Fabrication of $Na_3V_2(PO_4)_3$/C as a Positive Electrode with High Power Densities for Sodium Secondary Battery Utilizing Ionic Liquid Electrolyte

Jinkwang Hwang[a], Kazuhiko Matsumoto[a, b], and Rika Hagiwara[a, b]
[a] *Graduate School of Energy Science, Kyoto University, Kyoto, Japan*
[b] *Unit of Elements Strategy Initiative for Catalysts & Batteries (ESICB), Kyoto University, Kyoto, Japan*

E-mail: hwang.kwang.44w@st.kyoto-u.ac.jp

Sodium secondary batteries are attractive owing to abundant sodium resources. However, the performance is still limited for practical use. A number of studies have reported about positive electrode materials for sodium secondary batteries, and the $Na_3V_2(PO_4)_3$ (NVP) with a NASICON structure is one of the most promising in consequence of its high operation voltage, structural stability, and fast ionic conductivity [1, 2]. However, its low electrical conductivity is a big drawback to achieve actual performance [2].

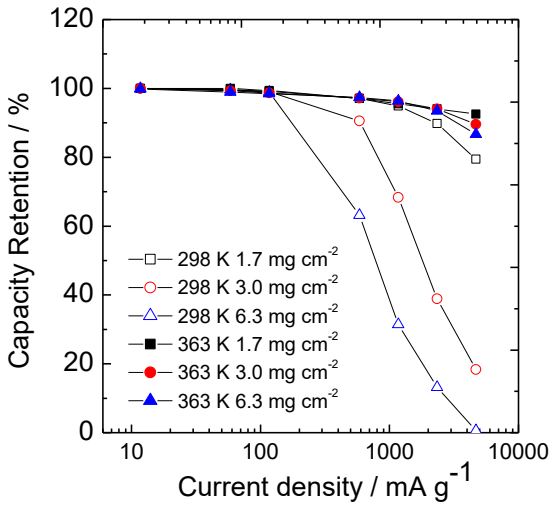

Figure 1 Rate capability of NVPC with various thickness at 298 K and 363 K in IL electrolyte.

To overcome its low electrical conductivity, we have prepared NVP with carbon (NVPC) by a sol-gel method. After preparation, electrochemical tests were conducted at intermediate temperatures using Na[FSA]-[C_2C_1im][FSA] (C_2C_1im = 1-ethyl-3-methylimaidazolium, FSA = bis(fluorosulfonyl)amide) ionic liquid (IL) electrolyte. High thermal stability of IL electrolytes are essential to realize intermediate temperature operation by considering the improvement of battery performance [3]. Figure 1 shows that NVP reveals superior rate capability at 363 K even using high loading mass (Capacity retentions at 40 C compared to 0.1C for NVP with 1.7 mg cm^{-2}, 3.0 mg cm^{-2}, and 6.3 mg cm^{-2} at 363 K are 92.5, 89.5, 86.6%, respectively.) .

The results from this study suggest that the combination of NVP and carbon can efficiently improve the electrical conductivity, and the use of IL electrolyte can further improve its rate capacity with superior power and energy density at 363 K. Finally, high loading mass electrode test will step closer to construct practical sodium secondary batteries.

References:

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