

All solid state Li ion Battery with Ni-Co-Mn cathode and LiPSCI solid electrolyte

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All-solid-state lithium secondary batteries using sulfide-based solid electrolytes are highly focused on novel application as next generation batteries, since their potential of high power and energy density, long cycle life, and higher safety in comparison with liquid electrolyte-based batteries [1]. The value of Li ion conductivity in solid state electrolytes(sulfide, oxide) has been important, before the super Li ion conductivity of solid state electrolyte was obtained with $>10^{-2}$ S/cm[1]. These days, key issues to be solved for the use as a commercialized product are moving from the development of battery materials [2, 3] into material combination and the development of a processing technology [1].

In this respect, we used sulfide-based solid electrolyte via ball milling process, and wet-resolution process. The core-shell of $\text{LiNi}_{0.6}\text{Co}_{0.2}\text{Mn}_{0.2}\text{O}_2$ (NCM622) active materials were prepared with Li-P-S-Cl solution for the coating layer of sulfide-based solid electrolytes (85/15, 90/10, 95/5 wt%). Also, we successfully fabricated all solid state Li ion battery consisted of $\text{LiNi}_{0.6}\text{Co}_{0.2}\text{Mn}_{0.2}\text{O}_2$ (NCM622) cathode with Li-P-S-Cl solid electrolyte. Here, composite cathode consisted of NCM622/LPSCI=(85/15, 90/10, 95/5,100/00wt%), LPSCI(2nd ball milled powders), VGCF, and PEPMNB(70 : 25 : 3 : 2wt%) were also prepared by slurry coating method, and two VGCF-free, and VGCF-embedded samples were prepared and tested as the control cases.

The cell assembly of NCM622 cathode, LPSCI-based solid electrolyte was carried out under the pressure of 4 tons, following the attachment of Li-In (80 : 20wt %) sheets as an anode. I-V test of such solid state Li batteries was conducted under the conditions of c-rate(0.1C), aging condition(55°C, 5h), and test temperature(55°C) in the voltage range of 2.5~4.3V vs. Li/Li⁺.

In this study, we achieved the capacity value of ~160 mAh/g in the discharge process. We understand that the mixing condition, solid electrolyte distribution into the composite, and the addition of electronic conductive VGCF materials are key parameters to achieve excellent performance of NCM622 and sulfide-based solid state Li ion battery. We will discuss on the importance of mixing process and distribution of ionic conductive as well as electronic conductive materials.

References:

- [1] Ryoji Kanno, <http://techon.nikkeibp.co.jp/atcl/news/16/071308349/>
- [2] Jérémie Auvergniot, and Rémi Dedryvère, et. Chem. Mater. 29 3883(2017)
- [3] Chuang Yu, Lambert van Eijck, Swapna Ganapathy, Marnix Wagemaker, Electrochimica Acta 215 93(2016)
- [4] So Yubuchi, Shingo Teragawa, Keigo Aso, Kiyoharu Tadanaga, Akitoshi Hayashi, Masahiro Tatsumisago, Journal of Power Sources 293 941 (2015)