Claims

1. An anode comprising a three dimensional heteroatom-doped carbon nanotube foam, wherein an active material is embedded into the pores of the foam.

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

11. A cathode comprising a three dimensional heteroatom-doped carbon nanotube foam, wherein an active material is embedded into the pores of the foam.

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

13. The cathode of Claim 12, 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. The cathode of Claim 11, 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. The cathode of Claim 11, 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. The cathode of Claim 11, wherein the three dimensional heteroatom-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. A battery comprising an anode of any of Claims 1-10 and 21.

23. A battery comprising a cathode of any of Claims 11-21.

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

25. A capacitor or supercapacitor comprising a cathode of any of Claims 11-21.