CLAIMS

1. A method of generating hydrogen peroxide in a pH neutral solution having a pH in the range from 6 to 8, the method comprising:

providing an electrochemical reaction cell;

providing a mesoporous carbon catalyst including both nitrogen doping and oxygen doping in the electrochemical reaction cell, wherein a ratio of nitrogen to carbon (N/C) of the mesoporous carbon catalyst is between 0.026 and 0.050; and

providing electrical current to the electrochemical reaction cell to drive an oxygen reduction reaction that produces hydrogen peroxide at the pH neutral solution;

wherein the oxygen reduction reaction is catalyzed by the mesoporous carbon catalyst.

2. The method of claim 1, wherein the method is performed to provide treatment of environmental water.

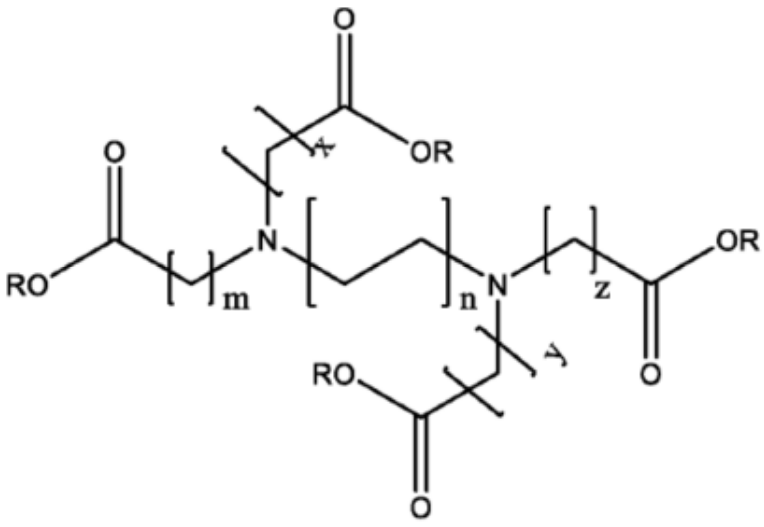
3. The method of claim 2 wherein the treatment is selected from the group consisting of: disinfection, chemical degradation of pollutants, and any combination thereof.

4. The method of claim 1, wherein the step of providing a mesoporous carbon catalyst comprises:

providing a nitrogen-containing organic precursor; and

carbonizing the nitrogen-containing organic precursor with a base to provide the mesoporous carbon catalyst including the nitrogen doping and the oxygen doping.

5. The method of claim 4, wherein the nitrogen-containing organic precursor has a chemical structure given by



wherein n ≥ 1, m ≥ 1, x ≥ 1, y ≥ 1, z ≥ 1, and wherein each R is independently selected from a group consisting of H, hydrocarbon group, alkali metal ion and alkaline earth metal ion.

6. The method of claim 4, wherein the base is selected from a group consisting of: potassium hydroxide (KOH), sodium hydroxide (NaOH), lithium hydroxide (LiOH), rubidium hydroxide (RbOH), caesium hydroxide (CsOH), ammonium hydroxide (NH_4OH), beryllium hydroxide (BeOH), magnesium hydroxide ($Mg(OH)_2$), and calcium hydroxide ($Ca(OH)_2$).

7. The method of claim 4, wherein the carbonizing the nitrogen-containing organic precursor with a base is performed at a temperature in a range from 600 °C to 900 °C.

8. A mesoporous carbon catalyst including both nitrogen doping and oxygen doping, wherein the catalyst is configured as porous microsheets of amorphous carbon including nano-scale graphitized domains, wherein a ratio of

nitrogen to carbon (N/C) of the mesoporous carbon catalyst is between 0.026 and 0.050; and

configured to catalyze an electrochemical oxygen reduction reaction for producing hydrogen peroxide in a pH neutral solution having a pH in the range from 6 to 8.

9. The catalyst of claim 8, wherein a nitrogen content of the catalyst is 1% or more, and wherein an oxygen content of the catalyst is 1% or more.

10. The catalyst of claim 8, wherein no transition metal catalyst is included in the mesoporous carbon catalyst.

11. An electrochemical cell for the production of hydrogen peroxide including the catalyst of claim 8.

12. The catalyst of claim 8, wherein the nitrogen doping is in a configuration selected from a group consisting of: pyrrolic configurations, pyridinic configurations and mixtures thereof.