Durability of Nickel-based Air Electrodes for Charge-discharge Cycles

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We have been developing a highly durable air electrode for a metal-air secondary cell. The air electrode is required to have a bi-functionality and a high stability for oxygen evolution. Recently, our laboratory has developed a novel air electrode consisting of nickel and PTFE powders [1]. In this study, the durability of the nickel-based air electrode for charge-discharge cycles was examined.

Nickel powders were used as a conductive and catalyst-supporting material for an air electrode. The nickel powder was mixed with the aqueous solution containing H_2IrCl_6 and H_2PtCl_6, dried at 393 K, and heated at 743 K so as to partially cover the surface of the nickel powder with platinum and iridium oxide as catalysts. The catalyst-loaded nickel, PTFE, and catalyst-free nickel powders were mixed with 30:10:60 mass ratio, dried, and pressed on nickel mesh sheet to make a disk. Then, the disk was heated at 643 K for 12.5 minutes under nitrogen atmosphere.

The air electrode was mounted in a self-made PTFE holder, which allows the electrode to contact to an electrolyte on one side and to open to air on the other side. The electrolyte was a 7 mol dm^{-3} KOH solution. A platinum counter electrode and an HgO/Hg reference electrode were used. The charge-discharge test of the air electrode was carried out at 333 K with constant current method, in which oxygen gas was supplied to the electrode at 140 cm^3 min^{-1}.

Figure 1 shows the variation in the electrode potential at the ends of charge and discharge at 38.3 mA cm^{-2} for 680 cycles. Within 500 cycles, the potential showed little change to the initial value, suggesting a high durability for a rechargeable use. However, the discharge potential gradually became lower in further charge-discharge cycles, while the charge potential was also constant. SEM observations of the cross section of the electrode after 680 cycles indicated that nickel powders were partially consumed. The variation in charge-discharge curves also suggested that the reaction between NiOOH and $Ni(OH)_2$ occurred in the electrode after charge-discharge cycles had been repeated. The relationship between the nickel consumption and the NiOOH/$Ni(OH)_2$ reaction will be discussed in this paper.

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References
1. M. Morimitsu, S. Ikeda, T. Ogawa, M. Matsunaga, S. Taniguchi, M. Takahashi, 204th ECS meeting, Abs# 218 (2003).

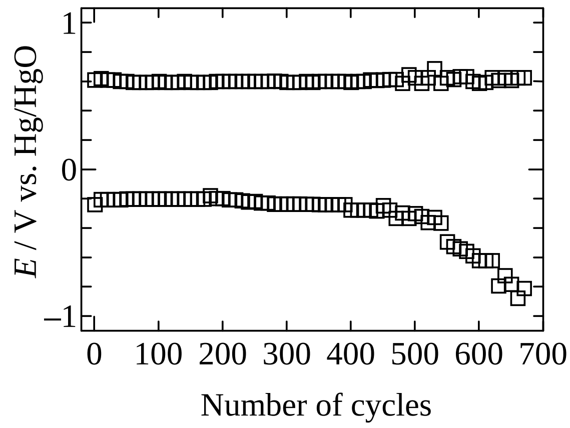

Fig. 1 Dependences of the electrode potentials at the ends of charge and discharge with the number of cycles. 38.3 mA cm^{-2}, 333 K.