CLAIMS

We claim:

1. A method of providing a modified polymeric composite flake for use in forming articles, comprising:

(a) providing a composite having at least one polymeric matrix material and long reinforcing fibers of a first fiber material extending through the polymeric matrix material; and

(b) forming from the composite at least one flake, wherein the at least one flake comprises an exterior surface having an exterior edge, a portion of the exterior edge being configured to provide at least one exterior edge feature to the exterior edge of the at least one flake thereby providing a modified polymeric composite flake.

2. The method according to claim 1, further comprising forming the at least one flake by cutting the composite to form the at least one flake.

3. The method according to claim 2, wherein the at least one flake is cut by a cutting device.

4. The method according to claim 1, wherein the composite is in a form selected from a tape, a plate, and a sheet.

5. The method according to claim 1, wherein the long reinforcing fibers within the composite are unidirectional.

6. The method according to claim 5, wherein the long reinforcing fibers within the composite are continuous long reinforcing fibers.

7. The method according to claim 1, wherein the composite is in the form of a tape and the long reinforcing fibers are unidirectional continuous long reinforcing fibers.

8. The method according to claim 1, wherein the at least one exterior edge feature has at least two angled sides.

9. The method according to claim 8, wherein the at least two angled sides of the exterior edge feature are angled towards each other at an angle of about 5° to about 120°.

10. The method according to claim 9, wherein the at least two angled sides of the exterior edge feature are angled towards each other at an angle of about 20° to about 90°.

11. The method according to claim 10, wherein the at least two angled sides of the exterior edge feature are angled towards each other at an angle of about 20° to about 60°.

12. The method according to claim 11, wherein the at least two angled sides of the exterior edge feature are angled towards each other an angle of about 30° to about 60°.

13. The method according to claim 12, wherein the at least two angled sides of the exterior edge feature are contiguous and together form a vertex of the angle at a point of contact between the at least two angled sides.

14. The method according to claim 8, wherein there are a plurality of exterior edge features.

15. The method according to claim 14, wherein the at least two angled sides of each exterior edge feature are contiguous and together form a vertex of an angle at a point of contact between the at least two angled sides, and wherein at least two of the exterior edge features in the plurality of exterior edge features are also contiguous so that the portion of the exterior edge having the at least one edge feature comprises a zig zag pattern.

16. The method according to claim 15, wherein the exterior edge of the at least one flake comprises at least three exterior edge portions, and at least two of the exterior edge portions comprise the zig zag pattern.

17. The method according to claim 15, wherein the long reinforcing fibers in the at least one flake are unidirectional and extend through the at least one flake in a first direction and the exterior edge portion comprising the zig zag pattern extends in a second direction that is at an angle with respect to the first direction.

18. The method according to claim 17, wherein the angle between the second direction and the first direction is about 90°.

19. The method according to claim 17, wherein the angle between the second direction and the first direction is about 60° to about 90°.

20. The method according to claim 1, wherein the at least one exterior edge feature is configured to have a shape selected from a triangle shape, a parabola shape, a parallelogram shape, a bell shape, a bullet shape, an arrowhead shape, and a trapezoid shape, and, wherein, when there are more than one exterior edge feature, each exterior edge feature may be the same or different.

21. The method according to claim 20, wherein the at least one exterior edge feature is a parallelogram, having a rectangular shape.

22. The method according to claim 20, wherein there are two or more exterior edge features on the portion of the exterior edge having the edge features and together the exterior edge features form a pattern.

23. The method according to claim 22, wherein the at least one flake has four exterior edge portions, two of which are opposing exterior edge portions, each of which two opposing exterior edge portions has the pattern formed thereon so that the pattern extends along substantially all of the two opposing exterior edge portions and so that a distance

measured across the at least one flake longitudinally between the two opposing edge portions remains substantially the same throughout the pattern.

24. The method according to claim 1, wherein the polymeric matrix material is a thermoplastic and is one or more of a polysulfone, a polysulfide, a polyimide, a polyamideimide, a polyamide, a polyarylene polymer, a fluoropolymer, and combinations and copolymers thereof.

25. The method according to claim 24, wherein the polymeric matrix material is a polyarylene polymer that is one or more of polyether ketones, polyetherether ketones, polyetherketone ketones, and combinations and copolymers thereof.

26. The method according to claim 24, wherein the polymeric matrix material is a fluoropolymer that is at least one of copolymers of tetrafluoroethylene and at least one perfluoroalkylvinyl ether; copolymers of tetrafluoroethylene and at least one other perfluorinated alkylene, polychlorotrifluoroethylene, ethyl chlorotrifluoroethylene, ethyltrifluoroethylene, polyvinylidene fluoride, polyvinyl fluoride, and combinations and copolymers thereof.

27. The method according to claim 1, wherein the polymeric matrix material is a thermoset polymer and is one or more of thermoset elastomers, epoxy resins, thermosetting biscitraconicimides, bismaleimides, bismaleimide/triazine/epoxy resins, cyanate esters, cyanate resins, furanic resins, phenolic resins, urea-formaldehyde resins, melamine-formaldehyde resins, phthalocyanine resins, polybenzoxazole resins, acetylene-terminated polyimide resins, silicones, polytriazines, thermosetting polyvinyl esters, thermosetting polyurethanes, polytetrafluoroethylene, melamines, polyalkyds, and xylene resins

28. The method according to claim 1, wherein the long reinforcing fibers in the at least one flake are one or more of inorganic fibers, ceramic fibers, glass fibers, graphite fibers, carbon fibers, thermoplastic fibers, thermosetting fibers, and combinations thereof.

29. The method according to claim 1, wherein the exterior edge of the at least one flake defines on the exterior surface of the at least one flake a surface area having an overall shape that is generally a triangle, a polygon having at least five sides, a circle, a parallelogram or a trapezoid, and the at least one exterior edge feature is formed on at least one edge portion of such surface area shape.

30. The method according to claim 29, wherein the surface area defined by the exterior edge is a parallelogram selected from a square, a rectangle and a rhombus.

31. The method according to claim 29, wherein, there are a plurality of flakes, each having the surface area defined on the exterior surface of the flake by the exterior edge of the flake and having a thickness measured along the exterior edge of each flake in a plane

orthogonal to the surface area of the flake, and wherein an average exterior surface area for the plurality of flakes is about 20 square millimeters to about 650 square millimeters and an average thickness of the plurality of flakes is about 0.05 mm to about 0.25 mm.

32. The method according to claim 31, wherein an average exterior surface area of the plurality of flakes is about 150 square millimeters to about 170 square millimeters, and the average thickness of the plurality of flakes is about 0.1 to about 0.20 mm.

33. The method according to claim 1, wherein, when an article is formed using a plurality of the modified polymeric composite flakes having the exterior edge features, and the article formed has an average tensile strength that is at least about 30% greater than a tensile strength of an article formed using a plurality of flakes formed of the same material, and having a same overall shape and size, but that lack the exterior edge features.

34. The method according to claim 33, wherein the average tensile strength of the article formed using the plurality of the modified polymeric composite flakes is at least about 40% to about 60% greater.

35. The method according to claim 1, wherein the at least one exterior edge feature has at least two angled sides, and wherein the at least two angled sides of each exterior edge feature on the at least one modified flake are contiguous and together form a vertex of an angle at a point of contact between the at least two angled sides, and wherein there are a plurality of the exterior edge features on the at least one modified polymeric composite flake and at least two of the angled features in the plurality of exterior edge features are also contiguous so that a portion of the exterior edge of the at least one modified polymeric composite flake comprises a zig zag pattern.

36. The method according to claim 35, wherein there are about two to about twelve of the exterior edge features in the zig zag pattern on the at least one modified polymeric composite flake.

37. The method according to claim 36, wherein there are about four to about eight of the exterior edge features in the zig zag pattern.

38. The method according to claim 36, wherein the at least one modified polymeric composite flake comprises at least three exterior edge portions, at least two of which have the zig zag pattern.

39. The method according to claim 38, wherein there are about four to about eight of the exterior edge features in the zig zag pattern.

40. An article formed by heat molding or curing a plurality of the modified polymeric composite flakes formed by the method of claim 1.

41. The article according to claim 40, wherein the article is a component, apparatus or part for use in high temperature and/or high pressure end applications or for use in aircraft, medical device, robotics, automotive, semiconductor, or sports end applications.

42. The article according to claim 41, wherein the article is a bracket, a cover, a fairing or a cabin sidewall attachments for use in an aircraft.

43. The article according to claim 40, wherein the article is a containment shell.

44. The article according to claim 40, wherein the article is formed by molding or curing the plurality of the modified polymeric composite flakes together with unmodified polymeric composite flakes that may be the same or different than the at least one modified polymeric composite flake formed by the method of claim 1.

45. The article according to claim 44, wherein the unmodified polymeric composite flakes incorporate the same polymeric matrix material and the same long reinforcing fibers as those of the at least one modified polymeric composite flake formed by in the method of claim 1.

46. A method of increasing one of more of an average tensile strength and an impact resistance of articles formed from composite flakes having at least one polymeric matrix material and long reinforcing fibers extending through the polymeric matrix material, and wherein the composite flakes comprise an exterior surface having at least one exterior edge, the method comprising:

providing a plurality of modified polymeric composite flakes, wherein each of the modified polymeric composite flakes has an exterior edge feature along a portion of an exterior edge of the flake; and

forming the articles using a plurality of the modified polymeric composite flakes.

47. The method according to claim 46, wherein the impact resistance of articles formed using the modified polymeric composite flakes is high velocity impact resistance.