Fabrication of $LiCoO_2$ Composite Electrode on $Li_{6.25}Al_{0.25}La_3Zr_2O_{12}$ Solid Electrolyte by Aerosol Deposition Method

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All-solid-state rechargeable lithium batteries using non-flammable ceramic solid electrolytes are promising as next-generation batteries with high safety. In general, high temperature sintering is carried out for those batteries to form an electrochemical interface since both electrode and electrolyte are solid. However, the high temperature heat treatment limits the combination of electrode and electrolyte materials because of a formation of impurities through their chemical reactions at high temperatures. Aerosol deposition (AD) method is one of new dry processes which can form a ceramic layer on a substrate without high temperature heat treatment. In this study, we tried to optimize AD conditions to obtain a thick $LiCoO_2$ layer on a $Li_{6.25}Al_{0.25}La_3Zr_2O_{12}$ (LLZ) solid electrolyte for all-solid-state rechargeable lithium batteries. In addition to $LiCoO_2$ particles, its composite particles with Li^+-conducting Li_3BO_3 were synthesized and tested. Fig. 1 shows the cross-sectional SEM images of electrodes formed using $LiCoO_2$ particles and $LiCoO_2/Li_3BO_3$ (7/3 in weight) composite particles. They indicate that soft Li_3BO_3 works like binder to provide a thick electrode. Fig. 2 shows the charge-discharge curves of $LiCoO_2$ electrode and $LiCoO_2/Li_3BO_3$ composite electrode on LLZ pellets at 60 °C. The initial discharge capacity and utilization of $LiCoO_2$ were estimated to be 12.8 mA h g^{-1} and 9.3 % in the $LiCoO_2$ electrode, 55.5 mA h g^{-1} and 40.1 % in the $LiCoO_2/Li_3BO_3$ composite electrode, respectively. This result indicates that Li_3BO_3 works as not only binder but also Li^+-conducting pathways to improve the utilization of $LiCoO_2$. However, the obtained electrochemical performance was still low. Thus, the optimization of Li_3BO_3 content, electrode densification and so on are now underway for further improvement of $LiCoO_2$ utilization.

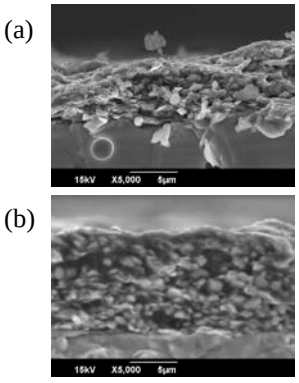

Fig.1 Cross-sectional SEM images of (a) $LiCoO_2$ electrode and (b) $LiCoO_2/Li_3BO_3$ composite electrode formed on LLZ pellets by AD method.

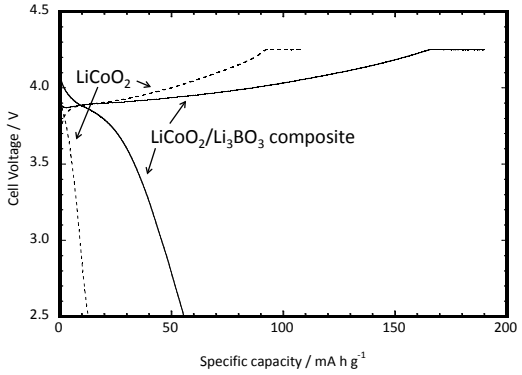

Fig.2 1st charge-discharge curves of (a) $LiCoO_2$ electrode and (b) $LiCoO_2/Li_3BO_3$ composite electrode on LLZ pellets, measured at 60 °C and 0.1 C-rate.