

Electrochemical characteristics of $\text{Na}_2\text{FeP}_2\text{O}_7$ as the cathode material of Na ion batteries

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Introduction

Na ion batteries (NIBs) have been considered as an attractive alternative to Li ion batteries (LIBs) from the viewpoints of cost and stable supply. Honma et al. reported that $\text{Na}_2\text{FeP}_2\text{O}_7$ glass ceramic (NFP g.c.) powder prepared by a glass crystallization method shows good performance as the cathode material in NIBs [1]. We have investigated the relationship between the BET specific surface area (BET SSA) of NFP g.c. powder and its charge-discharge characteristics. We also evaluated the diffusion constants of the cations in NFP g.c. and LiFePO_4 glass ceramic (LFP g.c.) [2].

Experimental

A precursor glass was made by melting raw materials and quenching. Glass ceramic powder was prepared by heating the precursor glass at 620°C for 3h and grinding with a ball mill. The cathode material was processed by coating the surface of the glass ceramic powder with carbon and heating in N_2 gas at 620°C for 3h.

A coin cell was used for electrochemical experiments. The cathode was fabricated by coating an aluminum foil with slurry. The slurry was a mixture of the cathode material, polyvinylidene fluoride, and acetylene black in a weight ratio of 90:5:5 with N-methylpyrrolidone used as a solvent. The anode was a sodium metal foil. Each electrode was punched out from the foil and had a diameter of $\phi 11\text{mm}$. The electrolyte was a 1M NaPF_6 solution in a mixture of ethylene carbonate and diethyl carbonate (1:1, v/v).

The diffusion constant of the cations in NFP g.c. was calculated from the slope of the peak current obtained by cyclic voltammogram measurement at several sweep rates. The diffusion constant of the cations in LFP g.c., which is used as a cathode active material in LIBs, was also evaluated.

Results and Discussion

Figure 1 shows charge-discharge curves of an NIB with various BET SSAs of NFP g.c. at a rate of 10C (full charge and discharge in 6min.). The charge-discharge capacity increased with increasing BET SSA. The charge-discharge capacity of NFP g.c. at a rate of 0.1C (full charge and discharge in 10h) was 90mAh/g. By increasing BET SSA of NFP g.c. to $15\text{m}^2/\text{g}$, the ratio of the discharge capacity at a rate of 10C to that of 0.1C reached 83%.

Figure 2 shows the diffusion constants of the cations in NFP g.c. and LFP g.c. The charge and discharge diffusion constants in NFP g.c. are more than ten times higher than those in LFP g.c. The high diffusion constants in NFP g.c. indicate its suitability for use as a rapid chargeable-dischargeable material.

These results show that NFP g.c. is an attractive cathode material for NIBs.

Reference

- 1) T. Honma et al., Journal of the Ceramic Society of Japan, 120 (2012) 344-346.
- 2) T. Honma et al., Journal of Non-Crystalline Solids, 356 (2010) 2032-3036.

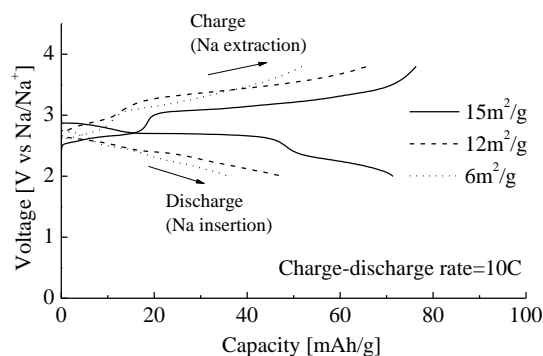


Fig.1 Charge-discharge curves of NIB with various BET SSAs of NFP g.c.

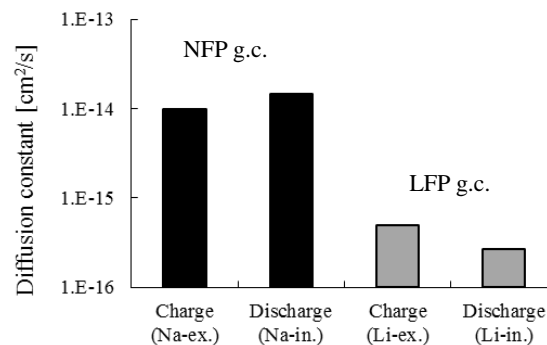


Fig.2 Diffusion constants of NFP g.c. and LFP g.c.