What is claimed is:

~~1. A cathode in a lithium-air/oxygen or zinc-air/oxygen battery, the cathode comprising a nanoporous carbon material, the nanoporous carbon material having a pore structure comprising a fibrillar morphology and an array of pores that surround lithium peroxide particles.~~

~~2~~1. A nanoporous carbon cathode ~~for a lithium-air/oxygen or zinc-air/oxygen battery, the nanoporous carbon cathode having~~ comprising:

a carbonized aerogel material having:

a pore structure comprising a fibrillar morphology with a substantially uniform pore size distribution, where pores accommodate formation of lithium peroxide particles;

a Young modulus of at least about 0.2 GPa; and

a density between about 0.10 g/cc and about 1.5 g/cc.

~~3. A nanoporous carbon cathode for a lithium-air/oxygen or zinc-air/oxygen battery, the nanoporous carbon cathode having:~~

~~a pore structure comprising a fibrillar morphology with a substantially uniform pore size distribution, where pores accommodate formation of lithium peroxide particles;~~

~~an electrical conductivity of at least about 1 S/cm; and~~

~~a density between about 0.10 g/cc and about 1.5 g/cc.~~

~~4~~2. The nanoporous carbon cathode ~~material~~ of claim 1 ~~or claim 2~~, wherein the ~~carbon material~~ carbonized nanoporous carbon material has an electrical conductivity of at least about 1 S/cm.

~~5. The nanoporous carbon material of claim 1 or claim 3, wherein the carbon material has a Young modulus of at least about 0.2 GPa.~~

~~6. The nanoporous carbon material of one or more of claims 1-5, wherein the nanoporous carbon material comprises a carbon aerogel.~~

~~7~~3. The nanoporous carbon ~~material~~ cathode of claim ~~6~~1, wherein the ~~carbon material~~ carbonized nanoporous carbon material comprises a polyimide-derived carbon aerogel.

84. The nanoporous carbon ~~material~~cathode ~~of any of claim 6 and claim 7~~ claim 3, wherein the ~~carbon aerogel~~ polyimide-derived carbon aerogel is in a monolith ~~or a powder~~ form.

95. The nanoporous carbon ~~material~~cathode of claim ~~8~~4, wherein the ~~monolithic~~ carbon aerogel is substantially or completely binder-free.

~~10~~6. The nanoporous carbon ~~material~~cathode of ~~any of claim 6 and claim 7~~ claim 4, wherein the ~~monolithic~~ carbon aerogel has a thickness between about 10 μm and about 1000 μm.

~~11~~7. The nanoporous carbon ~~material~~cathode of ~~one or more of claims 1-10~~ claim 1, wherein the pore structure is characterized by pores surrounding the lithium peroxide particles.

~~12~~8. The nanoporous carbon ~~material~~cathode of claim ~~11~~7, wherein the pores form interconnected structures around the lithium peroxide particles, characterized by a plurality of connection points between the lithium peroxide particles and pore walls of each pore in which the lithium peroxide particles are surrounded.

~~13~~9. The nanoporous carbon ~~material~~cathode of ~~one or more of claims 1-12~~ claim 1, wherein the nanoporous carbon cathode accommodates~~includes~~ about 5%-90% of the lithium peroxide particles by weight of the carbonized nanoporous carbon material.

~~14~~10. The nanoporous carbon ~~material~~ cathode of ~~one or more of claims 1-13~~ claim 1, wherein the carbonized nanoporous carbon material has a pore volume of at least 0.3 cc/g.

~~15~~11. The nanoporous carbon ~~material~~cathode of ~~one or more of claims 1-14~~ claim 1, wherein the carbonized nanoporous carbon ~~material~~cathode has a porosity between about 10% and about 90%.

~~16~~12. The nanoporous carbon ~~material~~cathode of ~~one or more of claims 1-15~~claim 1, wherein the carbonized nanoporous carbon material has a capacity of at least about 800 mAh/g.

~~17~~13. The nanoporous carbon ~~material~~cathode of ~~one or more of claims 1-16~~ claim 1, wherein the pore structure comprises a full width at half max of about 50 nm or less.

~~18~~14. The nanoporous carbon ~~material~~cathode of ~~one or more of claims 1-17~~ claim 1, wherein the pore structure comprises a pore size at max peak from distribution of about 100 nm or less.

~~19~~15. The nanoporous carbon ~~material~~cathode of ~~one or more of claims 1-18~~ claim 1, wherein the fibrillar morphology comprises a plurality of struts, wherein the struts further comprise ~~of~~

~~the nanoporous~~ carbonized carbon material and wherein at least some of the struts ~~includes~~have an average strut width of about 2-10 nm.

~~20. A monolithic polyimide-derived carbon aerogel composite formed of a nanoporous carbon material, wherein the composite is free of binders and wherein lithium peroxide particles are disposed along a surface or within pores of the monolithic polyimide-derived carbon aerogel composite, wherein the carbon aerogel composite forms a cathode in a lithium-air/oxygen or zinc-air/oxygen battery.~~

~~21. A collector-less, binder-less, interconnected cathode material for a lithium-air/oxygen or zinc-air/oxygen battery comprising an open-cell, monolithic, polyimide-derived nanoporous carbon aerogel having a fibrillar network and an array of pores; and lithium peroxide particles disposed along a surface or within pores of the carbon aerogel.~~

~~22~~16. An electrochemical cell comprising the carbonized nanoporous carbon ~~material~~cathode of claim 1~~or carbon aerogel of any one or more of claim 1 through claim 21~~.

~~23. A lithium-air/oxygen or zinc-air/oxygen battery comprising the nanoporous carbon material or carbon aerogel of any one or more of claim 1 through claim 21.~~

~~24~~17. A lithium-air/oxygen or zinc-air/oxygen battery, comprising the electrochemical cell of claim ~~22~~16.