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Elucidating the Impact of Sodium Salt Concentration on the Cathode-Electrolyte Interface of Na-Air Batteries

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Abstract

A promising approach to improve the specific capacity and cyclability in a Na-O2 cell using a pyrrolidinium-based ionic liquid electrolyte in a half-cell has been explored in this work. Increasing the concentration of sodium salt in an ionic liquid electrolyte produces a significant enhancement in the discharge capacity of up to 10 times, a reduction of the overpotential and an increase in long-term cyclability. Additionally, a distinct discharge morphology is also observed, which is demonstrated to be a result of a different oxygen reduction reaction (ORR) mechanisms. These improvements are likely due to the solvation of Na+ in the electrolyte mixtures containing different Na+ concentrations; the coordination of Na+ by the anion of the ionic liquid dictates the discharge product morphology. At low Na+ concentrations, Na+ is strongly coordinated by the anion of the ionic liquid, and this also can have an effect on its mobility; however, at high Na+ concentration this interaction is weakened, and favouring mass transport prior to product deposition. It therefore appears that the "highly-concentrated" electrolyte strategy is a useful route to enhance the performance of Na-O2 batteries. Interestingly, when using a pressurized Swagelok-type cell the discharge product presents cubic morphology which is typical of NaO2. This is the first work where this characteristic morphology appears when using an ionic liquid which opens new venues for future research.

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