CLAIMS

What is claimed is:

1. A method of producing a catalytic carbon fiber comprising:

oxidizing a virgin carbon fiber to produce an oxidized carbon fiber;

reacting the oxidized carbon fiber with a polyamine compound to produce an amine modified carbon fiber; and

reacting the amine modified carbon fiber with an organometallic macrocycle to produce the catalytic carbon fiber.

2. The method of claim 1 wherein the step of oxidation comprises contacting the virgin carbon fiber with an acid selected from hydrochloric acid, nitric acid, phosphoric acid, sulfuric acid, boric acid, hydrofluoric acid, hydrobromic acid, perchloric acid, hydroiodic acid, fluoroantimonic acid, carborane acid, fluoroboric acid, fluorosulfuric acid, hydrogen fluoride, triflic acid, perchloric acid, acetic acid, formic acid, citric acid, oxalic acid, tartaric acid, and combinations thereof.

3. The method of claim 1 wherein the polyamine compound comprises a primary or secondary polyamine with a carbon length from C2-C20.

4. The method of claim 1 wherein the polyamine compound comprises at least one polyamine compound selected from ethylenediamine, propane-1,3-diamine, butane-1,4-diamine, pentane-1,5-diamine, hexamethylenediamine, diethylenetriamine, benzene-1,3,5-triamine, and combinations thereof.

5. The method of claim 1 wherein the organometallic macrocycle comprises an unsubstituted metal phthalocyanine a substituted metal phthalocyanine, or combinations thereof, wherein the substituted metal phthalocyanine is substituted with at least one of a halogen group, a hydroxyl group, an amine group, an alkyl group, an aryl group, a thiol group, an alkoxy group, a nitrosyl group, or combinations thereof and wherein the unsubstituted metal phthalocyanine or the substituted metal phthalocyanine comprises a metal selected from vanadium (V), manganese (Mn),

iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), ruthenium (Ru), rhodium (Rh), palladium (Pd), silver (Ag), and combinations thereof.

6. A method of producing a catalytic carbon fiber comprising:

providing a carbon fiber and an aminated macrocycle,

mixing the carbon fiber and the aminated macrocycle with a solvent; and

reacting the carbon fiber and the aminated macrocycle to form an amide bond between the carbon fiber and the aminated macrocycle thereby forming the catalytic carbon fiber.

7. The method of claim 6, wherein the aminated macrocycle comprises an organometallic macrocycle and an amine group with a carbon length from C2-C20 grafted to the organometallic macrocycle.

8. The method of claim 7, wherein the organometallic macrocycle comprises an unsubstituted metal phthalocyanine a substituted metal phthalocyanine, or combinations thereof, wherein the substituted metal phthalocyanine is substituted with at least one of a halogen group, a hydroxyl group, an alkyl group, an aryl group, a thiol group, an alkoxy group, a nitrosyl group, sulfonic group, or combinations thereof, and wherein the unsubstituted metal phthalocyanine or the substituted metal phthalocyanine comprises a metal selected from vanadium (V), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), ruthenium (Ru), rhodium (Rh), palladium (Pd), silver (Ag), and combinations thereof.

9. The method of claim 6, wherein the solvent comprise at least one solvent selected from the group consisting of water, pyridine, DMSO, DMF, THF, ethanol, acetonitrile, chloroform, ethylene glycol, methanol, benzene, and combinations thereof.

10. The method of claim 7, wherein the amine group comprises a reaction product of at least one amine compound selected from ethylenediamine, propane-1,3-diamine, butane-1,4-diamine, pentane-1,5-diamine, hexamethylenediamine, diethylenetriamine, benzene-1,3,5-triamine, and combinations thereof and wherein the aminated macrocycle comprises at least one of mono-amino

cobalt phthalocyanine, di-amino cobalt phthalocyanine, tri-amino cobalt phthalocyanine, tetra-amino cobalt phthalocyanine, and combinations thereof.

11. A fiber bundle contactor comprising:

a flow path defined by a conduit;

a catalytic carbon fiber bundle disposed in the conduit, wherein the catalytic carbon fiber comprises an amine compound covalently bonded to the carbon fiber, and an organometallic macrocycle covalently bonded to the amine compound; and

an inlet allowing fluid flow into the flow path.

12. The fiber bundle contactor of claim 11 wherein the amine compound comprises a primary or secondary polyamine with a carbon length from C2-C20.

13. The fiber bundle contactor of claim 11 wherein the amine compound comprises at least one polyamine compound selected from ethylenediamine, propane-1,3-diamine, butane-1,4-diamine, pentane-1,5-diamine, hexamethylenediamine, diethylenetriamine, benzene-1,3,5-triamine, and combinations thereof.

14. The fiber bundle contactor of claim 11 wherein the organometallic macrocycle comprises an unsubstituted metal phthalocyanine, a substituted metal phthalocyanine, or combinations thereof, wherein the substituted metal phthalocyanine is substituted with at least one of a halogen group, a hydroxyl group, an amine group, an alkyl group, an aryl group, a thiol group, an alkoxy group, a nitrosyl group, or combinations thereof, and wherein the unsubstituted metal phthalocyanine or the substituted metal phthalocyanine comprises a metal selected from vanadium (V), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), ruthenium (Ru), rhodium (Rh), palladium (Pd), silver (Ag), and combinations thereof.

15. The fiber bundle contactor of claim 11 wherein the catalytic carbon fiber bundle comprises a carbon fiber and ethylenediamine covalently bonded to the carbon fiber and phthalocyanine.

16. A method comprising:

introducing into vessel a hydrocarbon comprising mercaptan sulfur, an aqueous caustic solution, and an oxidizer;

reacting at least a portion of the mercaptan sulfur and the aqueous caustic solution to produce a mercaptide; and

reacting the mercaptide and the oxidizer in the presence of a catalytic carbon fiber bundle to produce a disulfide oil, wherein the catalytic carbon fiber bundle comprises a carbon fiber, an amine compound covalently linked to the carbon fiber, and an organometallic macrocycle covalently linked to the amine compound.

17. The method of claim 16 wherein the amine compound comprises a primary or secondary polyamine with a carbon length from C2-C20.

18. The method of claim 16 wherein the amine compound comprises at least one polyamine compound selected from ethylenediamine, propane-1,3-diamine, butane-1,4-diamine, pentane-1,5-diamine, hexamethylenediamine, diethylenetriamine, benzene-1,3,5-triamine, and combinations thereof.

19. The method of claim 16 wherein the organometallic macrocycle comprises an unsubstituted metal phthalocyanine a substituted metal phthalocyanine, or combinations thereof, wherein the substituted metal phthalocyanine is substituted with at least one of a halogen group, a hydroxyl group, an amine group, an alkyl group, an aryl group, a thiol group, an alkoxy group, a nitrosyl group, or combinations thereof, and wherein the unsubstituted metal phthalocyanine or the substituted metal phthalocyanine comprises a metal selected from vanadium (V), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), ruthenium (Ru), rhodium (Rh), palladium (Pd), silver (Ag), and combinations thereof.

20. The method of claim 16 further comprising contacting the hydrocarbon comprising mercaptan sulfur and the aqueous caustic solution on a fiber bundle, wherein the reacting the portion of the mercaptan sulfur and the aqueous caustic solution to produce a mercaptide occurs within the fiber bundle.