Development of electrodes for metal hydride-air batteries

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The rechargeable metal hydride (MH)-air battery features a cell configuration analogous to that of the Ni-MH battery, wherein the heavy nickel electrode is replaced with the lightweight air electrode, representing a primary advantage of these batteries. In general, the air battery is expected to have no limitations on potential discharge capacity, given that the positive active mass is oxygen sourced from the air. This implies that the rechargeable MH-air battery theoretically has an unlimited capacity of the gas diffusion electrode (GDE). The energy density of this battery depends on the specific capacity of the MH electrode, which varies depending on the type of alloy used, such as AB_5, AB, A_2B, AB_2, and others. A major problem facing the commercialization of an MH-air battery is the development of a charge-discharge stable GDE. Over the past 30 years, enormous efforts have been made to overcome this problem, mainly focusing on the development of bifunctional GDEs through their integration into rechargeable zinc-air batteries. On the other hand, MH electrodes have been widely studied and found practical applications. The development of a laboratory MH electrode and its adaptation in an MH-air battery is also a challenge facing researchers in the field. In this study, mechanically, chemically, and electrochemically stable GDEs with a composite structure (CGDE) of clinoptilolite + Teflonized carbon black in the gas diffusion layer were developed. More than 1000 cycles with a current density of ±10 mA cm^{-2} in continuous operation mode in half cell configuration were achieved. The as-developed GDEs meet the condition for predominantly Knudsen diffusion (average size of mesopores 7-15 nm). The optimization of the composition and structure of the MH electrode (with an alloy composition of $LaNi_{4.5}Co_{0.4}Al_{0.1}$) by introducing additional carbon black and spinel oxides of transition metals aims to improve its main characteristics: a discharge capacity increase of over 30 % and a charge/discharge endurance more than three times that of the basic MH electrode.
The design and construction of electrochemical cells allowing the systematic study of a large part of the main electrochemical characteristics of an MH-air battery resulted in satisfactory values for charge and discharge voltage, smooth loss of capacity, and a lifetime of about 1000 hours in continuous operation (with no pause between charge and discharge).

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