Claims

1. An electrolyte comprising:

a) a sodium salt;

b) an additive comprising at least one additional metallic/metalloid cation having a standard reduction potential which is at least 2.5V more positive than that of sodium cation, wherein the metallic / metalloid cation comprises an element selected from the group consisting of silver, gold, and copper;

wherein said sodium salt and said additive are dispersed in a solvent comprising at least one alkyl carbonate, and

wherein the concentration of said metallic/metalloid cation in the electrolyte is 15 mM to 250 mM.

~~2. The electrolyte of claim 1, wherein the metallic / metalloid element of said metallic / metalloid cation is selected from Groups 11, 14 or 15 of the Periodic Table of Elements.~~

~~3. The electrolyte of claim 2, wherein said metallic / metalloid element is selected from the group consisting of silver, gold, and copper.~~

4. The electrolyte of claim ~~3~~1, wherein said metallic / metalloid cation is a silver cation.

5. The electrolyte of claim ~~3~~ 1 or ~~4~~2, wherein the concentration of said metallic / metalloid cation in the electrolyte is 50 to 250 mM.

6. The electrolyte of claim ~~5~~3, wherein the concentration of said metallic / metalloid cation in the electrolyte is 100 mM.

~~7. The electrolyte of claim 2, wherein said metallic /metalloid cation comprises a metal / metalloid element selected from the group consisting of tin, antimony, and bismuth.~~

~~8. The electrolyte of claim 7, wherein said metallic / metalloid cation is a tin cation.~~

~~9. The electrolyte of claim 7 or 8, wherein the concentration of said metallic / metalloid cation in the electrolyte is 15 to 50 mM.~~

~~10. The electrolyte of claim 9, wherein the concentration of said metallic / metalloid cation in the electrolyte is 20 mM.~~

~~11~~5. The electrolyte of any one of the preceding claims, wherein the additive comprises at least one halogen-containing anion.

~~12~~6. The electrolyte of claim ~~11~~5, wherein the halogen containing anion is a monoatomic halogen anion selected from group consisting of F^-, Cl^-, and Br^-.

~~13~~7. The electrolyte of claim ~~11~~5, wherein the halogen-containing anion is a polyatomic anion selected from group consisting of BF_4^-, $B(C_6F_5)_4^-$, PF_6^-, ClO_4^- and $CF_3SO_3^-$.

~~14~~8. The electrolyte of claim ~~11~~5, wherein the halogen-containing anion is BF_4^- or Cl.

~~15~~9. The electrolyte of any one of the preceding claims, wherein the alkyl carbonate is a cyclic alkyl carbonate, a non-cyclic alkyl carbonate, or a combination thereof.

~~16~~10. The electrolyte of claim ~~15~~9, wherein the cyclic alkyl carbonate is selected from the group consisting of fluoroethylene carbonate, ethylene carbonate, propylene carbonate, trimethylene carbonate, vinylene carbonate, and combinations thereof.

~~17~~11. The electrolyte of claim ~~15~~9, wherein the non-cyclic alkyl carbonate is selected from the group consisting of dimethyl carbonate, ethyl methyl carbonate, diethyl carbonate, dibenzyl carbonate, diallyl carbonate, diphenyl carbonate, dipropyl carbonate, and combinations thereof.

~~18~~12. The electrolyte of claim ~~15~~9, wherein the alkyl carbonate is fluoroethylene carbonate, ethylene carbonate, dimethyl carbonate, or a combination thereof.

~~19~~13. The electrolyte of any of the preceding claims, wherein the concentration of the carbonate in the electrolyte is 0.2 mM to 1.5 mM.

~~20~~14. The electrolyte of any of the preceding claims, wherein the sodium salt is selected from the group consisting of sodium perchlorate ($NaClO_4$), sodium trifluoromethanesulfonate (NaOTf), sodium bis(fluorosulfonyl)imide (NaFSI) and sodium trifluoromethanesulfonimide (NaTFSI).

~~21~~15. The electrolyte of claim ~~20~~14, wherein the sodium salt is sodium trifluoromethanesulfonimide (NaTFSI).

~~22~~16. The electrolyte of any one of the preceding claims, wherein the concentration of the sodium salt in the electrolyte is 0.1 M to 5 M.

~~23~~17. The electrolyte of any one of the preceding claims, wherein the electrolyte is substantially free of water.

~~24~~18. A sodium-sulfur cell comprising:

a. a sodium anode;

b. a microporous sulfur cathode, and

c. the electrolyte of any one of the preceding claims.

~~25~~19. The sodium-sulfur cell of claim ~~24~~18, wherein the sodium anode comprises a sodium alloy interphase, said sodium alloy being formed between a reduced metal / metalloid of the electrolyte and the sodium anode.

~~26~~20. A method of improving cycling life of a sodium-sulfur cell, wherein the sodium-sulfur cell comprising a sodium anode, a sulfur cathode, and an electrolyte containing a sodium salt dispersed in an alkyl carbonate solvent, the method comprising the step of:

introducing one or more additives into said electrolyte, each additive independently capable of forming a sodium alloy interphase on a surface on the sodium anode; and

wherein the one or more additives independently comprise a ~~one~~ metal or metalloid cation having a standard reduction potential which is at least 2.5V more positive than that of sodium cation, wherein the metal or metalloid cation comprises an element selected from the group consisting of silver, gold, and copper.