LMO CATHODE COMPOSITIONS

The present invention relates to a set of electroactive lithium-rich manganese cathode compositions having a rock salt structure. More specifically the present invention relates to a set of high capacity lithium-rich manganese oxide cathode compositions which can be used as bulk or composite cathode material in an electrochemical cell.

The performance and cost of lithium ion batteries primarily relies on the composition of the positive electrode (cathode). Currently available lithium-based cathode compositions are graded mainly on their energy density, electrochemical performance and the price of raw materials required to formulate the composition. Manganese would be an ideal sole-transition metal centre for a lithium-based cathode composition, as the abundance of manganese in the Earth's crust is far greater than cobalt and nickel. Although much higher capacities and energy densities can currently be achieved with compositions comprising nickel, cobalt and aluminium, the cost of these metals is far greater. In addition, these nickel, cobalt and aluminium-based composition still suffer with problems of the voltage profile evolving on cycling, costly (because of the inclusion of cobalt and nickel) and show significant stability issues, such as gas loss during cycling. There is a need for a simple, robust and cost-effective lithium-rich material which delivers parity or better in terms of energy density and performance.

Summary

In a first example, the present disclosure refers to a cathode composition for a lithium-ion battery of the general formula: $Li_{1+x}Mn_{1-x}O_2$; wherein the composition is in the form of a single phase having a rock salt crystal structure; and the value of x is greater than 0, and equal to or less than 0.3.

In a first aspect, the present disclosure refers to a cathode composition for a lithium-ion battery of the general formula: $Li_{1+x}Mn_{1-x}O_2$; wherein the composition is in the form of a single phase having a rock salt crystal structure that exhibits the Fm3(bar)m space group; and the value of x is greater than 0, and equal to or less than 0.3.

Conventional ordered or layered lithium and manganese-rich compositions ($Li_{1+x}Tm_{1-x}O_2$ where Tm is predominately Mn) have lithium ions sitting in both the alkali and transition metal sites. This is compared to an ideal $LiCoO_2$ R3/m type structure, where lithium and cobalt ions fully occupy alternating layers within the structure.

It has been found that a cathode composition with an improved stability and capacity performance can be achieved by the lithium-rich manganese oxide compositions as defined above. The cathode compositions of the present disclosure also exhibit improved

Claims

1. A cathode composition for a lithium-ion battery of the general formula:

$$Li_{1+x}Mn_{1-x}O_2$$

wherein the composition is in the form of a single phase having a rock salt crystal structure that exhibits the Fm3(bar)m space group; and the value of x is greater than 0, and equal to or less than 0.3.

2. The cathode composition according to claim 1, wherein the value of x is equal to or greater than 0.1.

3. The cathode composition according to claim 1, wherein the value of x is equal to or greater than 0.17.

4. The cathode composition according to claim 1, wherein the value of x is equal to or greater than 0.2.

5. The cathode composition according to claim 1, wherein the value of x is equal to or greater than 0.2 and equal to or less than 0.3.

6. The cathode compound according to claim 1, wherein the value of x is equal to or greater than 0.1 and equal to or less than 0.2.

7. The cathode composition according to any one of the previous claims, wherein the value of x is equal to 0.2.

8. The cathode composition according to claim 1, wherein the composition is expressed as the general formula:

$$(a)LiMnO_2 \bullet (1\text{-}a)Li_2MnO3$$

wherein two precursors are provided in proportions defined by a, and a has a value in the range greater than 0, and less than 1; and

the precursors are mixed by a ball milling process.

9. The composition according to claim 8, wherein the value of a is equal or greater than 0.15 and equal to or less than 0.7.

10. The composition according to claim 8, wherein the value of a is equal or greater than 0.15 and equal to or less than 0.4.

11. The composition according to claim 8, wherein the material is $0.4LiMnO_2 \bullet 0.6Li_2MnO_3$.

12. An electrode comprising the cathode composition according to any one of previous claims 1 to 11.

13. The electrode according to claim 12, wherein the electrode comprises electroactive additives and/or a binder.

14. The electrode according to claim 13, wherein the electroactive additive is selected from at least one of carbon or carbon black.

15. The electrode according to claim 13 or claim 14, wherein the polymeric binder is selected from at least one of PVDF, PTFE, NaCMC or NaAlginate.

16. An electrochemical cell comprising a cathode according to any one of claims 12 to 15, an electrolyte, and an anode.