Binder-free electrodes with Polymer-assisted Deeply Supercooled Li Salt

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In recent years, there has been an increasing call for the expansion of electric vehicles (EVs) and stationary storage batteries to reduce carbon dioxide (CO_2) emissions, which are a primary cause of global warming. To address this challenge, there is an urgent need to develop high energy density storage devices. A common method to improve energy density of Li secondary batteries is to increase the thickness of composite electrodes. The thicker electrodes increase the percentage of electrode-active materials in the overall batteries, thereby enhancing the energy density.[1] However, this enhancement in energy density requires the use of a greater amount of binder to prevent delamination, resulting in higher resistance. Furthermore, the Li-ion mass transport within the thicker electrodes exerts a significant influence on battery performance.[2] Therefore, developing electrolytes with high ionic conductivity and a high Li^+ transference number (t_{Li}) is also an essential challenge.

We previously reported a Li ionic liquid electrolyte, deeply supercooled Li salt (Li-DSS), which is obtained by adding a small amount of polymer to Li salt. Li-DSS remains liquid at ambient temperature and exhibits a high t_{Li}. In addition to those properties, Li-DSS has strong adhesive property. The objective of this study was to utilize Li-DSS not only as an electrolyte but also as a binder with Li ion conductivity for thicker electrodes, as has been recently proposed.[3, 4] The adhesive property of Li-DSS was evaluated by peeling test and rheological measurement. In this study, we investigated the impact of the molecular weight and mixing ratio of polymers added to Li salt on the adhesive properties. Thick binder-free composite electrodes of Li secondary batteries were also prepared by simply mixing the optimized Li-DSS and electrode-active materials. In addition to the adhesive property of Li-DSS, we report charge-discharge properties of the binder-free electrodes.

References

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Choji Niwamura is Master course student at Department of Chemistry and Life Science, Yokohama National University. He is working on the development of materials and manufacturing processes for next-generation high-performance Li secondary batteries. His research includes adhesive property of ionic liquid and application to binder-free electrodes with them.