CLAIMS

1. A method of making graphene quantum dots from a carbon source, wherein the method comprises:

exposing the carbon source to an oxidant,

wherein the carbon source is selected from the group consisting of coal, coke and combinations thereof, and

wherein the exposing of the carbon source to the oxidant provides oxidative reaction conditions sufficient to result in formation of the graphene quantum dots from the carbon source.

2. The method of claim 1, wherein the carbon source comprises coal, wherein the coal is selected from the group consisting of anthracite, bituminous coal, sub-bituminous coal, metamorphically altered bituminous coal, asphaltenes, asphalt, peat, lignite, steam coal, petrified oil, and combinations thereof.

3. The method of claim 1, wherein the carbon source comprises coke.

4. The method of claim 1, wherein the carbon source comprises bituminous coal.

5. The method of claim 1, wherein the carbon source comprises anthracite.

6. The method of claim 1, wherein the oxidant comprises an acid.

7. The method of claim 6, wherein the acid is selected from the group consisting of sulfuric acid, nitric acid, phosphoric acid, hypophosphorous acid, fuming sulfuric acid, hydrochloric acid, oleum, chloro sulfonic acid, and combinations thereof.

8. The method of claim 1, wherein the oxidant is a mixture of sulfuric acid and nitric acid.

9. The method of claim 1, wherein the oxidant is selected from the group consisting of potassium permanganate, sodium permanganate, hypophosphorous acid, nitric acid, sulfuric acid, hydrogen peroxide, and combinations thereof.

10. The method of claim 1, wherein the oxidant is a mixture of potassium permanganate, sulfuric acid, and hypophosphorous acid.

11. The method of claim 1, wherein the exposing comprises sonicating the carbon source in presence of the oxidant.

12. The method of claim 1, wherein the exposing comprises heating the carbon source in presence of the oxidant.

13. The method of claim 12, wherein the heating occurs at temperatures of at least about 100 °C.

14. The method of claim 12, wherein the heating occurs at temperatures ranging from about 100 °C to about 150 °C.

15. The method of claim 1, further comprising a step of separating the formed graphene quantum dots from the oxidant.

16. The method of claim 15, wherein the separating comprises:
neutralizing a solution comprising the formed graphene quantum dots,
filtering the solution, and
dialyzing the solution.

17. The method of claim 1, further comprising a step of enhancing a quantum yield of the graphene quantum dots.

18. The method of claim 17, wherein the enhancing occurs by hydro thermal treatment of the graphene quantum dots, treatment of the graphene quantum dots with one or more bases, treatment of the graphene quantum dots with one or more hydroxides, treatment of the graphene quantum dots with one or more dopants, and combinations thereof.

19. The method of claim 17, wherein the enhancing occurs by hydro thermal treatment of the graphene quantum dots.

20. The method of claim 1, further comprising a step of reducing the formed graphene quantum dots.

21. The method of claim 20, wherein the reducing comprises exposure of the formed graphene quantum dots to a reducing agent.

22. The method of claim 20, wherein the reducing agent is selected from the group consisting of hydrazine, sodium borohydride, heat, light, sulfur, sodium sulfide, sodium hydrogen sulfide, and combinations thereof.

23. The method of claim 1, wherein the formed graphene quantum dots have diameters ranging from about 1 nm to about 50 nm.

24. The method of claim 1, wherein the carbon source is bituminous coal, and wherein the formed graphene quantum dots have diameters ranging from about 1 nm to about 5 nm.

25. The method of claim 1, wherein the carbon source is anthracite, and wherein the formed graphene quantum dots have diameters ranging from about 10 nm to about 50 nm.

26. The method of claim 1, wherein the carbon source is coke, and wherein the formed graphene quantum dots have diameters ranging from about 2 nm to about 10 nm.

27. The method of claim 1, further comprising a step of controlling the diameter of the formed graphene quantum dots.

28. The method of claim 27, wherein the controlling comprises selecting the carbon source.

29. The method of claim 28, wherein the selected carbon source is bituminous coal, and wherein the formed graphene quantum dots have diameters ranging from about 1 nm to about 5 nm.

30. The method of claim 28, wherein the selected carbon source is anthracite, and wherein the formed graphene quantum dots have diameters ranging from about 10 nm to about 50 nm.

31. The method of claim 28, wherein the selected carbon source is coke, and wherein the formed graphene quantum dots have diameters ranging from about 2 nm to about 10 nm.

32. The method of claim 1, wherein the formed graphene quantum dots have a crystalline hexagonal structure.

33. The method of claim 1, wherein the formed graphene quantum dots have a single layer.

34. The method of claim 1, wherein the formed graphene quantum dots have multiple layers.

35. The method of claim 34, wherein the formed graphene quantum dots have from about two layers to about four layers.

36. The method of claim 1, wherein the formed graphene quantum dots are functionalized with a plurality of functional groups.

37. The method of claim 36, wherein the functional groups are selected from the group consisting of amorphous carbon, oxygen groups, carbonyl groups, carboxyl groups, esters, amines, amides, and combinations thereof.

38. The method of claim 36, wherein the formed graphene quantum dots are edge functionalized with a plurality of functional groups.

39. The method of claim 38, wherein the formed graphene quantum dots comprise oxygen addends on their edges.

40. The method of claim 38, wherein the formed graphene quantum dots comprise amorphous carbon addends on their edges.

41. The method of claim 1, wherein the formed graphene quantum dots are utilized in road stickers, road signs, coatings, clothing, paints, photographic processing materials, and combinations thereof.

42. The method of claim 1, wherein the exposing comprises stirring the carbon source in the presence of the oxidant.