EPD FOR COMPOSITE CATHODE LAYER IN ALL-SOLID-ATATE LITHIUM ION BATTERY BASED ON SULFIDE ELECTROLYTE

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All-solid-state lithium ion batteries (LIBs), in which liquid-organic electrolytes are replaced with solid state inorganic electrolytes, are expected to be the optimal rechargeable batteries in the next generation because of their higher energy density, cycle stability and ignition safety. In order to develop all-solid-state LIBs with practical performance, controlling architecture in electrode layer consisting of active materials and solid electrolyte, to obtain good contact of the solids interfaces, with high packing ratio is necessary. However, there are few studies on controlled fabrication of macrostructure. We would like to propose a novel method which is employs electrophoretic deposition (EPD) for preparing composite cathode layer, with $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$ (NMC) and $75Li_2S\text{-}25P_2S_5$ (LPS) used as the cathodic active material and solid electrolyte, respectively. The EPD technique can be used to prepare a cathodic layer with a desired structure because its equipment set up is simple but can be used to obtain complex composite structures.

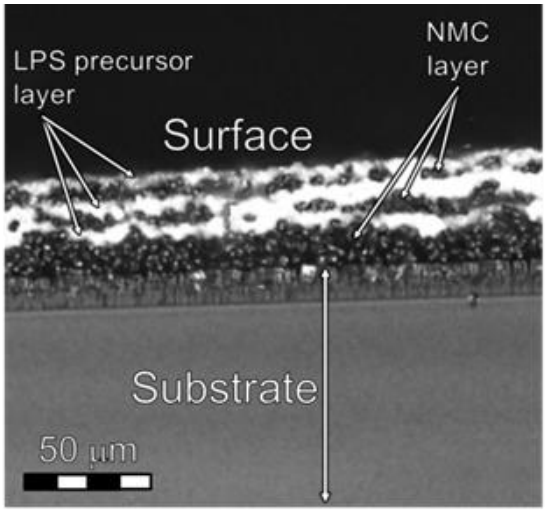

Figure 1 Cross-sectional image of (NMC|LPS-precursor)$_3$ stacking film, deposited on conductive grass substrate, fabricated by alternative EPD in NMC and LPS-precursor dispersions.

In EPD fabrication of cathodes like LPS with high reactivity with water and polar media, there is the need for research into the possibility of preparing them as precursor colloids in non-polar solvents. In this study, we found an EPD procedure for the preparation of NMC and LPS composite layers, in non-polar media. This was achieved by employing their precursors as: NMC coated with composite of organic-onium salts and ion conductive resins; and as-prepared LPS colloid via liquid shaking method in as reported by us in our previous work[1)]. We obtained NMC-LPS precursor composite film as a laminate structure as shown in Figure 1 via alternative EPD in dispersions of NMC and LPS precursor. The deposited composite film, about 40 micrometer thick, consisted of several separated sub-layers of NMC-LPS precursor composite, each of thickness in the range of 8-17 micrometer. For application of EPD film as practical cathode, a film based on many stacked thin layers of NMC-LPS precursor would be suitable because of enhanced contact of their interfaces of the layers, in on vertical direction to substrate.

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Reference
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