Rechargeable Metal Air Batteries

Write up:

Demand for a reliable method to store electrical energy is expected to increase with the increasing use of renewable energy sources. Batteries are one of the most practical ways to store electrical energy so that it can be used during intermittent non-availability of renewable energy sources. Lithium ion technology is slowly reaching its performance limit. Therefore, it has become necessary to find an alternative to lithium ion battery which has advantages in terms of performance and cost.

Metal-air battery is one of such candidates which can theoretically possess much higher specific energy than Li-ion batteries. Metal-air batteries can be visualized as a fuel cell which uses metal as fuel. A simple metal-air battery contains a metal anode, an air cathode which is open to air and a suitable electrolyte. In order to be used as an energy storage device, the battery must be electrically rechargeable. However, rechargeable metal-air batteries possess some fundamental weaknesses which can be summarized as follows:

- In the case of almost all metal-air batteries except zinc-air battery, it is difficult to recharge them just by reversing the electric current through the terminals, similar to what is done for most of the other commercial secondary batteries.
- Metal-air cells based on Li, Na and other alkali metals which are not stable in the presence of water employ an organic aprotic electrolyte.
- They suffer from issues such as poor cycle life, low efficiency.
- Batteries employing metals such as Al, Mg which are stable in the presence of water are not rechargeable natively because of the limitation of the electrochemical window of the water.
- The losses due to parasitic reactions (H2 evolution) cause it to have low coulombic efficiency.
- Zinc metal also suffers from passivation due to zinc oxide deposition.

Therefore, there is a need to develop metal-air batteries, which can be efficiently recharged.

Features of our invention:

- Because of the aprotic electrolyte, parasitic reactions and passivation problems are avoided.
- By employing the aqueous electrolyte in air cell, it is possible to evolve oxygen without any irreversibility or significant loss of capacity. The cell can be recharged electrically in a reliable way.
- By employing some of the variations mentioned earlier the capacity of the cell can be increased to a greater extent.
- It is possible to tune the electrolytes and other components in individual cells independently. For example, in this case acidic electrolyte can be used is aqueous air cell therefore problem of CO2 contamination is avoided.
- This method can enable electrical recharging in metal-air batteries such as Al-air, Mg-air or other alkali/alkaline earth/transition metals-air, which do not yet have a reliable method to charge electrically.