

Research and Development of All-Solid-State Lithium Ion Batteries using Hydride-based Solid Electrolytes - Manufacturing Method and its Performance -

Naoto Yamashita ^a, Takashi Mukai ^a, Hideaki Tanaka ^a, Keita Noguchi ^b,
Aki Katori ^b, Genki Nogami ^b, Masahiro Yanagida ^a

^a *Research Institute of Electrochemical Energy, National Institute of Advanced Industrial Science and Technology (AIST), 1-8-31 Midorigaoka, Ikeda, Osaka 563-8577, Japan*

^b *Niigata Research Laboratory, MITSUBISHI GAS CHEMICAL COMPANY, INC., 182, Tayuhama Shinwari, Kita-ku, Niigata-city, Niigata 950-3112, Japan*

E-mail: m-yanagida@aist.go.jp

The all-solid-state lithium ion battery (LIB) is one of the promising candidates for next generation energy storage devices for electric vehicles and wearable devices. Hydrides have attractive properties such as a high lithium ion conductivity, a highly deformable nature as a new class of solid electrolyte for LIBs [1-2]. Meanwhile bulk solid electrolytes are usually prepared by mechanical methods such as milling and compaction [3].

In this study, we report the all-solid-state LIB with LiBH₄-LiI system as a solid electrolyte. Cathode and anode were prepared by the same method for conventional LIBs with liquid-electrolyte. The cathode slurry was prepared sulfurized rubber (Sumitomo Rubber Industries, Ltd.) as a cathode active material, acetylene black and acrylic polymer in water. The anode slurry was prepared SiO (Shin-Etsu Chemical Co., Ltd.) as an anode active material, acetylene black, VGCF[®] (Showa Denko K.K.) and polyimide in NMP. Then the cathode and anode slurries were spread onto 10 μm-thickness stainless-steel foil and 20 μm-thickness aluminum one, respectively. Subsequently, Li was doped into the anode electrode electrochemically. Mixture of commercially available powders LiBH₄ (≥ 95%, Sigma-Aldrich) and LiI (99.999%, Sigma-Aldrich) for the solid-state electrolyte, respectively, were dissolved in THF to give concentration of 10 wt.%. Both electrodes were coated and soaked with the electrolyte solution and dried several times under dry atmosphere (DP -60°C). Before setting up the coin cell, both electrodes were dried under vacuum at 150°C for 10 h and pressed. The CR2032-type coin cells were fabricated using these electrodes with electrolyte.

Fig. 1 shows the charge-discharge performance of the coin cells operated at 30 and 80°C. Capacity was increased with increased temperature.

References:

- [1] M. Matsuo, S. Orimo, *Adv. Energy Mater.* 1 (2011) 161–172.
- [2] H. Maekawa, M. Matsuo, H. Takamura, M. Ando, Y. Noda, T. Karahashi, S. Orimo, *J. Am. Chem. Soc.* 131 (2009) 894–895.
- [3] A. Unemoto, G. Nogami, M. Tazawa, M. Taniguchi, S. Orimo, *MATERIALS TRANSACTIONS* 58 (2017) 1063–1068.

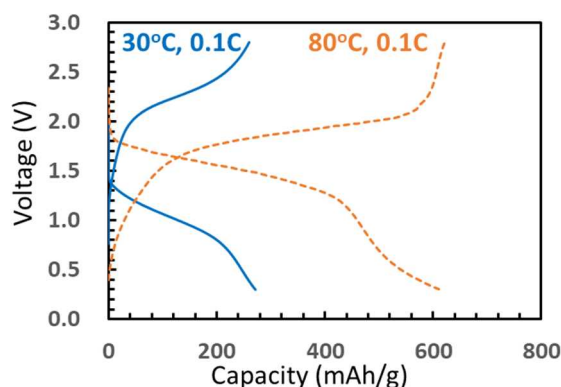


Fig.1 Cell performance of the bulk-type all-solid-state batteries operated at 30 and 80 °C. Cathode: S-compound (0.23mAh/cm²), Anode: SiO (1.0mAh/cm²), Electrolyte:LiBH₄-LiI, Cell type:CR2032-type coin cell. Cut-off voltage: 2.8-0.3 V.