Enhanced electrochemical performance of the NMC cathode for a lithium ion secondary battery using lithium ion conductive glass-ceramics

Takashi Katoh, Ryouhei Satoh, Tatsuya Kato, Kousuke Nakajima
OHARA Inc., 1-15-30 Oyama, Sagamihara, Kanagawa 229-1186, Japan

E-mail: tkatoh@ohara-inc.co.jp

A ceramics powder such as SiO_2 and Al_2O_3 are incorporated in to the polymer electrolyte to form the composite film for the sake of improving ionic conductivity, mechanical and thermal properties. Though these filler enhanced ionic conductivity of gel electrolyte due to the disruption of polymer matrix and increasing micro pores, these are not ionic conductive material. We found that the gel electrolyte film (Pvdf based polymer) was enhanced ionic conductivity by adding LICGC^{TM} .

We have developed lithium ion conducting glass-ceramics LICGC^{TM} with a NASICON type structure for solid lithium ion electrolyte.[1-3)] The ionic conductivity of the glass ceramics with a $Li_{1+x+y}Al_xTi_{2-y}Ge_yPO_4$ composition shows over 1×10^{-4} Scm^{-1} at room temperature. Such ceramics have a very stable in ionic conduction. In addition, the ionic conductivity does not decrease, even if it was soaked in an aqueous of Li salt solution[4-5)], and does not lose the weight in boiling distilled-water for 1 h. The glass-ceramics with the crystalline form of $Li_{1+x+y}Al_xTi_{2-x}Si_yP_{3-y}O_{12}$ with a NASICON-type structure by heat-treated glass with a specific composition[1-2)]. This glass-ceramics has a high lithium-ion conductivity that is equal to or more than 10^{-3} Scm^{-1} at room temperature. Furthermore, because it is very stable in the atmosphere and even to exposure to moist air, it is possible to use this material to apply a solid-electrolyte for a lithium ion secondary battery using organic liquid electrolyte.

The effect of LICGC^{TM} as additive for a lithium ion secondary battery was investigated. We found that $LiCoO_2$ cathode with LICGC^{TM} as additive was increased discharge capacity at 2.0-3.0C. In this work, we synthesized NMC cathode with 1wt.% LICGC^{TM} filler and evaluated it the charge and discharge property using a half cell. We confirm the rate performance at room temperature is enhanced at 0.2-3.0C comparing pristine NMC cathode. The rate performance was indicated 21 percent increasing at 2.0C rate as compared to pristine NMC cathode. The charging performance was also enhanced at higher rate at room temperature.

References:

[1] J. Fu, Solid State Ionics, 96 (1997) 195-200
[2] J. Fu, J. Material Science 33 (1998) 1549-1553.
[3] Y. Inda, T. Katoh, and M. Baba, J. Power Sources, 174 (2007) 741
[4] N. Imanishi, S. Hasegawa, T. Zhang, A. Hirano, Y. Takeda and O. Yamamoto: J. Power Sources 185 (2008)1392.
[5]S. Hasegawa, N. Imanishi, T. Zhang, J. Xie, A. Hirano, Y. Takeda and O. Yamamoto: J. Power Sources 189 (2009)371.