

Performance boost for primary aqueous Mg batteries

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Nowadays the increasing demand of green power sources with high energy density and long running time has become one of the most popular social issues. Considering the regulations that limit the use of environmentally hazardous batteries such as Li-ion, the urgency to find alternative power source for remote applications is greater than ever. In this context, aqueous primary Mg-based batteries might offer a promising alternative to conventional energy storage devices, attributed to the highly negative electrode potential and high volumetric capacity of metallic Mg. However, there are several critical factors limiting wider application of Mg-based batteries. During the discharge process the deposits form on the anode surface. This limits the lifetime, i.e. if the reaction products are not removed, they block available surface for electrochemical reaction. The self-corrosion of Mg anode also lower efficiency of Mg battery.

In this work, the discharge properties of Mg-based batteries were boosted through optimization of Mg-based anodes with Ca addition and through electrolyte additives for Mg-Ca anode.

In view of the more negative electrode potential of Ca than Mg, moderate addition of Ca into Mg anodes might increase the cell voltage of Mg-based batteries. Moreover, grain refinement caused by Ca addition would also be beneficial for the improvement of self-corrosion resistance of Mg-based anodes. However, the introduced Mg₂Ca phase promotes the self-corrosion of Mg anodes because of its high electrochemical activity. Therefore, composition of Mg-Ca anodes has been optimized in terms of reduced self-corrosion and improved discharge properties. The optimized Mg-Ca anode shows higher cell voltage and higher specific energy density than high purity Mg and several commercial Mg alloys in Mg-air battery test.

The enhancement of Mg-based batteries performance can also be achieved by adding organic additives into electrolyte, which can prevent the formation of insoluble precipitate on the electrode and accelerate the dissolution of magnesium anode. Therefore, it can increase the cell voltage and specific energy of Mg-Ca system battery.