CLAIMS

What is claimed is:

1. A nanoporous carbon material comprising:

a carbon aerogel material comprising a fibrillar morphology that comprises a plurality of interconnected structures, wherein the plurality of interconnected structures comprises a plurality of carbonized struts having a strut width from 2 nm to 10 nm and wherein the plurality of interconnected structures defines a plurality of pores;

elemental sulfur disposed within a pore of the plurality of pores; and

wherein the carbon aerogel material has an electrical conductivity of at least 1 S/cm.

2. The nanoporous carbon material of claim 1, wherein the elemental sulfur is in contact with an interior pore wall of the pore.

3. The nanoporous carbon material of claim 1, wherein the carbon material has a Young's modulus of at least 0.2 GPa.

4. The nanoporous carbon material of claim 1, wherein the elemental sulfur comprises a conformal coating on a carbon surface of an interior of the pore.

5. The nanoporous carbon material of claim 1, wherein the carbon aerogel material has a density from 0.10 g/cc to 1.5 g/cc.

6. The nanoporous carbon material of claim 1, wherein the plurality of pores form interconnected porous structures that surround the elemental sulfur.

7. The nanoporous carbon material of claim 1, wherein the carbon aerogel material is doped with 5%-90% of the elemental sulfur by weight of the carbon aerogel material.

8. The nanoporous carbon material of claim 1, wherein the carbon material has a pore volume of at least 0.3 cc/g.

9. The nanoporous carbon material of claim 1, wherein the carbon aerogel material is in a monolith form.

10. The nanoporous carbon material of claim 9, wherein the carbon aerogel material is substantially or completely binder-free.

11. The nanoporous carbon material of claim 1, wherein the plurality of pores form interconnected porous structures that surround the elemental sulfur.

12. A collector-less, binder-less, interconnected cathode material for a lithium-sulfur battery comprising an open-cell, monolithic, polyimide-derived nanoporous carbon aerogel that includes residual nitrogen, the nanoporous carbon aerogel having a fibrillar network that comprises a plurality of interconnected, carbonized struts characterized by a strut width from 2 nm to 10 nm, wherein the plurality of interconnected, carbonized struts define a plurality of pores, the nanoporous carbon aerogel having an electrical conductivity of at least 1 S/cm, and a particle of elemental sulfur disposed within a pore of the plurality of pores.