Zinc-air batteries: prospects and challenges for future improvement

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Zinc-air primary batteries are known since nearly 100 years, but have to date found use only in special markets. The best known application is the power supply for hearing aids where the high energy density is the main reason for using this battery system. The high energy density is also attractive for other applications and has led to less familiar uses like power supplies for electric high tension cattle fences, safety lights at street construction sites or recharging stations for Lithium based batteries. All these examples show the main characteristics of todays zinc-air batteries:

- Long lasting energy supply,
- low weight,
- reliable operation for long times,
- safe and easily available materials.

However, recharging is until now not possible with zinc-air batteries despite considerable research effort. Several reasons are responsible for this fact. The most serious problem is the formation of dendritic zinc structures during recharge. The zinc dendrites may penetrate the separator finally causing short cut of the battery. Another disadvantage is related to the electrolyte, which is aqueous KOH solution in most cases. This leads in an air-operated battery to the formation of potassium carbonate plugging the pores of the gas diffusion electrode. Special membranes can reduce this carbonate formation to some extent, however, at the expense of additional losses and effort.

To meet the challenges of rechargeable zinc-air batteries several approches are possible. One chance to avoid dentritic zinc is the application of non-aquaeous electrolytes, especially ionic liquids. It has been shown in the literature that the nature of the electrolyte has a strong influence on the structure of the deposited metal and dendrite-free zinc deposition has already been demonstrated. With these electrolytes, carbonate formation is also avoided because they are no bases. Cathode materials also need improvement for the development of rechargeable zinc-air systems. For primary batteries, manganese dioxide, platinum on carbon or silver have been used as electrocatalysts. However, these materials are not well suited for the oxygen evolution reaction during battery recharge, because the catalytic activity is too low or changes in the electrode structure occur. New concepts with other cathode catalysts and/or electrode designs are promising directions. In the future, rechargeable zinc-air batteries may lead to systems wich could be used in stationary power supply or in future electromobility beyond Lithium batteries.