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PREPARATION OF NICKEL HYDROXIDE FOR NICKEL-CADMIUM CELL

Yasushi Sasaki and Tsugito Yamashita

*Faculty of Engineering Kanto Gakuin University
4834, Mutsuuracho, Kanazawa-ku, Yokohama 236 JAPAN*

ABSTRACT

Electrolytic impregnation of nickel hydroxide into porous sintered nickel plaque from various nickel solutions were carried out at room or high temperatures and current density range of 2.5mA cm^{-2} to 25mA cm^{-2} . The morphology of the deposited surface was observed with an electron microscope and the surface products were analyzed by means of X-ray diffraction method. Nickel hydroxide was deposited in nickel nitrate electrolyte, while deposits from sulphate or chloride solutions were almost metallic nickel. The loading level of nickel hydroxide from nitrate solutions was 1.6g cm^{-3} void volume and the appearance of the surface was good quality. Discharge capacity of prepared electrodes in nickel nitrate electrolyte was larger than that of the others bath. It was considered that the cell capacity was dependent on the surface roughness of active material.

INTRODUCTION

The nickel active material is used as battery cathode. The nickel-cadmium alkaline battery is a subject of research for high energy density and extend the life-time. Nickel electrode are often prepared by chemical impregnation of active nickel hydroxide in the porous sintered nickel plaque. Since the operation of chemical impregnation is very complicated, its process requires a special technique. In the electrochemical method, nickel hydroxide is electrolytically deposited in the pores of the plaque¹⁾. This method is operate efficiently.

However, electrolytic impregnation deteriorates the properties of the nickel nitrate solution due to the formation of ammonium hydroxide²⁾. Therefore, reproducibility is not

necessarily uniform. In the present paper, the properties of electrodes prepared by electrochemical impregnation from various nickel solutions were investigated.

EXPERIMENTAL PROCEDURE

The typical process flow sheet for electrochemical impregnation of nickel hydroxide electrode is shown in Figure 1. Sintered nickel plaque ($50 \times 70 \times 0.7\text{mm}$, porosity 85%) was placed between two counter electrolytic nickel plates. $0.5 \sim 3.0\text{M Ni}(\text{NO}_3)_2$, NiSO_4 and NiCl_2 solutions were carried out at room or high temperature (85°C) and current densities in the region of $2.5 \sim 25\text{ mA cm}^{-2}$ were used. The nickel hydroxide electrodes were assembled with two negative cadmium electrodes in the cells and 6M KOH was used as an electro-

lyte. The characteristics of the cells prepared by electrolytic impregnation were compared with high temperature chemical impregnation³⁾. The surface morphology was analyzed by means of a scanning electron microscope.

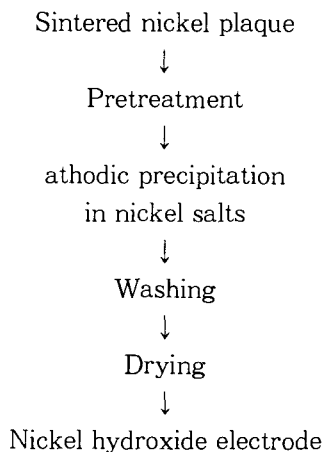


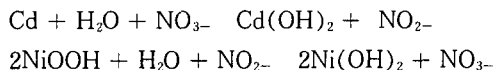
Fig. 1 Schematic of electrochemical impregnation process.

RESULT AND DISCUSSION

The best condition of deposition of electrolytic impregnation from $\text{Ni}(\text{NO}_3)_2$ solution was constant current-constant voltage electrolysis at 85.

In this method, constant current electrolysis at 25mA cm^{-2} 60min was followed by constant voltage 2.4V 60min electrolysis. Sometimes, the loading level of nickel hydroxide in this case was almost 1.6g cm^{-3} void volume. However, the amount of nickel hydroxide was decreased with a number of impregnation times. Table 1 shows typical data of loading levels. This may be due to change of bath condition.

Nitrate ions increase the self-discharge of the nickel-cadmium cell⁴⁾.



The discharge of the positive and negative electrodes were promoted very much by the nitrate-nitrite shuttle. It should be taken to minimize the content of nitrate. Table 2 shows initial capacities of the nickel positive electrodes.

Electrochemical impregnation from nickel sulphate and chloride solutions can be taken nitrate free electrode. However, these electrodes had little discharge capacities. Figure 2 shows X-ray diffraction patterns of nickel positive electrodes. From the figure, it can be considered as deposits from sulphate and chloride solutions were almost metallic nickel.

Table 1 Impregnation data of nickel positive electrodes.

Number of Impregnation	Weight gain/g	Loading level / $\text{g} \cdot \text{cm}^{-3}$ void vol.
1	0.763	1.04
2	0.633	0.87
3	0.618	0.85
4	0.599	0.82

Table 2 Initial capacities of nickel positive electrodes

Impregnated solution	$\text{Ni}(\text{NO}_3)_2$	NiSO_4	NiCl_2
Discharge capacity/Ah	1.00	0.01	0.01
Utilization /%	106	0.93	0.92

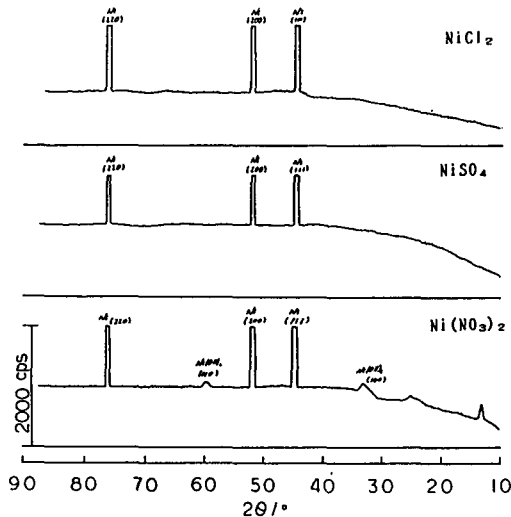


Fig. 2 X-ray diffraction patterns from nickel positive electrodes.

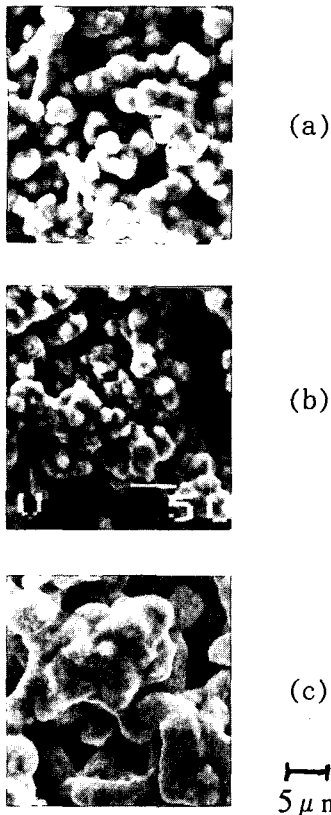


Fig. 3 SEM photographs of the surface of nickel
(a) Impregnated in $\text{Ni}(\text{NO}_3)_3$ solution
(b) Impregnated in NiSO_4 solution
(c) Impregnated in NiCl_3 solution

The results of the surface observations are presented in Figure 3. The morphological change was observed in the respective electrodes.

In order to compare characteristics of electrochemical impregnation with chemical it (90°C), the cells were measured a quantity of self-discharge on standing (Figure 4, 5). The cell prepared by electrochemical impregnation from $\text{Ni}(\text{NO}_3)_3$ was showed good quality.

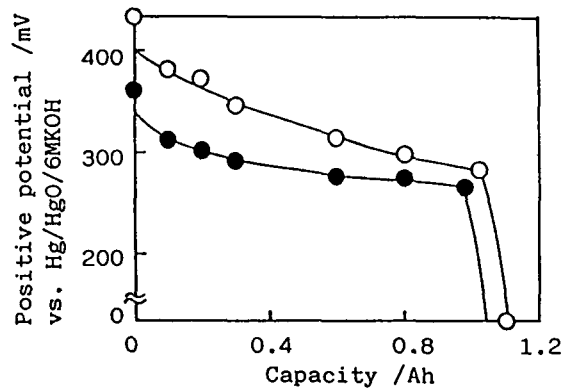


Fig. 4 Charge retention characteristics of Ni-Cd cell.

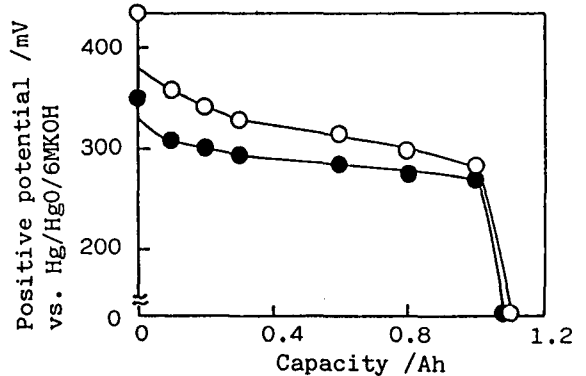


Fig. 5 Charge retention characteristics of Ni-Cd Cell.

4. CONCLUSIONS

In this work, the best condition of electro-

lytic impregnation from $\text{Ni}(\text{NO}_3)_2$ solution is constant current-constant voltage electrolysis at high temperature. However, deposits from NiSO_4 and NiCl_2 solutions are deposited almost metallic nickel. Self-discharge characteristics of Ni-Cd cell prepared by $\text{Ni}(\text{NO}_3)_2$ solution is better than that of high temperature chemical impregnation. It is considered that the cell capacity is dependent on the surface roughness of active material.

REFERENCES

1. L. Kandler, U. S. Pat. 3,214,355 (1965)
2. Y. Kikuchi, T. Ogawa, K. Hasegawa, K. Sugita, DENKIKAGAKU 50, 236 (1982)
3. L. Horn, Chemie-Ing.-Techn. 38, 660 (1966)
4. S. U. Falk and A. J. Salkind, "Alkaline Storage Batteries", John Wiley & Sons, Inc. (1969) p.631