

WHAT IS CLAIMED IS:

1. A strain tolerant particle comprising:  
a composite structure including:  
an energy storage structure comprising at least one element, wherein the energy storage structure is configured to store ions; and  
a reinforcing structure comprising one or more elements that phase separate from the energy storage phase via a eutectic or eutectoid reaction, wherein the reinforcing structure provides mechanical support to the energy storage structure.
2. The strain tolerant particle of Claim 1, wherein the energy storage structure comprises silicon and/or tin.
3. The strain tolerant particle of Claim 1, wherein the reinforcing structure comprises nickel, copper, iron, aluminum, magnesium, manganese, cobalt, molybdenum, zirconium, vanadium, titanium, chromium, bismuth, antimony, germanium, boron, phosphorus, carbon, sulfur, nitrogen, and/or oxygen.
4. The strain tolerant particle of Claim 1, wherein the energy storage structure comprises silicon and the reinforcing structure comprises an intermetallic compound including nickel and silicon.
5. The strain tolerant particle of Claim 4, wherein the intermetallic compound comprises  $\text{NiSi}_2$  and  $\text{NiSi}$ .
6. The strain tolerant particle of Claim 4, wherein the reinforcing structure comprises a higher nickel content than the nickel content of the energy storage structure.
7. The strain tolerant particle of Claim 4, wherein the composite structure comprises a silicon mole fraction greater than or equal to about 0.56.
8. The strain tolerant particle of Claim 4, wherein the composite structure comprises a silicon mole fraction greater than or equal to about 0.7.
9. The strain tolerant particle of Claim 1, wherein the energy storage structure comprises silicon and the reinforcing structure comprises an intermetallic compound including copper and silicon.
10. The strain tolerant particle of Claim 9, wherein the intermetallic compound comprises  $\text{Cu}_{19}\text{Si}_6$ .

11. The strain tolerant particle of Claim 9, wherein the reinforcing structure comprises a higher copper content than the copper content of the energy storage structure.

12. The strain tolerant particle of Claim 1, wherein the composite structure comprises a plurality of energy storage structures and a plurality of reinforcing structures that bind the plurality of energy storage structures.

13. The strain tolerant particle of Claim 9, wherein the composite structure comprises a silicon mole fraction greater than or equal to about 0.24.

14. The strain tolerant particle of Claim 9, wherein the composite structure comprises a silicon mole fraction greater than or equal to about 0.32.

15. A method of manufacturing a strain tolerant particle comprising:

preparing a feedstock comprising finely divided droplets or particles with a certain ratio of constituent elements that phase separate into two or more phases by eutectic or eutectoid reaction;

introducing the feedstock into a plasma or plasma exhaust of a microwave plasma torch to melt the feedstock; and

cooling the feedstock in a rapid but controlled manner so as to trigger a eutectic or eutectoid transition resulting in one or more phase separations which create a composite structure comprising an energy storage structure and a reinforcing structure that provides mechanical support to the energy storage structure.

16. The method of manufacturing of Claim 15, wherein the feedstock comprises silicon and at least one of copper, nickel, or iron.

17. The method of manufacturing of Claim 16, wherein the feedstock comprises copper and comprises a silicon mole fraction greater than or equal to about 0.24.

18. The method of manufacturing of Claim 16, wherein the feedstock comprises copper and comprises a silicon mole fraction greater than or equal to about 0.32.

19. The method of manufacturing of Claim 16, wherein the feedstock comprises nickel and comprises a silicon mole fraction greater than or equal to about 0.56.

20. The method of manufacturing of Claim 16, wherein the feedstock comprises nickel and comprises a silicon mole fraction greater than or equal to about 0.7.

21. An anode of a lithium ion battery comprising:

a plurality of strain tolerant particles comprising an in-situ formed composite structure comprising a plurality of energy storage structures and reinforcing structures;

wherein the energy storage structure comprises substantially silicon; and

wherein the reinforcing structure comprises an element or elements that phase separate into two or more phases with silicon by eutectic or eutectoid reaction.

22. The anode of a lithium ion battery of Claim 21, wherein the element comprises at least one of nickel, copper, or iron.

23. A strain tolerant particle comprising:

a composite structure including:

an energy storage phase comprising at least one element, wherein the energy storage phase is configured to store ions; and

a reinforcing phase comprising one or more elements;

wherein upon cooling the composite structure from a melt, a eutectic or eutectoid transition occurs resulting in phase separation of the composite structure into two or more distinct phases, at least one phase of which is the energy storage phase, and at least one phase of which is the reinforcing phase, resulting in an in-situ grown composite microstructure at a particle level, wherein the reinforcing phase provides mechanical support to the energy storage phase.