group, a second spacer, and a third amino group; and

bonding said first amino group and said second amino to said graphitic material.

CLAIMS

What is claimed is:

1. A process for preparing a functionalized graphitic material, comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first group, a first spacer, and a second group, wherein the first group comprises at least one of hydroxyl, thiol, amino, epoxy, carboxyl, and silyl, wherein the second group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol;

providing a second molecule comprising a third group, a second spacer, and a fourth group, wherein said third group is a different group from said first group, wherein said third group comprises at least one of thiol, carboxyl, trialkoxysilyl, phosphoryl ester, crown ether, cryptand, dioxime, and N-heterocycle, wherein the fourth group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol;

binding a sacrificial metal particle to either said first or said third group, wherein said first and second spacers are less than 1.0 nm;

transferring a cation of said sacrificial metal particle by ionic conductance; and

bonding said second group and said fourth group to said graphitic material.

2. The process of Claim 1, wherein said graphitic material comprises at least one material of a carbon nanotube and graphene.

3. The process of Claim 1, wherein said first molecule comprises at least one molecule of diamino compound, diepoxy compound, and amino alcohol compound.

4. The process of Claim 1, wherein said second molecule comprises at least one molecule of a diester of O-phosphorylethanolamine and aminopropyl trialkoxysilane.

5. The process of Claim 1, wherein said bonding is provided by at least one method of mechanical milling, ultrasonic vibration, and high pressure microfluidic injection.

6. The process of Claim 1, further comprising the step of:

polymerizing said first group.

7. The process of Claim 1, further comprising the step of:

polymerizing said third group.

8. The process of Claim 1, further comprising the step of:

binding a sacrificial metal particle to said third group.

9. The process of Claim 8, wherein said sacrificial metal particle comprise at least one metal of zinc, magnesium, nickel, aluminum, and cobalt.

10. The process of Claim 8, wherein an electrical contact is made between said sacrificial metal particle and said functionalized graphitic material.

11. The process of Claim 8, further comprising the step of:

transferring a cation of said sacrificial metal particle by ionic conductance.

12. The process of Claim 1, further comprising the step of:

incorporating said functionalized graphitic material into a plastic composite.

13. The process of Claim 12, wherein said plastic composite is thermoset.

14. A tunable material composition comprising:

a thermoset plastic; and

a functionalized graphitic material, wherein the functionalized graphitic material comprises:

a first molecule comprising a first group, a first spacer, and a second group, wherein the first group comprises at least one of hydroxyl, thiol, amino, epoxy, carboxyl, and silyl, wherein the second group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol;

a second molecule comprising a third group, a second spacer, and a fourth group, wherein said third group is a different group from said first group, wherein said third group comprises at least one of thiol, carboxyl, trialkoxysilyl,

phosphoryl ester, crown ether, cryptand, dioxime, and N-heterocycle, wherein the fourth group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol;

a sacrificial metal particle bound either to said first group or said second group such that a cation of said sacrificial metal particle is transferred by ionic conductance, wherein said first and second spacers are less than 1.0 nm; and

said second group and said fourth group are bonded to said graphitic material.

15. The composition of Claim 14, wherein said thermoset plastic is at least one plastic of an epoxy, a polyacrylate, a polyurethane, and a phenolformaldehyde.

16. The composition of Claim 14, wherein said graphitic material is at least one material of carbon nanotubes and graphene.

17. The composition of Claim 14, wherein said graphitic material is functionalized with at least one hardener of diaminobenzene, diamino polyethyleneoxide, diamino polypropyleneoxide, diamine cyclohexane derivatives, and aminated tall oil.

18. The composition of Claim 14, further comprising at least one particle of macroparticles, microparticles, and nanoparticles.

19. The composition of Claim 18, wherein said macroparticles comprise at least one macroparticle of sand, glass, basalt, alumina, silica, titanium dioxide, ceramic, and graphite fibers.

20. The composition of Claim 18, wherein said microparticles comprise at least one microparticle of titanium dioxide, silica, ceramic, graphite, iron phosphate, alumina, nickel, cobalt, zinc, aluminum, and magnesium.

21. The composition of Claim 18, wherein said nanoparticles comprise at least one nanoparticle of titanium dioxide, copper oxide, iron phosphate, silver, silica, and alumina.

22. The composition of Claim 14, wherein said tunable material composition is used in anticorrosion coatings for electromagnetic interference shields, magnetic shields, conductors, super capacitors, and pre-impregnated composites.

23. A process for preparing a functionalized graphitic material, comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first amino group, a first spacer, and a

trialkoxysiloxane group;

providing a second molecule comprising a second amino group, a second spacer, and a third amino group, wherein the first and second spacers are less than 1 nm;

binding a sacrificial metal particle to either said first or said third group, wherein said first and second spacers are less than 1.0 nm;

transferring a cation of said sacrificial metal particle by ionic conductance; and

bonding said first amino group and said second amino group to said graphitic material.

24. The process of Claim 23, wherein said graphitic material comprises at least one material of a carbon nanotube and graphene.

25. The process of Claim 23, wherein said bonding is provided by at least one method of mechanical milling, ultrasonic vibration, and high pressure microfluidic injection.

26. The process of Claim 23, further comprising the step of:

polymerizing said third amino group with an epoxy monomer or epoxy oligomer.

27. The process of Claim 23, further comprising the step of:

polymerizing said third amino group with urethane monomer or urethane oligomer.

28. The process of Claim 23, further comprising the step of:

polymerizing said trialkoxysiloxane group with silicone monomer.

29. The process of Claim 23, further comprising the step of:

binding aluminum oxide to said trialkoxysiloxane group.

30. The process of Claim 23, further comprising the step of:

binding silica to said trialkoxysiloxane group.

31. The process of Claim 23, further comprising the step of:

binding a sacrificial metal particle to said trialkoxysiloxane group.

32. The process of Claim 31, wherein said sacrificial metal particle comprise at least one metal of zinc, magnesium, nickel, aluminum, and cobalt.

33. The process of Claim 31, wherein an electrical contact is made between said sacrificial metal particle and said functionalized graphitic material.

34. The process of Claim 23, further comprising the step of:

incorporating said functionalized graphitic material into a plastic composite.

35. The process of Claim 34, wherein said plastic composite is thermoset.

36. The process of Claim 34, wherein said plastic composite comprises at least one resin of epoxy, polyacrylate, polyurethane, and phenolformaldehyde.

37. A tunable material composition comprising:

a thermoset plastic;

silicone; and

a functionalized graphitic material, wherein said functionalized graphitic material comprises:

a first molecule comprising a first amino group, a first spacer, and a trialkoxysiloxane group;

a second molecule comprising a second amino group, a second spacer, and a third amino group, wherein the first and second spacers are less than 1 nm;

a sacrificial metal particle bound either to said first group or said second group such that a cation of said sacrificial metal particle is transferred by ionic conductance; and

said first amino group and said second amino group bonded to said graphitic material.

38. The composition of Claim 37, wherein said thermoset plastic is at least one plastic of an epoxy, polyacrylate, polyurethane, and phenolformaldehyde.

39. The composition of Claim 37, wherein said graphitic material is at least one material of carbon nanotubes and graphene.

40. The composition of Claim 37, wherein said graphitic material is functionalized with at least one hardener of diaminobenzene, diamino polyethyleneoxide, diamino polypropyleneoxide, diamine cyclohexane derivatives, and aminated tall oil.

41. The composition of Claim 37, further comprising at least one particle of macroparticles, microparticles, and nanoparticles.

42. The composition of Claim 41, wherein said macroparticles comprise at least one macroparticle of sand, glass, basalt, alumina, silica, titanium dioxide, ceramic, and graphite fibers.

43. The composition of Claim 41, wherein said microparticles comprise at least one microparticle of titanium dioxide, silica, ceramic, graphite, iron phosphate, alumina, nickel, cobalt, zinc, aluminum, and magnesium.

44. The composition of Claim 41, wherein said nanoparticles comprise at least one nanoparticle of titanium dioxide, copper oxide, iron phosphate, silver, silica, and alumina.

45. The composition of Claim 37, wherein said tunable material composition is used in electromagnetic interference shields, magnetic shields, conductors, super capacitors, and pre- impregnated composites.

46. A process of making a corrosion resistant coating system, comprising the steps of:

providing a substrate;

applying to said substrate a first layer of a tunable material composition comprising a thermoset plastic; and at least one functionalized graphitic material of carbon nanotubes and graphene prepared by the method comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first group, a first spacer, and a second group, wherein the first group comprises at least one of hydroxyl, thiol, amino, epoxy, carboxyl, and silyl, wherein the second group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol;

providing a second molecule comprising a third group, a second spacer, and a fourth group, wherein said third group is a different group from said first group, wherein said third group comprises at least one of thiol, carboxyl, trialkoxysilyl, phosphoryl ester, crown ether, cryptand, dioxime, and N-heterocycle, wherein the fourth group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol, wherein the first and second spacers are less than 1 nm;

binding a sacrificial metal particle to said third group;

transferring a cation of said sacrificial metal particle by ionic conductance; and

bonding said second group and said fourth group to said graphitic material;

applying a second layer comprising an electrically insulating material to said first layer; and

applying to said second layer a third layer of a tunable material composition comprising a thermoset plastic; and at least one functionalized graphitic material of carbon nanotubes and graphene prepared by the method comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first group, a first spacer, and a second group, wherein the first group comprises at least one of hydroxyl, thiol,

amino, epoxy, carboxyl, and silyl, wherein the second group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol;

providing a second molecule comprising a third group, a second spacer, and a fourth group, wherein said third group is a different group from said first group, wherein said third group comprises at least one of thiol, carboxyl, trialkoxysilyl, phosphoryl ester, crown ether, cryptand, dioxime, and N-heterocycle, wherein the fourth group comprises at least one of amino, epoxy, hydroxyl, carboxyl, silyl, and thiol, wherein the first and second spacers are less than 1 nm; and

bonding said second group and said fourth group to said graphitic material.

47. A process of making a corrosion resistant coating system, comprising the steps of:

providing a substrate;

applying to said substrate a first layer of a tunable material composition comprising a thermoset plastic; silicone; and at least one functionalized graphitic material of carbon nanotubes and graphene prepared by the method comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first amino group, a first spacer, and a trialkoxysiloxane group;

providing a second molecule comprising a second amino group, a second spacer, and a third amino group, wherein the first and second spacers are less than 1 nm;

transferring a cation of said sacrificial metal particle by ionic conductance; and

bonding said first amino group and said second amino group to said graphitic material;

applying a second layer comprising an electrically insulating material to said first layer; and

applying to said second layer a third layer of a tunable material composition comprising a thermoset plastic; silicone; a sacrificial metal particle; and at least one functionalized graphitic material of carbon nanotubes and

graphene prepared by the method comprising the steps of:

providing a graphitic material;

providing a first molecule comprising a first amino group, a first spacer, and a trialkoxysiloxane group;

providing a second molecule comprising a second amino group, a second spacer, and a third amino group; and

bonding said first amino group and said second amino group to said graphitic material.