What is claimed is:

1. A composition comprising:

a polyfunctional epoxy comprising the reaction product of reactants comprising:

(a) a polyfunctional compound having at least three terminal groups reactive with a thiol group;

(b) a dithiol having the structure of Formula (4):

$$HS–R^1–SH \quad (4)$$

wherein $R^1$ is $–[–(CHR^3)_s–X–]_q–(CHR^3)_r–$;

wherein:

each $R^3$ is independently selected from hydrogen and methyl;

each X is independently selected from –O– and –S–;

s is an integer from 2 to 6;

q is an integer from 1 to 5; and

r is an integer from 2 to 10; and

(c) allyl glycidyl ether;

a difunctional epoxide;

a combination of thiol-terminated polythioethers characterized by an average functionality from 2.05 to 3; and

a low density filler.

2. The composition of claim 1, wherein the combination of thiol-terminated polythioethers comprises a thiol-terminated polythioether of Formula (6) and a thiol-terminated polythioether of Formula (6a):

$$HS–R^1–[–S–(CH_2)_p–O–(R^2–O)_m–(CH_2)_2–S–R^1–]_n–SH \quad (6)$$

$$\{HS–R^1–[–S–(CH_2)_p–O–(R^2–O)_m–(CH_2)_2–S–R^1–]_n–S–V'–\}_zB \quad (6a)$$

wherein:

each $R^1$ is independently selected from $C_{2-6}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-10}$ alkanecycloalkanediyl, $C_{5-8}$ heterocycloalkanediyl, and $-[(-CHR^3-)_s-X-]_q-(-CHR^3-)_r-$, wherein:

s is an integer from 2 to 6;

q is an integer from 1 to 5;

r is an integer from 2 to 10;

each $R^3$ is independently selected from hydrogen and methyl; and

each X is independently selected from O, S, and –NHR–, wherein R is selected from hydrogen and methyl;

each $R^2$ is independently selected from $C_{1-10}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-14}$ alkanecycloalkanediyl, and $-[(-CHR^3-)_s-X-]_q-(-CHR^3-)_r-$, wherein s, q, r, $R^3$, and X are as defined for $R^1$;

m is an integer from 0 to 50;

n is an integer from 1 to 60;

p is an integer from 2 to 6;

B represents a core of a z-valent, polyfunctional compound $B(-V)_z$ wherein:

z is an integer from 3 to 6; and

each –V is a moiety comprising a terminal group that is reactive with a thiol group; and

each –V'– represents a moiety formed by the reaction of each –V with a thiol group.

3. The composition of claim 1, wherein the combination of thiol-terminated polythioethers comprises the reaction product of reactants comprising:

(a) a dithiol of Formula (4):

$$HS-R^1-SH \qquad (4)$$

wherein:

$R^1$ is selected from $C_{2-6}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-10}$ alkanecycloalkanediyl, $C_{5-8}$ heterocycloalkanediyl, and $-[-(CHR^3)_s-X-]_q-(CHR^3)_r-$; wherein:

each $R^3$ is independently selected from hydrogen and methyl;

each X is independently selected from –O–, –S–, –NH–, and –NR– wherein R is selected from hydrogen and methyl;

s is an integer from 2 to 6;

q is an integer from 1 to 5; and

r is an integer from 2 to 10; and

(b) a divinyl ether of Formula (7):

$$CH_2=CH-O-[-R^2-O-]_m-CH=CH_2 \quad (7)$$

wherein:

each $R^2$ is independently selected from $C_{1-10}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-14}$ alkanecycloalkanediyl, and $-[(-CHR^3-)_s-X-]_q-(-CHR^3-)_r$, wherein s, q, r, $R^3$, and X are as defined for $R^1$;

m is an integer from 0 to 50;

n is an integer from 1 to 60; and

p is an integer from 2 to 6.

4. The composition of claim 3, wherein the reactants comprise (c) a polyfunctional compound $B(-V)_z$, wherein:

z is an integer from 3 to 6; and

each –V is a moiety comprising a terminal group that is reactive with a thiol group.

5. The composition of claim 1, formulated as a sealant.

6. An aperture sealed with the composition of claim 5.

7. A cured sealant, comprising the composition of claim 5.

8. The composition of claim 1, wherein,

the polyfunctional compound comprises triallyl cyanurate; and

the dithiol comprises 1,8-dimercapto-3,6-dioxaoctane.

9. The composition of claim 1, wherein the difunctional epoxide comprises bisphenol A diglycidyl ether.

10. The composition of claim 1, wherein,

the polyfunctional compound comprises triallyl cyanurate;

the dithiol comprises 1,8-dimercapto-3,6-dioxaoctane;

the difunctional epoxide comprises bisphenol A diglycidyl ether; and

the combination of thiol-terminated polythioethers comprises a thiol-terminated polythioether of Formula (6) and a thiol-terminated polythioether of Formula (6a):

$$HS–R^1–[–S–(CH_2)_p–O–(R^2–O)_m–(CH_2)_2–S–R^1–]_n–SH \quad (6)$$

$$\{HS–R^1–[–S–(CH_2)_p–O–(R^2–O)_m–(CH_2)_2–S–R^1–]_n–S–V'–\}_zB \quad (6a)$$

wherein:

each $R^1$ is independently selected from $C_{2-6}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-10}$ alkanecycloalkanediyl, $C_{5-8}$ heterocycloalkanediyl, and $–[(–CHR^3–)_s–X–]_q–(–CHR^3–)_r–$, wherein:

s is an integer from 2 to 6;

q is an integer from 1 to 5;

r is an integer from 2 to 10;

each $R^3$ is independently selected from hydrogen and methyl; and

each X is independently selected from O, S, and –NHR–, wherein R is selected from hydrogen and methyl;

each $R^2$ is independently selected from $C_{1-10}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-14}$ alkanecycloalkanediyl, and $-[(-CHR^3-)_s-X-]_q-(-CHR^3-)_r-$, wherein s, q, r, $R^3$, and X are as defined for $R^1$;

m is an integer from 0 to 50;

n is an integer from 1 to 60;

p is an integer from 2 to 6;

B represents a core of a z-valent, polyfunctional compound $B(-V)_z$ wherein:

z is an integer from 3 to 6; and

each –V is a moiety comprising a terminal group that is reactive with a thiol group; and

each –V'– represents a moiety formed by the reaction of each –V with a thiol group.

11. The composition of claim 1, wherein the compositions comprises:

from 0.2 wt% to 5 wt% of the polyfunctional epoxide;

from 2 wt% to 14 wt% of the difunctional epoxide; and

from 50 wt% to 90 wt% of the combination of thiol-terminated polythioether,

wherein wt% is based on the total dry weight of the composition.

12. A method of sealing an aperture comprising:

(a) applying the composition of claim 5 to one or more surfaces defining an aperture;

(b) assembling the surfaces defining the aperture; and

(c) curing the sealant to provide the sealed aperture.

What is claimed is:

1. A polyfunctional sulfur-containing epoxy comprising the reaction products of reactants comprising:

(a) a polyfunctional compound having at least three terminal groups reactive with a thiol group;

(b) a dithiol; and

(c) an epoxide comprising an epoxy group and a group that is reactive with a thiol group;

wherein the polyfunctional sulfur-containing epoxy has a molecular weight from 500 Daltons to 3,000 Daltons.

2. The polyfunctional sulfur-containing epoxy of claim 1, wherein the dithiol has the structure of Formula (4):

$$HS–R^1–SH \quad (4)$$

wherein $R^1$ is selected from $C_{2-6}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-10}$ alkanecycloalkanediyl, $C_{5-8}$ heterocycloalkanediyl, and $–[–(CHR^3)_s–X–]_q–(CHR^3)_r–$; wherein:

each $R^3$ is independently selected from hydrogen and methyl;

each X is independently selected from –O–, –S–, and –NR– wherein R is selected from hydrogen and methyl;

s is an integer from 2 to 6;

q is an integer from 1 to 5; and

r is an integer from 2 to 10.

3. The polyfunctional sulfur-containing epoxy of claim 1, wherein the group that is reactive with a thiol group is selected from an alkenyl group, an epoxy group, and a Michael acceptor group.

4. The polyfunctional sulfur-containing epoxy of claim 1, wherein the epoxide is an alkenyl ether epoxy.

5. The polyfunctional sulfur-containing epoxy of claim 1, wherein the polyfunctional compound comprises triallyl cyanurate, the dithiol comprises 1,8-dimercapto-3,6-doxaoctane, and the epoxide comprises allyl glycidyl ether.

6. A compound of Formula (1):

$$B(-V'-S-R^1-S-A')_z \quad (1)$$

wherein

each $R^1$ is independently selected from $C_{2-6}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-10}$ alkanecycloalkanediyl, $C_{5-8}$ heterocycloalkanediyl, and $-[-(CHR^3)_s-X-]_q-(CHR^3)_r-$; wherein:

each $R^3$ is independently selected from hydrogen and methyl;

each X is independently selected from –O–, –S–, and –NR– wherein R is selected from hydrogen and methyl;

s is an integer from 2 to 6;

q is an integer from 1 to 5; and

r is an integer from 2 to 10;

each –A' represents a moiety formed by the reaction of compound A with a thiol group, wherein compound A is an epoxide comprising an epoxy group and a group that is reactive with a thiol group;

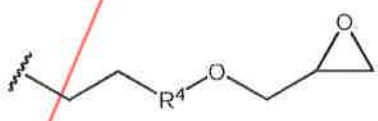
B represents a core of a z-valent, polyfunctional compound $B(-V)_z$, wherein:

z is an integer from 3 to 6; and

each –V is a moiety comprising a terminal group that is reactive with a thiol group; and

each –V'– represents a moiety formed by the reaction of each –V with a thiol group.

7. The compound of claim 6, wherein –A' has the structure of Formula (3a):




(3a)

wherein $R^4$ is $C_{1-6}$ alkanediyl.

8. The compound of claim 6, wherein –V'– is selected from $C_{1-6}$ alkanediyl and $C_{1-6}$ heteroalkanediyl.

9. The compound of claim 6, wherein the compound is 2,2'-[1,2-ethanediylbis(oxy)]bis-ethanethiol.

10. A composition comprising:

(a) a sulfur-containing polymer; and

(b) a curing agent comprising the polyfunctional sulfur-containing epoxy of claim 1.

11. The composition of claim 10, wherein the sulfur-containing polymer comprises one or more thiol-terminated polythioethers.

12. The composition of claim 11, wherein the one or more thiol-terminated polythioethers comprises a thiol-terminated polythioether selected from a difunctional thiol-terminated polythioether, a trifunctional thiol-terminated polythioether, and a combination thereof.

13. The composition of claim 11, wherein the at least one thiol-terminated polythioether as an average functionality from 2.05 to 3.

14. The composition of claim 11, wherein the one or more thiol-terminated polythioethers is selected from a thiol-terminated polythioether of Formula (6), a thiol-terminated polythioether of Formula (6a), and a combination thereof:

$$HS–R^1–[–S–(CH_2)_p–O–(R^2–O)_m–(CH_2)_2–S–R^1–]_n–SH \quad (6)$$

$$\{HS–R^1–[–S–(CH_2)_p–O–(R^2–O)_m–(CH_2)_2–S–R^1–]_n–S–V'–\}_zB \quad (6a)$$

wherein:

each $R^1$ is independently selected from $C_{2-6}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-10}$ alkanecycloalkanediyl, $C_{5-8}$ heterocycloalkanediyl, and $–[(–CHR^3–)_s–X–]_q–(–CHR^3–)_r–$, wherein:

s is an integer from 2 to 6;

q is an integer from 1 to 5;

r is an integer from 2 to 10;

each $R^3$ is independently selected from hydrogen and methyl; and

each X is independently selected from O, S, and –NHR–, wherein R is selected from hydrogen and methyl;

each $R^2$ is independently selected from $C_{1-10}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-14}$ alkanecycloalkanediyl, and $-[(-CHR^3-)_s-X-]_q-(-CHR^3-)_r-$, wherein s, q, r, $R^3$, and X are as defined for $R^1$;

m is an integer from 0 to 50;

n is an integer from 1 to 60;

p is an integer from 2 to 6;

B represents a core of a z-valent, polyfunctional compound $B(-V)_z$ wherein:

z is an integer from 3 to 6; and

each –V is a moiety comprising a terminal group that is reactive with a thiol group; and

each –V'– represents a moiety formed by the reaction of each –V with a thiol group.

15. The composition of claim 11, wherein the one or more thiol-terminated polythioethers comprises the reaction product of reactants comprising:

(a) a dithiol of Formula (4):

$$HS-R^1-SH \qquad (4)$$

wherein:

$R^1$ is selected from $C_{2-6}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-10}$ alkanecycloalkanediyl, $C_{5-8}$ heterocycloalkanediyl, and $-[-(CHR^3)_s-X-]_q-(CHR^3)_r-$; wherein:

each $R^3$ is independently selected from hydrogen and methyl;

each X is independently selected from –O–, –S–, –NH–, and –NR– wherein R is selected from hydrogen and methyl;

s is an integer from 2 to 6;

q is an integer from 1 to 5; and

r is an integer from 2 to 10; and

(b) a divinyl ether of Formula (7):

$$CH_2=CH-O-[-R^2-O-]_m-CH=CH_2 \quad (7)$$

wherein:

each $R^2$ is independently selected from $C_{1-10}$ alkanediyl, $C_{6-8}$ cycloalkanediyl, $C_{6-14}$ alkanecycloalkanediyl, and $-[(-CHR^3-)_s-X-]_q-(-CHR^3-)_r$, wherein s, q, r, $R^3$, and X are as defined for $R^1$;

m is an integer from 0 to 50;

n is an integer from 1 to 60; and

p is an integer from 2 to 6.

16. The composition of claim 15, wherein the reactants comprise (c) a polyfunctional compound $B(-V)_z$, wherein:

z is an integer from 3 to 6; and

each –V is a moiety comprising a terminal group that is reactive with a thiol group.

17. The composition of claim 10, wherein the curing agent comprises a difunctional epoxy.

18. The composition of claim 10, comprising a low density filler.

19. An aperture sealed with the composition of claim 10.

20. A method of sealing an aperture comprising:

(a) applying the composition of claim 10 to one or more surfaces defining an aperture;

(b) assembling the surfaces defining the aperture; and

(c) curing the sealant to provide the sealed aperture.