Claims

1. A battery comprising:

a cathode; and

an anode comprising a silicon active material having a first porosity and lithiated with a printable lithium composition comprised of a lithium metal powder, a polymer binder compatible with the lithium metal powder, a carbon-based rheology modifier compatible with the lithium metal powder, and a non-polar solvent compatible with the lithium metal powder and with the polymer binder;

wherein on electrolyte addition, a surface of the silicon active material is alloyed with lithium particles diffused from the printable lithium composition to form an anode having a porous structure wherein the silicon active material has a second porosity of the silicon active material increased from the first porosity by between 5% to 15% and forms a three-dimensional porous framework within the anode and provides an improved rate capability between 20% to 50% at a 2C charge rate as compared to a non-lithiated silicon anode.

2. The battery of Claim 1, wherein the second porosity of the anode active materials is between 25% and 60%.

3. The battery of Claim 1, wherein the anode has a first cycle efficiency greater than 90%.

4. The battery of Claim 1, wherein the lithium metal powder is a non-pyrophoric stabilized lithium metal powder, SLMP®.

5. The battery of Claim 1, wherein the rheology modifier is selected from the group consisting of carbonaceous materials, silicon-containing materials, tin-containing materials, Group IIA oxides, Group IIIA oxides, Group IVB oxides, Group VB oxides and Group VIA oxides.

6. The battery of Claim 5, wherein the carbonaceous material is selected from the group consisting of carbon black, carbon nanotubes, graphite, hard carbon, and graphene.

7. The battery of Claim 5, wherein the silicon-containing material is selected from the group consisting of silicon nanotubes and fumed silica.

8. The battery of Claim 1, wherein the polymer binder has a molecular weight of 1,000 to 8,000,000 and is selected from the group consisting of unsaturated elastomers, saturated elastomers, thermoplastics, polyacrylic acid, polyvinylidene chloride, polyvinyl acetate, poly(ethylene oxide), polystyrene, polyisobutylene, natural rubbers, butadiene rubbers, styrene-butadiene rubber, polyisoprene rubbers, butyl rubbers, hydrogenated nitrile butadiene rubbers, epichlorohydrin rubbers, acrylate rubbers, silicon rubbers, nitrile rubbers, polyacrylic acid, polyvinylidene chloride, polyvinyl acetate, ethylene propylene diene termonomer, ethylene vinyl acetate copolymer, ethylene-propylene copolymers, ethylene-propylene terpolymers, polybutenes, and wax.

9. The battery of Claim 1, wherein the solvent is selected from the group consisting of alkanes, toluene, ethylbenzene, cumene, xylene, sulfones, mineral oil, glymes, and isoparaffinic synthetic hydrocarbon solvents.

10. The battery of Claim 9 further including an artificial solid electrolyte interface layer on a surface of the anode.

11. The battery of Claim 10, wherein the artificial solid electrolyte interface is formed from the polymer binder and a lithium ion conducting additive.

12. The battery of Claim 11, wherein the lithium ion conducting additive comprises one or more solid electrolyte salts selected from the group comprising sulfides, oxides, phosphates, and argyrodite-type electrolytes.

13. The battery of Claim 1, wherein the anode active material is selected from the group consisting of graphite-SiOx composite, SiOx, SiO, SiO_2, SiC, Si, Si/C composite, Si-based alloys, graphite-SnO, and Sn/C composite.