DEPARTMENT OF MOLECULAR SCIENCE AND NANOSYSTEMS

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Aqueous zinc-ion batteries for stationary energy storage

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Abstract

Aqueous zinc-ion batteries have recently shown a good potential for stationary application and storage of energy from volatile regenerative sources, such as wind and solar. Using copper hexacyanoferrate (CuHCF) as intercalating active material for the positive electrode, it was possible to reach 100 life cycles, a specific energy equal to 46 Wh kg^{-1}, and a specific power equal to 480 W kg^{-1}, with a charge efficiency of 98%. The properties of this class of batteries appear to be ideal for short-term stationary applications, for which high power, low costs, and high safety are the main driving parameters. In order to reach the aim of cycle life superior to 10000 cycles, it is necessary to understand the origin of the battery degradation and optimizing not only the active materials for the positive (hexacyanoferrates) and negative (zinc and additives) electrodes, but also the electrolyte, in order to tune the interactions between these elements. In fact, it is known in general for batteries that side reaction products are correlated to the coupling of one of the electrodes with the electrolyte and they are not only influencing the efficiency, as part of the accumulated charge is lost, but also the aging of the battery, as they could damage the electrodes. In this work I will present the advancements of the last years in the performances of the aqueous zinc-ion battery, obtained by understanding the aging mechanism in CuHCF and tuning the properties of this material in order to reach more than 1000 cycle life (see figure). Simultaneously, we have investigated also the degradation of the negative electrodes based on metallic zinc, and we were able to identify two classes of additives, liquid and solid-state components, which can be used to improve the performances of the negative electrode and can bring the efficiency of zinc electrodeposition from 85% to 98%.

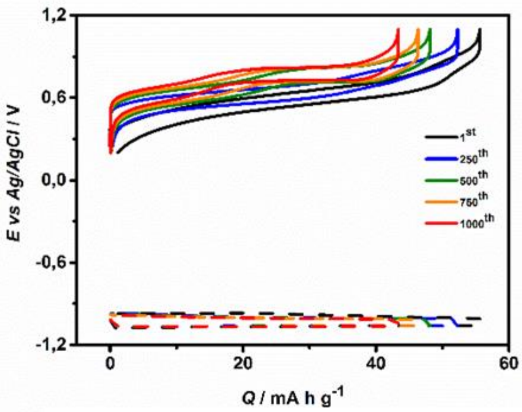

Figure: *galvanostatic cycling of modified CuHCF in 0.1 M $ZnSO_4$ solution, coupled with a metallic zinc negative electrode.*

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