CLAIMS

What is claimed is:

1. A thermoset material containing β-hydroxyesters wherein said thermoset material is subject to a mechano-chemical mixing process delivering at least 1.9 x 10^5 W/l to regenerate an epoxide and a carboxylic acid functionality, wherein said thermoset material comprises a reaction product between an epoxidized triglyceride and a naturally occurring polyfunctional carboxylic acid.
2. The thermoset material according to claim 1 wherein said mechano-chemical process transforms the thermoset material into a millable gum.
3. The thermoset material according to claim 1 wherein said regenerated epoxide and carboxylic acid functionality is sufficient to affect a re-crosslinking of said thermoset material after said mechano-chemical process.
4. A composition comprising the thermoset material according to claim 1 and an epoxidized natural rubber, wherein said thermoset material acts as a curative for the epoxidized natural rubber.
5. The thermoset material according to claim 1 wherein said thermoset material constitutes over 20% by weight of an elastomeric content of a rubber compound.
6. The thermoset material according to claim 1 wherein an epoxidized natural rubber constitutes over 20% by weight of an elastomeric content of said thermoset material.
7. The thermoset material according to claim 1 wherein a power-per-unit-volume of said thermoset material required to regenerate said epoxide and carboxylic acid functionality is between 1.9 x 10^5 W/l and 6.67 x 10^5 W/l.
8. The thermoset material according to claim 1 wherein the thermoset material is further defined as being a thermoset resin.

9. A rubber compound comprising the thermoset material according to claim 1, wherein the thermoset material constitutes over 20% by weight of an elastomeric content ofthe rubber compound, wherein said thermoset material is mechano-chemically de-crosslinked during the mixing of the rubber compound.
10. The rubber compound according to claim 9 wherein said thermoset material consists of a reaction product between an epoxidized triglyceride and a naturally occurring polyfunctional carboxylic acid.
11. The rubber compound according to claim 10 wherein said epoxidized triglyceride is selected from a group consisting of epoxidized soybean oil, epoxidized linseed oil, epoxidized corn oil, epoxidized cottonseed oil, epoxidized canola oil, epoxidized rapeseed oil, epoxidized grape seed oil, epoxidized poppy seed oil, epoxidized tongue oil, epoxidized sunflower oil, epoxidized safflower oil, epoxidized wheat germ oil, epoxidized walnut oil, and epoxidized microbial-produced oil.
12. The rubber compound according to claim 9 wherein said naturally occurring polyfunctional carboxylic acid is selected from a group consisting of citric acid, tartaric acid, succinic acid, malic acid, maleic acid, and fumaric acid.
13. The rubber compound according to claim 9 wherein said mechano-chemical de-crosslinking regenerates an epoxide and a carboxylic acid functionality in the thermoset material.
14. The rubber compound according to claim 9 wherein an elastomeric content of the rubber compound consists of at least 20% by weight of an epoxidized natural rubber.
15. The rubber compound according to claim 9 wherein:
    a. the thermoset material is mechano-chemically de-crosslinked during a mixing of the rubber compound, and

b. the mechano-chemically de-crosslinked thermoset material constitutes at least 20% of a total elastomer content of the rubber compound.

16. A material comprising:
    a. an epoxidized natural rubber; and
    b. a thermoset material reaction product of an epoxidized triglyceride and a naturally occurring polyfunctional carboxylic acid wherein the thermoset material reaction product is subjected to a mechano-chemical de-crosslinking prior to incorporation into the epoxidized natural rubber, and wherein the epoxidized natural rubber is subsequently mixed with the thermoset material reaction product to form the material.
17. The material according to claim 16 wherein the thermoset material reaction product of an epoxidized triglyceride and a naturally occurring polyfunctional carboxylic acid contains ß-hydroxyesters as linkages between the epoxidized plant-sourced triglyceride and the naturally occurring polyfunctional carboxylic acid so that the epoxidized natural rubber is crosslinked via β-hydroxyesters.
18. The material according to claim 16 further comprising a filler selected from among various non-petrochemically derived sources that include: cork powder, ground rice hulls, activated carbon, activated charcoal, kaolin clay, metakaolin clay, precipitated silica, talc, mica, corn starch, mineral pigments, cotton, jute, hemp, ramie, sisal, coconut fiber, kapok fiber, silk, or wool.
19. A thermoset material containing β-hydroxyesters wherein said thermoset material is subject to a mechano-chemical mixing process to regenerate an epoxide and a carboxylic acid functionality such that said thermoset material may be uncured through a mechanical force applied to said thermoset material during said mechano-chemical mixing process and subsequently recured.

20. The thermoset material according to claim 19 wherein said thermoset material comprises a reaction product between an epoxidized triglyceride and a naturally occurring polyfunctional carboxylic acid.
21. The thermoset material according to claim 19 wherein said regenerated epoxide and carboxylic acid functionality is sufficient to affect a re-crosslinking of said thermoset material after said mechano-chemical process.
22. A composition comprising the thermoset material according to claim 19 and an epoxidized rubber, wherein said thermoset material acts as a curative for the epoxidized natural rubber.
23. The thermoset material according to claim 19 wherein a power-per-unit-volume of said thermoset material required to regenerate said epoxide and carboxylic acid functionality is at least 1.9×10^5 W/l.
24. A thermoset material containing β-hydroxyesters wherein said thermoset material is subject to a mechano-chemical mixing process and uncured by said mechano-chemical mixing process such that a recycled material produced thereby can be recured to a second thermoset material under a set of conditions substantially the same as those used to cure said thermoset material.
25. The thermoset material according to claim 24 wherein said thermoset material is further defined as being cured via a reaction between an epoxidized plant-sourced triglyceride and a carboxylic acid, and wherein said reaction is reversible to regenerate an epoxide and a carboxylic acid functionality.
26. The thermoset material according to claim 24 wherein said regenerated epoxide and carboxylic acid functionality is sufficient to affect a re-crosslinking of said thermoset material after said mechano-chemical process.

27. A composition comprising the thermoset material according to claim 24 and an epoxidized natural rubber, wherein said thermoset material acts as a curative for the epoxidized natural rubber.
28. The thermoset material according to claim 24 wherein a power-per-unit-volume of said thermoset material required to regenerate said epoxide and carboxylic acid functionality is at least 1.9×10^5 W/l.