electrically rechargeable and have high capacity. In addition, the metal air battery disclosed herein may be able to perform continuously for long periods of time.

There is provided a method for forming a catalyst for a metal air battery or fuel cell comprising a mixed metal oxide consisting of at least one lanthanide element and at least two different transition metal elements, comprising:

(i) mixing a solution containing a lanthanide element with a solution containing at least two different transition metal elements;

(ii) adjusting the pH of the solution from step (i) by adding an alkaline solution;

(iii) hydrothermally treating the mixture from step (ii) to form a precipitate from the solution;

(iv) separating the precipitate from the solution;

(v) drying the precipitate until complete dryness to form a precursor; and

(vi) calcinating the precursor to form the catalyst.

In another aspect, there is provided a method for forming a composite catalyst for a metal air battery or fuel cell comprising a mixed metal oxide and a conducting additive, wherein the mixed metal oxide is an oxide consisting of lanthanum, cobalt and manganese and has a perovskite structure, wherein the conducting additive is a carbon material, the method comprising the steps of:

(i) mixing a solution containing lanthanum with a solution containing manganese and cobalt elements;

(ii) adjusting the pH of the solution from step (i) by adding an alkaline solution;

(iii) hydrothermally treating the mixture from step (ii) to form a precipitate from the solution in the presence of the carbon material;

Claims

1. A composite catalyst for a metal air battery or fuel cell comprising a mixed metal oxide and a conducting additive, wherein the mixed metal oxide is an oxide consisting of lanthanum, cobalt and manganese and has a perovskite structure, wherein:
the conducting additive is a carbon material, and
the composite catalyst is made by a co-hydrothermal method comprising the precipitation of the mixed metal oxide in the presence of a carbon material.

2. The composite catalyst according to claim 1, wherein the mixed metal oxide has the chemical formula $La(M', M'')O_{3-\delta}$, wherein M' is cobalt and M'' is manganese.

3. The composite catalyst according to claim 2, wherein the ratio of $M':M''$ is selected from the group consisting of 9:1, 8:2, 7:3, 6:4, 5:5, 4:6, 3:7, 2:8 and 1:9.

4. The composite catalyst according to claim 2, wherein the ratio of $La:(M'+M'')$ is 1:1.

5. The composite catalyst according to claim 1, wherein the composite catalyst has the ability to catalyze oxygen reduction and evolution reactions.

6. The composite catalyst according to claim 1, wherein the carbon material is selected from the group consisting of carbon nanotube, carbon black and graphene oxide.

7. The composite catalyst according to claim 1, wherein the co-hydrothermal method comprises the step of:

(i) mixing a solution containing lanthanum with a solution containing manganese and cobalt elements;

(ii) adjusting the pH of the solution from step (i) by adding an alkaline solution;

(iii) hydrothermally treating the mixture from step (ii) to form a precipitate from the solution in the presence of the carbon material;

(iv) separating the precipitate from the solution;

(v) drying the precipitate until complete dryness to form a precursor; and

(vi) calcinating the precursor to form the composite catalyst.

8. The composite catalyst according to claim 1, wherein the carbon material is selected from the group consisting of carbon nanotube and N-doped reduced graphene oxide (NrGO).

9. An air electrode comprising a composite catalyst according to claim 1.

10. A metal air battery or fuel cell comprising a composite catalyst according to claim 1.

11. A method for forming a composite catalyst for a metal air battery or fuel cell comprising a mixed metal oxide and a conducting additive, wherein the mixed metal oxide is an oxide consisting of lanthanum, cobalt and manganese and has a perovskite structure, wherein the conducting additive is a carbon material, the method comprising the steps of:

(i) mixing a solution containing lanthanum with a solution containing manganese and cobalt elements;

(ii) adjusting the pH of the solution from step (i) by adding an alkaline solution;

(iii) hydrothermally treating the mixture from step (ii) to form a precipitate from the solution in the presence of the carbon material;

(iv) separating the precipitate from the solution;

(v) drying the precipitate until complete dryness to form a precursor; and

(vi) calcinating the precursor to form the composite catalyst.

12. The method according to claim 11, wherein the hydrothermal treating is carried out at a temperature of 100°C to 200°C.

13. The method according to claim 11, wherein the drying of the precipitate is carried out at a temperature of 50°C to 100°C or freeze dried for 3 days.

14. The method according to claim 11, wherein the calcination is performed in the temperature range of 700°C to 1000°C.

15. The method according to claim 11, wherein calcination leads to formation of the composite catalyst having the perovskite structure.

16. The method according to claim 11, additionally comprising the step of adding a conducting additive after adjusting the pH of the solution.

17. The method according to claim 11, further comprising the steps of:

(i) mixing the composite catalyst with an alcoholic medium to form a slurry;

(ii) drying the slurry to form a powder; and

(iii) grinding the powder.

18. The use of a composite catalyst of claim 1 in an air electrode, metal air battery or fuel cell.