1. A method of making a ~~metal-coated porous~~ silicon anode for a rechargeable lithium ion battery, comprising:

(a) providing a silicon substrate;

(b) etching silicon in an electrochemical cell under current to produce porous silicon having pores from 10 nm to 10 μm in diameter with an pore depth of 5-100 μm~~,~~; ~~and~~

(c) coating said porous silicon with at least 1 nm of a passivating material~~,~~; and

(d) crushing and binding the coated porous silicon with a matrix material to form an anode, wherein said ~~coated porous silicon~~ anode has a charge capacity of at least 1000 mAh/g for at least 50 cycles.

2. The method of claim 1, wherein said etching uses a high density plasma gas or an acid.

3. The method of claim 1, wherein said silicon is crystalline silicon, semicrystalline silicon, amorphous silicon, doped silicon, coated silicon, silicon precoated with silicon nanoparticles, or combinations thereof.

4. The method of claim 1, wherein said acid comprises hydrofluoric acid (HF) in dimethylformamide (DMF).

5. The method of claim 1, wherein said ~~coating~~ passivating material is carbon or gold.

6. The method of claim 1, wherein said ~~coating~~ passivating material is about 20 nm of gold.

7. The method of claim 2, wherein the porosity can be increased by decreasing the concentration of acid and/or increasing the current.

8. The method of claim 1, wherein the ~~coated porous~~ silicon anode has a pore depth of 5-10 μm and a charge capacity of at least 2000 mAh/g for at least 60 cycles.

9. The method of claim 1, wherein the ~~coated porous~~ silicon anode has a pore width of about 2 μm and a lifespan of at least 200 cycles.

10. The method of claim 1, wherein the silicon is pretreated with silicon nanoparticles, and the ~~coated porous~~ silicon anode has an pore width of about less than 1 μm, a depth of 5-10 μm and a lifespan of at least 150 cycles.

11. The method of claim 3, wherein the current ranges from 1-20 mA, the HF:DMF ratio ranges from 1:5 to 1:35 and the current is applied for 30-300 minutes.

12. The method of claim 3, wherein the current is 8 mA, the HF:DMF:water ratio is 1:10:1, the current is applied for 240 minutes, and the pore depth is at least 6 microns and pore diameter is at least 2 microns.

13. The method of claim 3, wherein the current is 8 mA, the HF: DMF ratio is 2:25, and the current is applied in intervals of about 30 minutes for about 120 minutes, and the pore depth is at least 5 microns.

14. The method of claim 1, comprising:

(a) etching crystalline silicon in HF:DMF in a ratio of 1:5-1:35 in an electrochemical cell at 3-10 mA, under constant or intermittent current for 30-300 minutes, to produce porous silicon having pores from 10 nm to 10 μm in diameter with a pore depth of 5-250 μm,

(b) coating said porous silicon with 5-50 nm gold, wherein said coated porous silicon has a charge capacity of at least 3000 mAh/g for at least 60 cycles.

15. An anode for a rechargeable lithium ion battery comprising

porous silicon having pores from 10 nm to 10 μm in diameter with an pore depth of 5-100 μm, wherein the porous silicon is coated with at least 1 nm of a passivating material and wherein the coated porous silicon is ~~the coated porous silicon anode of claim 1, that is crushed, bound with a matrix material and shaped to form an anode; or is~~ used as is or is lifted off bulk silicon and used on an optional substrate with an optional transition layer that is optionally doped.

16. A rechargeable battery comprising the anode of claim 1.

17. A rechargeable battery comprising the anode of claim 14.

18. A rechargeable battery comprising the anode of claim 15 overlayed on top of an optional substrate, an optional transition layer between said coated porous silicon and said substrate, a separator and a cathode material.

19. The rechargeable battery of claim 18, wherein said substrate is selected from the group consisting of copper, bulk silicon, carbon, silicon carbide, carbon, graphite, carbon fibers, graphene sheets, fullerenes, carbon nanotubes, and graphene platelets and combinations thereof.

20. A rechargeable battery comprising the anode of claim 1 , a separator and a cathode material, wherein said battery can be packaged in a coil-cell, pouch cell, cylindrical cell, or a prismatic cell configuration.