high-end sealing applications like those of semiconductor processing, particularly where high temperature environments are encountered.

BRIEF SUMMARY ~~OF THE INVENTION~~

**[0017a]** In a first aspect of the present disclosure, there is provided a curable fluorine-containing elastomer composition comprising

a first curable perfluoropolymer comprising tetrafluoroethylene, a first perfluoroalkylvinyl ether and at least two cure site monomers each having at least one cure site;

a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether and at least one second cure site monomer having at least one cure site, wherein the second curable perfluoropolymer comprises fluoroplastic particles therein; and

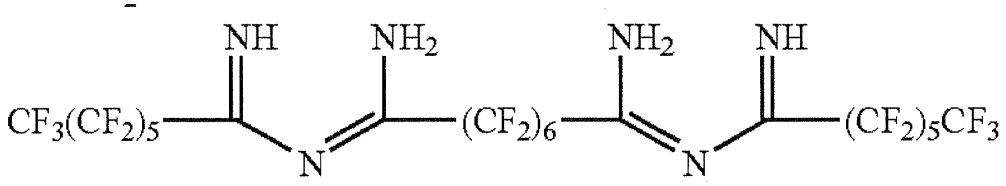
at least two curatives.

**[0017b]** In a second aspect of the present disclosure, there is provided a curable perfluoroelastomer composition comprising

a first curable perfluoropolymer comprising tetrafluoroethylene, a first perfluoroalkylvinyl ether and at least two cure site monomers, each having at least one nitrogen-containing cure site, wherein the tetrafluoroethylene is present in the first curable perfluoropolymer in an amount of about 50 mole percent to about 70 mole percent;

a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether and at least one second cure site monomer having at least one cure site, wherein the second curable perfluoropolymer comprises fluoroplastic particles therein; and

a first curative according to formula (XII)



(XII),

and a second curative selected from bisaminophenol, bisaminophenol AF, and combinations thereof, wherein the second curable fluoropolymer comprises fluoroplastic particles as a result of blending during latex polymerization, the fluoroplastic particles comprising a nitrogen-containing cure site monomer.

**[0017c]** In a third aspect of the present disclosure, there is provided a cured fluorine-containing elastomer formed by curing a curable fluorine-containing composition, comprising

a first curable perfluoropolymer comprising tetrafluoroethylene, a first perfluoroalkylvinyl ether and at least two cure site monomers, each having at least two cure sites;

a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether and at least one second cure site monomer having at least one cure site, wherein the second curable perfluoropolymer comprises fluoroplastic particles therein; and

at least two curatives.

**[0017d]** In a fourth aspect of the present disclosure, there is provided a molded article formed by heat curing and shaping a composition according to the third aspect.

**[0017e]** In a fifth aspect of the present disclosure, there is provided a molded article formed by heat curing and shaping a composition according to the first aspect.

**[0018]** Included in the ~~invention herein~~ present disclosure is a curable fluorine-containing elastomer composition comprising a first curable perfluoropolymer comprising tetrafluoroethylene, a first perfluoroalkylvinyl ether and at least one first cure site monomer having at least one cure site, wherein tetrafluoroethylene is present in the first curable perfluoropolymer in an amount of at least about 50 mole percent; a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether and at least one second cure site monomer having at least one cure site, wherein the second curable perfluoropolymer comprises fluoroplastic particles therein; and at least one curative. Preferably, the first curable perfluoropolymer comprises at least about 60 mole percent tetrafluoroethylene, more preferably at least about 70 mole percent tetrafluoroethylene. In addition, the first perfluoropolymer may comprise about 60 to about 95 mole percent tetrafluoroethylene.

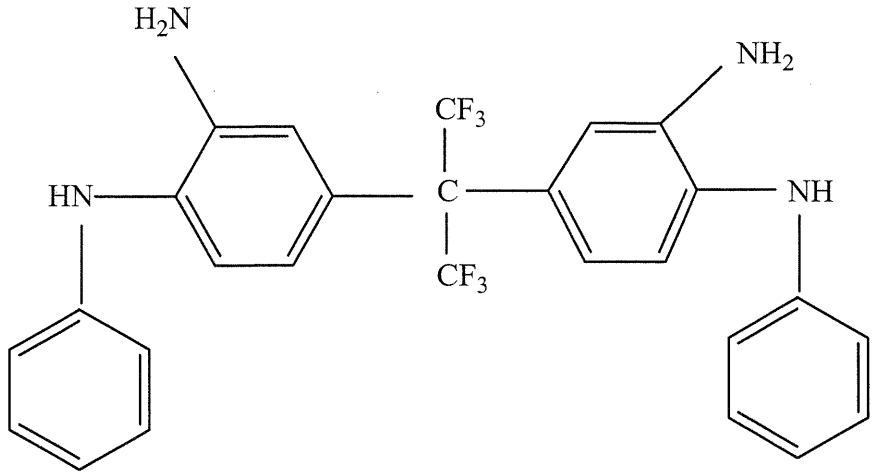
**[0019]** Such compositions are preferably blends having the first curable perfluoropolymer and the second curable perfluoropolymer in a ratio of about 25 to about 75 mole percent to about 75 to about 25 mole percent, preferably about 40 to about 60 mole percent to about 60 to about 40 mole percent, or about 70 to about 30 to about 30 to about 70, and most preferably about 50 to about 50.

**[0020]** Each of the at least one cure site monomers is preferably present in an amount of about 0.01 to about 10 mole percent respectively in each of the first curable perfluoropolymer and the second curable perfluoropolymer. The at least one curative is preferably present in an amount of about 0.01 to about 6 parts by weight per 100 parts by weight of the perfluoropolymers in the composition, and more preferably about 0.01 to about 2 parts by weight per 100 parts by weight of the perfluoropolymers in the composition.

**[0021]** The at least one cure site in the at least one cure site monomer in the first curable perfluoropolymer is preferably a nitrogen-containing cure site. The at least one cure site in the at least one cure site monomer in the first curable perfluoropolymer may be selected from the group consisting of cyano, carboxyl, carbonyl, alkoxycarbonyl, and combinations thereof. The cure site in the at least one cure site monomer in the second curable perfluoropolymer is preferably a nitrogen-containing cure site. The cure site in the at least

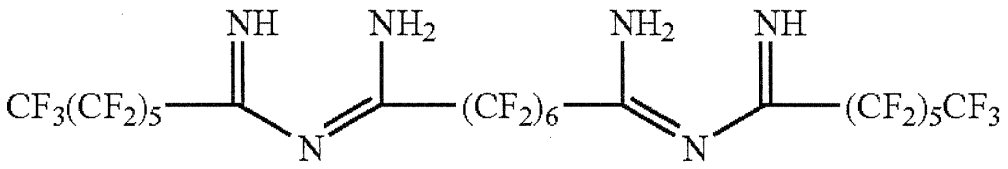
bisaminophenol, bisaminophenol AF, and combinations thereof.

**[0026]** In yet a further embodiment, in the composition herein as noted above, the elastomer composition is a perfluoroelastomer composition and the at least one curative comprises



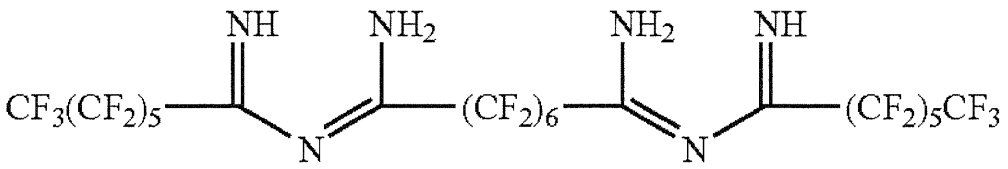
(XI).

**[0027]** In such an embodiment, the at least one curative may further comprise bisaminophenol or bisaminophenol AF. In addition or as an alternative thereto, the at least one curative may further comprise



(XII).

**[0028]** In another embodiment of the curable fluorine containing elastomer composition herein, the elastomer composition is a perfluoroelastomer composition and the at least one curative comprises



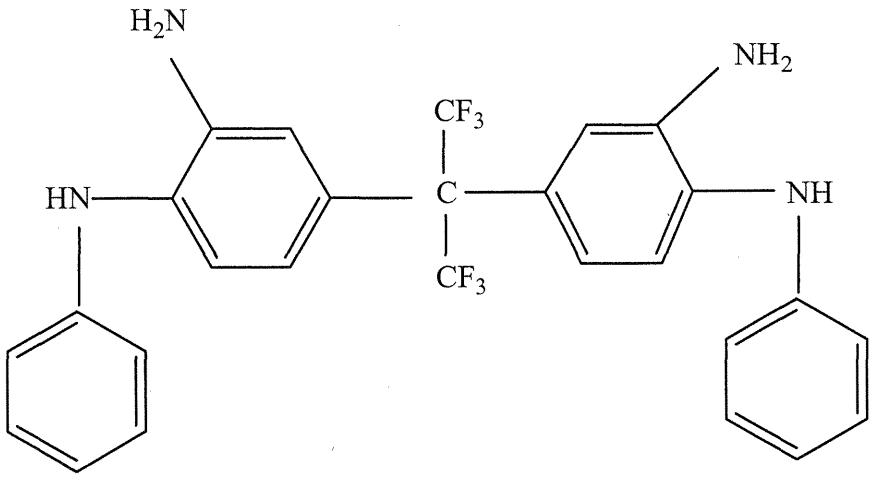
(XII).

**[0029]** It is further preferred that in one embodiment hereof, the cure site monomer in the first curable fluoropolymer and/or the second curable fluoropolymer is

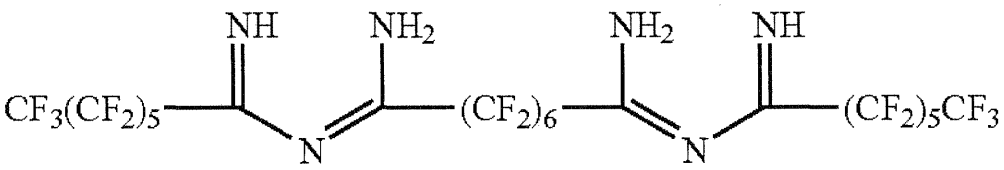
$CF_2$=CFO$(CF_2)_5$CN.

The ~~invention~~ present disclosure also includes a curable perfluoroelastomer composition comprising a first curable perfluoropolymer comprising tetrafluoroethylene, a first perfluoroalkylvinyl ether and at least one first cure site monomer having at least one cure site, wherein the

tetrafluoroethylene is present in the first curable perfluoropolymer in an amount of at least about 50 mole percent; a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether and at least one second cure site monomer having at least one cure site, wherein the second curable perfluoropolymer comprises fluoroplastic particles therein; and at least one curative the at least one curative is selected from the group consisting of: at least one curative the at least one curative is selected from the group consisting of:



(XI),



(XII),

bisaminophenol, bisaminophenol AF, and combinations thereof, wherein at least one of the cure site monomer in the first curable perfluoropolymer and the cure site monomer in the second curable perfluoropolymer is $CF_2=CFO(CF_2)_5CN$, and wherein the second curable fluoropolymer comprises fluoroplastic particles as a result of blending during latex polymerization, the fluoroplastic particles comprising a nitrogen-containing cure site monomer.

**[0030]** In this embodiment, tetrafluoroethylene is preferably present in the first curable perfluoropolymer in an amount of at least about 60 mole percent, and more preferably at least about 70 mole percent. The tetrafluoroethylene may also be present in the first curable perfluoropolymer in an amount of about 60 mole percent to about 95 mole percent.

**[0031]** The ~~invention~~ present disclosure also includes a cured fluorine-containing elastomer formed by curing a curable fluorine-containing composition comprising a blend of a first curable

perfluoropolymer comprising tetrafluoroethylene, a first perfluoroalkylvinyl ether and at least one first cure site monomer having at least one cure site, wherein tetrafluoroethylene is present in the first curable perfluoropolymer in an amount of at least about 50 mole percent; a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether and at least one second cure site monomer having at least one cure site, wherein the second curable perfluoropolymer comprises fluoroplastic particles therein; and at least one curative.

**[0032]** Molded articles are also within the scope of the ~~invention~~ present disclosure which are formed by heat curing and shaping a composition comprising a blend of a first curable perfluoropolymer comprising tetrafluoroethylene, a first perfluoroalkylvinyl ether and at least one first cure site monomer having at least one cure site, wherein tetrafluoroethylene is present in the first curable perfluoropolymer in an amount of at least about 50 mole percent; a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether and at least one second cure site monomer having at least one cure site, wherein the second curable perfluoropolymer comprises fluoroplastic particles therein; and at least one curative.

**[0033]** Preferred embodiments herein further includes a curable fluorine-containing elastomer composition comprising a first curable perfluoropolymer comprising tetrafluoroethylene, a first perfluoroalkylvinyl ether and at least two cure site monomers, each having at least two cure sites; a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether and at least one second cure site monomer having at least one cure site, wherein the second curable perfluoropolymer comprises fluoroplastic particles therein; and at least two curatives.

**[0034]** In this embodiment, tetrafluoroethylene may be present in the first curable perfluoropolymer in an amount of at least about 50 mole percent, and preferably about 50 to about 75 percent. The composition may comprise the first curable perfluoropolymer and the second curable perfluoropolymer in a ratio of about 25 to about 75 mole percent to about 75 to about 25 mole percent, preferably about 40 to about 60 mole percent to about 60 to about 40 mole percent; or about 30 to about 70 to about 70 to about 30; and most preferably in a ratio of about 50 to about 50.

**[0035]** The at least two cure site monomers of the first curable perfluoropolymer and the at least one second cure site monomer of the second curable perfluoropolymer, respectively are preferably present in an amount of about 0.01 to about 10 mole percent in each of the

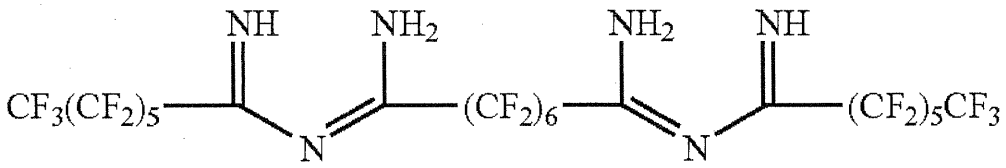
first curable perfluoropolymer and the second curable perfluoropolymer. The cure sites in the at least two cure site monomers in the first curable perfluoropolymer may preferably be nitrogen-containing cure sites. The first curable perfluoropolymer may comprise a first cure site monomer comprising a primary cyano cure site and a second cure site monomer comprising a secondary cyano cure site.

**[0036]** The at least one cure site in each of the at least two cure site monomers in the first curable perfluoropolymer may be selected from the group consisting of cyano, carboxyl, carbonyl, alkoxycarbonyl, and combinations thereof.

**[0037]** The at least two curatives in this embodiment of the ~~invention~~ present disclosure may be present in a total amount of about 0.01 to about 6 parts by weight per 100 parts by weight of the perfluoropolymers in the composition.

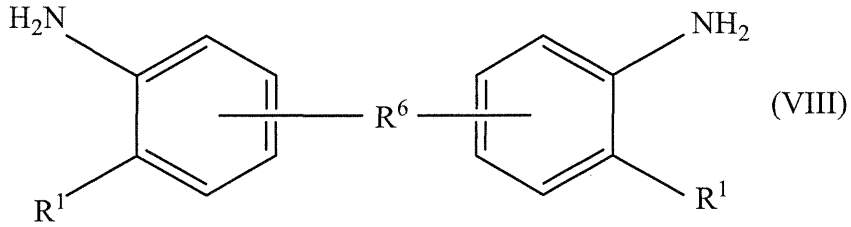
**[0038]** The composition may comprise a first curative in an amount of about 0.01 part to about 6 parts by weight per 100 parts by weight of the perfluoropolymers in the composition and a second curative in an amount of about 0.1 part to about 2 parts by weight of the perfluoropolymers in the composition.

**[0039]** The first curative in this embodiment is preferably



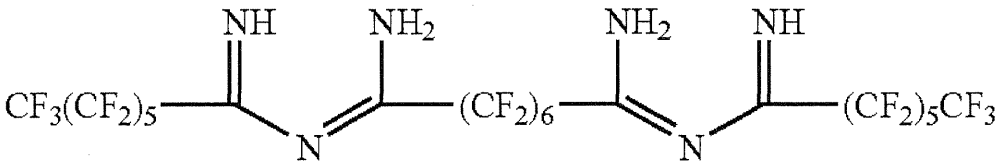
(XII)

and the second curative is preferably



(VIII)

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):

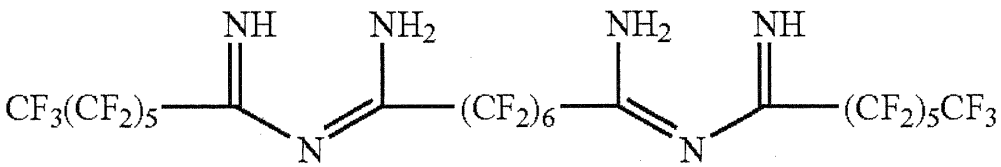


(XII),

bisaminophenol, bisaminophenol AF, and combinations thereof.

**[0045]** The cure site monomer in the second curable fluoropolymer may be $CF_2=CFO(CF_2)_5CN$.

**[0046]** In a further embodiment, the ~~invention~~ present disclosure includes a curable perfluoroelastomer composition comprising a first curable perfluoropolymer comprising tetrafluoroethylene, a first perfluoroalkylvinyl ether and at least two cure site monomers, each having at least one nitrogen-containing cure site, wherein the tetrafluoroethylene is present in the first curable perfluoropolymer in an amount of about 50 mole percent to about 70 mole percent; a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether and at least one second cure site monomer having at least one cure site, wherein the second curable perfluoropolymer comprises fluoroplastic particles therein; a first curative according to formula (XII)



(XII),

and a second curative selected from bisaminophenol, bisaminophenol AF, and combinations thereof, wherein the second curable fluoropolymer preferably comprises fluoroplastic particles as a result of blending during latex polymerization, the fluoroplastic particles comprising a nitrogen-containing cure site monomer.

**[0047]** In a further embodiment, the ~~invention~~ present disclosure includes a cured fluorine-containing elastomer formed by curing a curable fluorine-containing composition, comprising a first curable perfluoropolymer comprising tetrafluoroethylene, a first perfluoroalkylvinyl ether and at least two cure site monomers, each having at least two cure sites; a second curable perfluoropolymer comprising tetrafluoroethylene, a second perfluoroalkylvinyl ether and at least one second cure site monomer having at least one cure site, wherein the second curable perfluoropolymer comprises fluoroplastic particles therein; and at least two curatives.

**[0048]** The ~~invention~~ present disclosure further includes molded articles formed from the compositions of this embodiment.

## DETAILED DESCRIPTION OF THE INVENTION

**[0049]** Compositions are provided herein which have good plasma and chemical resistance and which can be made without additional filler loading, but which also provide required mechanical properties, excellent heat resistance and in some embodiments herein, good stiction (sticking force) properties. The combination of properties achieved can be obtained by selectively blending two or more curable perfluoropolymers in a composition with at least one curative as described herein. The resulting materials can be heat-cured and processed into molded articles. The curable fluorine-containing elastomer compositions herein have two or more such curable perfluoropolymers.

**[0050]** It is preferred herein that the two or more perfluoropolymers in the composition are used in and/or cured to form a perfluoroelastomeric blended composition, however, such polymers may be used in combination with other non-perfluorinated curable fluoropolymers forming a fluorinated elastomer having these components therein upon cure.

**[0051]** As used in this application, "perfluoroelastomer" or "cured perfluoroelastomer" unless otherwise indicated, includes any cured elastomeric material or composition that is formed by curing a curable perfluoropolymer(s) such as the curable perfluoropolymers in the curable perfluoroelastomeric compositions described herein.

**[0052]** A "curable perfluoropolymer" (sometimes referred to in the art as a "perfluoroelastomer" or more appropriately a "perfluoroelastomer gum") that may be used to form a cured perfluoroelastomer is a polymer that is substantially completely fluorinated, which is preferably completely perfluorinated on its polymeric backbone. It will be understood, based on this disclosure, that some residual hydrogen may be present in some perfluoroelastomers within the crosslinks of those materials due to use of hydrogen as part of a functional crosslinking group. Cured materials, such as perfluoroelastomers are cross-linked polymeric structures.

**[0053]** The curable perfluoropolymers that are used in the perfluoroelastomeric compositions to form cured perfluoroelastomers upon cure are formed by polymerizing one or more perfluorinated monomers, one of which is preferably a perfluorinated cure site monomer having a "cure site," which is a functional group to permit curing, wherein the functional group includes a reactive group that may not be perfluorinated. Two or more perfluoropolymers, and preferably at least one curative (curing agent), are combined herein