

7

2. The metal-air battery of claim 1, wherein at least a portion of the air electrode comprises fluorinated graphene nanosheets (CF_x , where $0.5 < x < 1.5$).

3. The metal-air battery of claim 1, wherein the air electrode further comprises a catalyst deposited on surfaces of the electrode, the catalyst comprising a transition metal or transition metal oxide.

4. The metal-air battery of claim 1, wherein the channels have average diameters between 0.1 and 10 μm .

5. The metal-air battery of claim 1, further comprising an electrolyte comprising ethers, glymes, or combinations thereof, wherein the electrolyte comprises lithium bis(trifluoromethylsulfonyl)imide (LiTFSI) in tri(ethylene glycol) dimethyl ether otherwise known as triglyme.

6. The metal-air battery of claim 1, further comprising an electrolyte comprising ethers, glymes, or combinations thereof, wherein the electrolyte comprises LiTFSI in di(ethylene glycol) dibutyl ether otherwise known as butyl diglyme.

7. The metal-air battery of claim 1, further comprising discharge product stored in mesopores adjacent to the channels.

8. A lithium-air battery having a specific capacity greater than or equal to 5000 mAh/g graphene/carbon and having an air electrode comprising graphene, the air electrode comprising randomly arranged graphene nanosheets forming a network of channels defining continuous flow paths through the air electrode, oxygen diffusing through the channels, and a carbon material mixed with the graphene nanosheets, the carbon material having a mesopore volume greater than 1 cc/g.

8

9. The lithium-air battery of claim 8, wherein the air electrode further comprises a catalyst deposited on surfaces of the electrode, the catalyst comprising a transition metal or transition metal oxide.

10. The lithium-air battery of claim 8, wherein the channels have average diameters between 0.1 and 5 μm .

11. The lithium-air battery of claim 8, wherein at least a portion of the air electrode comprises fluorinated graphene nanosheets (CF_x , where $0.5 < x < 1.5$).

12. The lithium-air battery of claim 8, further comprising an electrolyte comprising ethers, glymes, or combinations thereof.

13. The lithium-air battery of claim 12, wherein the electrolyte comprises lithium bis(trifluoromethylsulfonyl)imide (LiTFSI) in tri(ethylene glycol) dimethyl ether (triglyme).

14. The lithium-air battery of claim 12, wherein the electrolyte comprises LiTFSI in di(ethylene glycol) dibutyl ether (or butyl diglyme).

15. A lithium-based battery having a specific capacity greater than or equal to 8000 mAh/g graphene/carbon and having an electrode comprising graphene, the electrode comprising randomly arranged graphene nanosheets forming a network of channels defining continuous flow paths for fluids through the electrode, a carbon material mixed with the graphene nanosheets, the carbon material having a mesopore volume greater than 1 cc/g, and an electrolyte comprising glymes, ethers, or both.

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