Electrochemical Intercalation Behavior of Amide Anions into Graphite in Ionic Liquid Electrolytes

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The demands for large-scale rechargeable batteries are increasing with the spread of renewable energy resources due to their intermittent power generation. Lithium-ion batteries (LIBs), which are widely applied for portable electronic devices, have also garnered much attention for large-scale use. However, the utilization of scarce metals (cobalt, nickel, etc.) in positive electrodes and flammable organic solvent-based electrolytes may impede the further installation of large-scale LIBs. To address those potential risks for large-scale batteries, we have focused on dual-carbon batteries (DCBs) using ionic liquid (IL) electrolytes. DCBs are composed of carbon materials for both positive and negative electrodes, which is essentially unrelated to the usage of scarce transition metals. Since DCBs are categorized into reserve-type rechargeable batteries, their electrolytes should contain charge carriers at high concentrations before battery operation. In this regard, ILs are suitable as DCB electrolytes because ILs solely consist of cations and anions without any neutral solvents that cannot contribute to battery capacities.

We previously investigated charge–discharge behaviors of graphite positive electrodes in several amide-based IL electrolytes containing bis(fluorosulfonyl)amide (FSA^-) and (fluorosulfonyl)(trifluoromethylsulfonyl)amide (FTA^-) anions.[1,2] In the case of FSA-based ILs, despite anions being intercalated into graphite, alkali metal cations largely affect the performance of graphite positive electrodes.[1] In Na[FSA]–[C_3C_1pyrr][FSA] (C_3C_1pyrr = *N*-methyl-*N*-propylpyrrolidinium), the graphite positive electrode exhibits stable charge–discharge capacities of 80–100 mAh g^{-1}, entailing the formation of graphite intercalation compounds (GICs) with intercalant gallery height (d_i) of approximately 13 Å that is exceptionally larger than well-known values for FSA-GICs ($d_i \approx 8$ Å)[3]. In this study, we report further details of electrochemical behavior of graphite positive electrodes in amide-based IL electrolytes.

This study was partly supported by JSPS KAKENHI (JP24K01602) and JST PRESTO (JPMJPR2479) grants.

References

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