

CLAIMS

We claim:

1. A curable fluorine-containing elastomer composition comprising
5 at least one curable fluoropolymer comprising at least one fluorinated monomer, and at least one fluorine-containing cure site monomer comprising at least one cure site; and microdiamond particles having an average particle size of greater than 0.10 micron to about 100 microns.
2. The curable fluorine-containing elastomer composition according to claim 1, wherein
10 the microdiamond particles have an average particle size of greater than 0.1 micron to about 10 microns.
3. The curable fluorine-containing elastomer composition according to claim 2, wherein the microdiamond particles have an average particle size of about greater than 0.1 micron to about 5 microns.
- 15 4. The curable fluorine-containing elastomer composition according to claim 2, wherein the microdiamond particles have an average particle size of about 0.20 micron to about 2 microns.
5. The curable fluorine-containing elastomer composition according to claim 4, wherein the microdiamond particles have an average particle size of about 0.25 micron to about 1
20 micron.
6. The curable fluorine-containing elastomer composition according to claim 1, wherein the microdiamond particles have an average particle size of about 0.25 micron to about 0.5 micron.
7. The curable fluorine-containing elastomer composition according to claim 1, wherein
25 the microdiamond particles have a shape selected from spherical particles, fibers or flasks.
8. The curable fluorine-containing elastomer composition according to claim 1, wherein the microdiamond particles are natural microdiamond particles.
9. The curable fluorine-containing elastomer composition according to claim 1, wherein the microdiamond particles are synthetic microdiamond particles.
- 30 10. The curable fluorine-containing elastomer composition according to claim 1, wherein the microdiamond particles are a blend of natural microdiamond particles and synthetic microdiamond particles.

11. The curable fluorine-containing elastomer composition according to claim 1, wherein the particles are present in an agglomerated or aggregate form.

12. The curable fluorine-containing elastomer composition according to claim 1, wherein the composition comprises about 0.1 to about 100 parts of microdiamond particles per 100 parts
5 by weight of the at least one curable fluoropolymer.

13. The curable fluorine-containing elastomer composition according to claim 12, wherein the composition comprises about 1 to about 50 parts of microdiamond particles per 100 parts by weight of the at least one curable fluoropolymer.

14. The curable fluorine-containing elastomer composition according to claim 13, wherein
10 the composition comprises about 2 to about 20 parts of microdiamond particles per 100 parts by weight of the at least one curable fluoropolymer.

15. The curable fluorine-containing elastomer composition according to claim 1, wherein the at least one curable fluoropolymer is a curable perfluoropolymer, the at least one fluorinated monomer is tetrafluoroethylene and the perfluoropolymer further comprises a
15 perfluoroalkylvinyl ether monomer, and wherein the at least one fluorine-containing cure site monomer is a perfluorinated cure site monomer.

16. The curable fluorine-containing elastomer composition according to claim 15, further comprising at least one curative.

17. The curable fluorine-containing elastomer composition according to claim 16, wherein
20 the curative is a peroxide cure system.

18. The curable fluorine-containing elastomer composition according to claim 1, wherein the at least one curable fluoropolymer is a curable perfluoropolymer, the at least one fluorinated monomer is tetrafluoroethylene, the curable perfluoropolymer further comprises a perfluoroalkylvinyl ether monomer, and wherein the curable perfluoropolymer comprises
25 fluoroplastic particles therein.

19. The curable fluorine-containing elastomer composition according to claim 18, further comprising at least one curative.

20. The curable fluorine-containing elastomer composition according to claim 19, wherein the curative is a peroxide cure system.

21. The curable fluorine-containing elastomer composition according to claim 1, wherein
30 the curable fluoropolymer is a perfluoropolymer, the at least one fluorinated monomer is tetrafluoroethylene and the perfluoropolymer further comprises a perfluoroalkylvinyl ether

monomer, and there are at least two of the fluorine-containing cure site monomers, each having at least one cure site.

22. The curable fluorine-containing elastomer composition according to claim 21, further comprising at least one curative.

5 23. The curable fluorine-containing elastomer composition according to claim 22, wherein one of the curatives is a peroxide cure system.

24. The curable fluorine-containing elastomer composition according to claim 22, wherein the composition comprises a blend of the curable perfluoropolymer with a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether monomer and a perfluorinated cure site monomer, and wherein the second perfluoropolymer comprises fluoroplastic particles therein, and the composition further comprises at least two curatives.

25. The curable fluorine-containing elastomer composition according to claim 24, wherein a range of a ratio of a weight percent of first curable perfluoropolymer to a weight of the second curable perfluoropolymer is about 5:95 to about 95:5.

15 26. The curable fluorine-containing elastomer composition according to claim 25, wherein the range of the ratio of the weight percent of the first curable perfluoropolymer to the second curable perfluoropolymer is about 20:80 to about 80:20.

27. The curable fluorine-containing elastomer composition according to claim 26, wherein the range of the ratio of the weight percent of the first curable perfluoropolymer to the second curable perfluoropolymer is about 40:60 to about 60:40.

28. The curable fluorine-containing elastomer composition according to claim 27, wherein the range of the ratio of the weight percent of the first curable perfluoropolymer to the second curable perfluoropolymer is about 50:50.

29. The curable fluorine-containing elastomer composition according to claim 24, wherein each of the at least two cure site monomers of the first curable perfluoropolymer is present in an amount of about 0.1 to about 10 mole percent in the first curable perfluoropolymer and the at least one cure site monomer of the second curable perfluoropolymer, is present in an amount of about 0.1 to about 10 mole percent in the second curable perfluoropolymer.

30 30. The curable fluorine-containing elastomer composition according to claim 24, wherein the cure sites in at least two cure site monomers in the first curable perfluoropolymer are nitrogen-containing cure sites.

31. The curable fluorine-containing elastomer composition according to claim 30, wherein the first curable perfluoropolymer comprises a first cure site monomer comprising a primary cyano cure site and a second cure site monomer comprising a secondary cyano cure site.

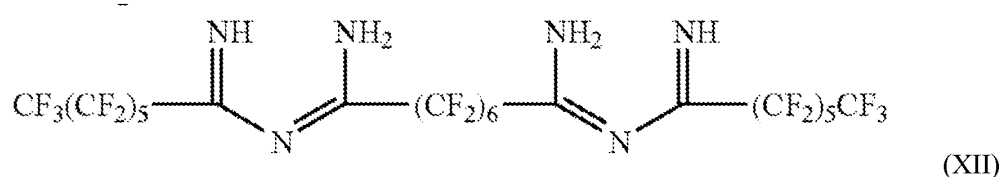
32. The curable fluorine-containing elastomer composition according to claim 24, wherein the at least one cure site in each of the at least two cure site monomers in the first curable perfluoropolymer is selected from the group consisting of cyano, carboxyl, carbonyl, alkoxycarbonyl, and combinations thereof.

33. The curable fluorine-containing elastomer composition according to claim 24, wherein the at least two curatives are present in the composition in a total amount of about 0.2 to about 10 parts by weight per 100 parts by weight of the curable perfluoropolymers in the composition.

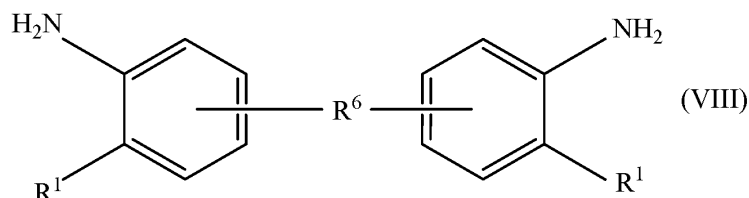
34. The curable fluorine-containing elastomer composition according to claim 24, wherein each of the at least two curatives is present in the composition in an amount of about 0.1 part to about 6 parts by weight per 100 parts by weight of the curable perfluoropolymers.

35. The curable fluorine-containing elastomer composition according to claim 24, wherein the at least two curatives comprises a first curative that is present in the composition in an amount of about 0.5 part to about 4 parts by weight per 100 parts by weight of the curable perfluoropolymers, and a second curative that is present in the composition in an amount of about 0.3 part to about 2 parts by weight per 100 parts by weight of the curable perfluoropolymers.

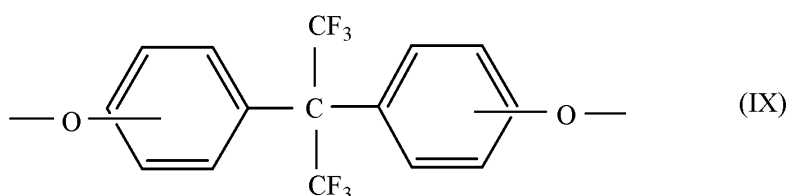
36. The curable fluorine containing elastomer composition according to claim 24, wherein the first curative is



and the second curative is

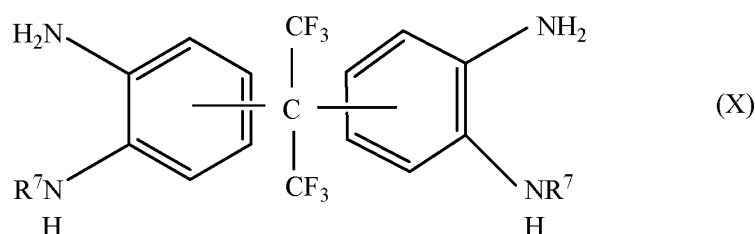


wherein each R^1 is independently $-NH_2$, $-NHR_2$, $-OH$ or $-SH$; R^2 is a monovalent organic group; and wherein R^6 is $-SO_2$, $-O-$, $-CO-$, an alkylene group of 1 to about 6 carbon atoms, a perfluoroalkylene group of 1 to about 10 carbon atoms, a single bond or a group as shown in Formula (IX):



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37. The curable fluorine-containing elastomer composition according to claim 36, wherein the second curative is a compound according to formula (X):

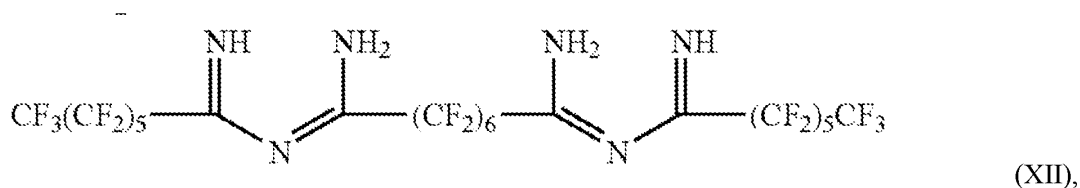


wherein R^7 is independently selected from hydrogen, an alkyl group of 1 to about 10 carbon atoms; a partially fluorinated or perfluorinated alkyl group of 1 to 10 carbon atoms; a phenyl group; a benzyl group; or a fluorinated or partially fluorinated phenyl group; a fluorinated or partially fluorinated benzyl group; or a phenyl or an alkyl group having a function group or groups that is a lower alkyl or perfluoroalkyl group.

38. The curable fluorine-containing elastomer composition according to claim 36, wherein the second curative is a bisaminophenol or a salt thereof.

39. The curable fluorine-containing elastomer composition according to claim 24, wherein the second curable perfluoropolymer comprises a cure site monomer having a cure site selected from the group consisting of halogen, nitrogen-containing groups, carboxyl, alkoxycarbonyl and combinations thereof.

40. The curable fluorine-containing elastomer composition according to claim 24, wherein the at least two curatives are selected from the group consisting of:



bisaminophenol and combinations thereof.

41. The curative fluorine-containing elastomer composition according to claim 40, wherein the first curative is a compound according to formula (XII) and the second curative is

5 bisaminophenol.

42. The curable fluorine-containing elastomer composition according to claim 1, comprising a second curable fluoropolymer comprising tetrafluoroethylene and at least one second fluorine-containing monomer, one of which is a cure site monomer comprising at least one second cure site.

43. The composition according to claim 42, wherein the first curable fluoropolymer and/or the second curable fluoropolymer is a perfluoropolymer, and wherein the first curable fluoropolymer and the second curable fluoropolymer are different.

44. A cured fluorine-containing elastomer formed by curing the curable fluorine-containing composition of claim 1.

15 45. A molded article formed by heat curing and shaping a composition according to claim

1.

46. A method for forming a fluoroelastomeric article with reduced particulation, comprising:

20 preparing a curable fluorine-containing elastomer composition comprising at least one curable fluoropolymer comprising at least one fluorinated monomer, and at least one fluorine-containing cure site monomer comprising at least one cure site;

adding into the curable fluorine-containing elastomer composition microdiamond particles having an average particle size of greater than 0.10 microns to about 100 microns; and

25 curing the curable fluorine-containing elastomer composition to form the fluoroelastomeric article, wherein the fluoroelastomeric article has reduced particulation in comparison to a second fluoroelastomeric article having the same fluorine-containing elastomer composition but that does not include the microdiamond particles, when the fluoroelastomeric

article and the second fluoroelastomeric article are exposed to at least one of a fluorine-based plasma, an oxygen-based plasma, a hydrogen-based plasma, and combinations thereof.

47. The method according to claim 46, wherein the curable fluorine-containing elastomer composition includes at least one filler and the method further comprises adding the
5 microdiamond particles into the fluorine-containing elastomer composition while adding the at least one filler to the at least one first curable fluoropolymer.

48. The method according to claim 46, further comprising adding at least one curative prior to curing the curable fluorine-containing elastomer composition to form the fluoroelastomeric article.

10 49. The method according to claim 46, wherein the at least one curable fluoropolymer is a perfluoropolymer, the fluorinated monomer is tetrafluoroethylene, the at least one fluorine-containing cure site monomer is a perfluorinated cure site monomer and the perfluoropolymer further comprises a perfluoroalkyl vinyl ether.

50. The method according to claim 46, wherein a compression set value of the
15 fluoroelastomeric article at 250°C/70 hours/25% deflection is reduced in comparison to the second fluoroelastomeric article.

51. The method according to claim 50, wherein the curable fluorine-containing elastomer composition used to form the second fluoroelastomeric article further comprises a carbon black filler.

20 52. The method according to claim 46, wherein the fluoroelastomeric article has a reduced sticking force in comparison to the second fluoroelastomeric article.

53. The method according to claim 50, wherein the curable fluorine-containing elastomer composition used to form the second fluoroelastomeric article further comprises a carbon black filler.

25 54. The method according to claim 46, wherein the fluoroelastomeric article has improved resistance to a fluorine-based plasma, an oxygen-based plasma, a hydrogen-based plasma, and combinations thereof in comparison to the second fluoroelastomeric article.

55. The method according to claim 46, wherein the fluoroelastomeric article has improved physical properties in comparison to the second fluoroelastomeric article.

30 56. The method according to claim 46, wherein a compression set value of the fluoroelastomeric article at 350°C/70 hours/18% deflection is reduced in comparison to the second fluoroelastomeric article.

57. The method according to claim 56, wherein the curable fluorine-containing elastomer composition used to form the second fluoroelastomeric article further comprises a carbon black filler

58. A method of forming an fluoroelastomeric article having reduced compression set,
5 comprising:

preparing a curable fluorine-containing elastomer composition comprising at least one first curable fluoropolymer comprising at least one fluorinated monomer, and at least one fluorine-containing cure site monomer comprising at least one cure site;

10 adding into the curable fluorine-containing elastomer composition microdiamond particles having an average particle size of greater than 0.10 microns to 100 microns;

and curing the curable fluorine-containing elastomer composition to form the fluoroelastomeric article, wherein the fluoroelastomeric article has a compression set value at 250°C/70 hours/25% deflection that is reduced in comparison to an second fluoroelastomeric
15 article formed of the same curable fluorine-containing elastomer composition, but that does not include the microdiamond particles.

59. The method according to claim 56, wherein the at least one curable fluoropolymer is a perfluoropolymer, the fluorinated monomer is tetrafluoroethylene, the at least one fluorine-containing cure site monomer is a perfluorinated cure site monomer and the perfluoropolymer
20 further comprises a perfluoroalkyl vinyl ether.

60. The method according to claim 56, further comprising adding at least one curative prior to curing the curable fluorine-containing elastomer composition to form the fluoroelastomeric article.

61. The method according to claim 56, wherein the fluoroelastomeric article has reduced
25 particulation in comparison to the second fluoroelastomeric article when the fluoroelastomeric article and the second fluoroelastomeric article are exposed to a fluorine-based plasma, an oxygen-based plasma, a hydrogen-based plasma, and combinations thereof.

62. The method according to claim 61, wherein the curable fluorine-containing elastomer composition used to form the second fluoroelastomeric article further comprises a carbon black
30 filler.

63. The method according to claim 58, wherein the fluoroelastomeric article has a reduced sticking force in comparison to the second fluoroelastomeric article.

64. The method according to claim 63, wherein the curable fluorine-containing elastomer composition used to form the second fluoroelastomeric article further comprises a carbon black filler.

65. The method according to claim 58, wherein the fluoroelastomeric article has improved resistance to a fluorine-based plasma, an oxygen-based plasma, a hydrogen-based plasma, and combinations thereof in comparison to the second fluoroelastomeric article.

66. The method according to claim 58, wherein the fluoroelastomeric article has improved physical properties in comparison to the second fluoroelastomeric article.

67. The method according to claim 58, wherein a compression set value of the fluoroelastomeric article at 350°C/70 hours/18% deflection is reduced in comparison to the second fluoroelastomeric article.

68. The method according to claim 67, wherein the curable fluorine-containing elastomer composition used to form the second fluoroelastomeric article further comprises a carbon black filler.

69. A method of forming an fluoroelastomeric article having a reduced sticking force, comprising:

preparing a curable fluorine-containing elastomer composition comprising at least one first curable fluoropolymer comprising at least one fluorinated monomer, and at least one fluorine-containing cure site monomer comprising at least one cure site;

adding into the curable fluorine-containing elastomer composition microdiamond particles having an average particle size of greater than 0.10 microns to 100 microns;

and curing the curable fluorine-containing elastomer composition to form the fluoroelastomeric article, wherein the fluoroelastomeric article has a sticking force that is reduced in comparison to a second fluoroelastomeric article formed of the same curable fluorine-containing elastomer composition as the curable fluorine-containing elastomer, but that does not include the microdiamond particles.

70. The method according to claim 69, wherein the at least one curable fluoropolymer is a perfluoropolymer, the fluorinated monomer is tetrafluoroethylene, the at least one fluorine-containing cure site monomer is a perfluorinated cure site monomer and the perfluoropolymer further comprises a perfluoroalkyl vinyl ether.

71. The method according to claim 69, further comprising adding at least one curative prior to curing the curable fluorine-containing elastomer composition to form the fluoroelastomeric article.

72. The method according to claim 69, wherein the fluoroelastomeric article has a
5 compression set value at 250°C/70 hours/25% deflection that is reduced in comparison to the second fluoroelastomeric article.

73. The method according to claim 72, wherein the curable fluorine-containing elastomer composition used to form the second fluoroelastomeric article further comprises a carbon black filler.

10 74. The method according to claim 69, wherein the fluoroelastomeric article has reduced particulation in comparison to the second fluoroelastomeric article when the fluoroelastomeric article and the second fluoroelastomeric article are exposed to a fluorine-based plasma, an oxygen-based plasma, a hydrogen-based plasma, and combinations thereof.

75. The method according to claim 74, wherein the curable fluorine-containing elastomer
15 composition used to form the second fluoroelastomeric article further comprises a carbon black filler.

76. The method according to claim 69, wherein the fluoroelastomeric article has improved resistance to a fluorine-based plasma, an oxygen-based plasma, a hydrogen-based plasma, and combinations thereof in comparison to the second fluoroelastomeric article.

20 77. The method according to claim 69, wherein the fluoroelastomeric article has improved physical properties in comparison to the second fluoroelastomeric article.

78. The method according to claim 69, wherein a compression set value of the fluoroelastomeric article at 350°C/70 hours/18% deflection is reduced in comparison to the second fluoroelastomeric article.

25 79. The method according to claim 78, wherein the curable fluorine-containing elastomer composition used to form the second fluoroelastomeric article further comprises a carbon black filler.

80. A method for forming a fluoroelastomeric article with reduced particulation,
comprising:

30 preparing a curable fluorine-containing elastomer composition comprising at least one curable fluoropolymer comprising at least one fluorinated monomer, and at least one

fluorine-containing cure site monomer comprising at least one cure site; and at least one curative;

adding into the curable fluorine-containing elastomer composition microdiamond particles having an average particle size of greater than 0.10 microns to about 100 microns; and

5 curing the curable fluorine-containing elastomer composition to form the fluoroelastomeric article, wherein the fluoroelastomeric article is capable of being used in service temperatures of at least about 350°C.

81. The method according to claim 80, wherein the fluoroelastomeric article is a perfluoroelastomeric article.

10 82. The method according to claim 80, further comprising adding at least one curative prior to curing the curable fluorine-containing elastomer composition to form the fluoroelastomeric article.

83. The method according to claim 80, wherein the fluoroelastomeric article has a compression set value at 350°C/70 hours/18% deflection that is reduced in comparison to a
15 second fluoroelastomeric article formed of the same curable fluorine-containing elastomer composition, but that does not include the microdiamond particles.

84. The method according to claim 83, wherein the curable fluorine-containing elastomer composition used to form the second fluoroelastomeric article further comprises a carbon black
20 filler.