Claims

1. An anode comprising a three dimensional ~~heteroatom~~boron-doped carbon nanotube foam, wherein an active material is embedded into the pores of the foam, wherein up to 99% of a pore volume of the foam is incorporated with the active material.

2. The anode of Claim 1, wherein the anode is formed on or adhered to a metal foil.

3. The anode of Claim 2, wherein the metal foil is a copper foil or an aluminum foil.

~~4. The anode of Claim 1, wherein 10% to 90% of a pore volume of the foam is incorporated with the active material.~~

~~5~~4. The anode of Claim 1, wherein the active material is selected from the group consisting of lithium metal, a material that reversibly intercalates/deintercalates lithium ions, a lithium metal alloy, a material capable of doping and dedoping lithium, or a transition metal oxide.

~~6~~5. The anode of Claim 1, wherein the active material is lithium metal or an alloy comprising lithium.

~~7. The anode of Claim 1, wherein the anode is formed on or adhered to a metal foil.~~

~~8. The anode of Claim 7, wherein the metal foil is a copper foil or an aluminum foil.~~

~~9. The anode of Claim 7, wherein the active material is selected from the group consisting of lithium metal, a material that reversibly intercalates/deintercalates lithium ions, a lithium metal alloy, a material capable of doping and dedoping lithium, or a transition metal oxide.~~

~~10~~6. The anode of Claim 1, wherein the three dimensional ~~heteroatom~~boron-doped carbon nanotube foam is formed using a CVD process, wherein the foam is formed on a metal foil.

~~11~~7. A cathode comprising a three dimensional ~~heteroatom~~boron-doped carbon nanotube foam, wherein an active material is embedded into the pores of the foam, wherein up to 99% of a pore volume of the foam is incorporated with the active material.

~~12~~8. The cathode of Claim ~~11~~7, wherein the cathode~~anode~~ is formed on or adhered to a metal foil.

~~13~~9. The cathode of Claim ~~12~~8, wherein the metal foil is a copper foil or an aluminum foil.

~~14. The cathode of Claim 11, wherein 10% to 90% of a pore volume of the foam is incorporated with the active material.~~

~~15~~10. The cathode of Claim ~~11~~7, wherein the active material is selected from the group consisting of lithium oxide, lithium sulfide, $LiPF_6$, $LiClO_4$, $LiAsF_6$, $LiBF_4$, $LiSbF_6$, $LiAlO_4$, $LiAlCl_4$, $LiCF_3SO_3$, $LiC_4F_9SO_3$, $LiN(C_2F_5SO_3)$ 2, $LiN(C_2F_5SO_2)_2$, $LiN(CF_3SO_2)_2$, LiCl, LiI, $LiB(C_2O_4)_2$, $LiCoO_2$, $LiMn_2O_4$, $LiFePO_4$, $Li_{1-x}Fe_xPO_4$ ($0\leq x\leq 1$), $Li[Mn_{2-x}M_x]O_4$ (M=Co, Ni, Cr, Al, Mg, $0\leq x\leq 0.1$), $Li_aCoM_aO_2$, $Li_{1-b}CoM'_yO_2$ (M and M' represent W, Mo, Zr, Ti, Mg, Ta, Al, Fe, V, Cr, and/or Nb; $1\leq a\leq 1.2$, $0<b\leq 0.05$, $0\leq x\leq 0.02$ and $0\leq y\leq 0.02$), $LiNiO_2$, $LiNiMnCoO_2$, Li_2FePO_4F, $LiCo_{0.33}Ni_{0.33}Mn_{0.33}O_2$, $Li(Li_aNi_xMn_yCo_z)O_2$ (also known as NMC), $LiNiCoAlO_2$, $Li_4Ti_5O_{12}$, $Li_3V_2(PO_4)_3$, and combinations thereof.

~~16~~11. The cathode of Claim ~~11~~7, wherein the active material is lithium oxide or lithium sulfide.

~~17. The cathode of Claim 11, wherein the anode is formed on or adhered to a metal foil.~~

~~18. The cathode of Claim 17, wherein the metal foil is a copper foil or an aluminum foil.~~

~~19. The cathode of Claim 17, wherein the active material is selected from the group consisting of lithium oxide, lithium sulfide, $LiPF_6$, $LiClO_4$, $LiAsF_6$, $LiBF_4$, $LiSbF_6$, $LiAlO_4$, $LiAlCl_4$, $LiCF_3SO_3$, $LiC_4F_9SO_3$, $LiN(C_2F_5SO_3)$ 2, $LiN(C_2F_5SO_2)_2$, $LiN(CF_3SO_2)_2$, LiCl, LiI, $LiB(C_2O_4)_2$, $LiCoO_2$, $LiMn_2O_4$, $LiFePO_4$, $Li_{1-x}Fe_xPO_4$ ($0\leq x\leq 1$), $Li[Mn_{2-x}M_x]O_4$ (M=Co, Ni, Cr, Al, Mg, $0\leq x\leq 0.1$), $Li_aCoM_aO_2$, $Li_{1-b}CoM'_yO_2$ (M and M' represent W, Mo, Zr, Ti, Mg, Ta, Al, Fe, V, Cr, and/or Nb; $1\leq a\leq 1.2$, $0<b\leq 0.05$, $0\leq x\leq 0.02$ and $0\leq y\leq 0.02$), $LiNiO_2$, $LiNiMnCoO_2$, Li_2FePO_4F, $LiCo_{0.33}Ni_{0.33}Mn_{0.33}O_2$, $Li(Li_aNi_xMn_yCo_z)O_2$ (also known as NMC), $LiNiCoAlO_2$, $Li_4Ti_5O_{12}$, $Li_3V_2(PO_4)_3$, and combinations thereof.~~

~~20~~12. The cathode of Claim ~~11~~7, wherein the three dimensional ~~heteroatom~~boron-doped carbon nanotube foam is formed using a CVD process, wherein the foam is formed on a metal foil.

~~21. The anode of any of Claims 1-10, or the cathode of any of Claims 11-20, wherein the heteroatom is boron.~~

~~22~~13. A battery comprising an anode of any of Claims ~~1-10 and 21~~1-6.

~~23~~14. A battery comprising a cathode of any of Claims ~~11-21~~7-12.

~~24~~15. A capacitor or supercapacitor comprising an anode of any of Claims ~~1-10 and 21~~1-6.

~~25~~16. A capacitor or supercapacitor comprising a cathode of any of Claims ~~11-21~~7-12.