

A low-cost Al-graphite battery with urea and acetamide-based electrolytes

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A key challenge facing future battery technologies is finding alternatives for currently used raw materials, which are often expensive and are becoming increasingly scarce. In recent years, Al-graphite batteries have been proposed as a valid alternative to Li-ion systems due to their low-cost and sustainability, as well as a stable long-term cycle life.^[1,2] In contrast to commonly used but typically expensive ionic liquid based electrolytes i.e. [EMIm]Cl/AlCl₃, our reported Al-graphite batteries use urea/AlCl₃ and acetamide/AlCl₃ based deep eutectic solvents (DES) as low-cost alternative.

By carefully selecting amide composition, Al speciation in the DESs electrolyte can be modified. Typical cationic and anionic complexes include [AlCl₂(amide)_n]⁺, Al₂Cl₇⁻, and AlCl₄⁻ in various ratios. [AlCl₂(amide)_n]⁺ and Al₂Cl₇⁻ are actively involved in anodic Al dissolution and deposition, whereas AlCl₄⁻ is intercalated between layers of graphite on the cathode.^[3,4] Hence battery performance is greatly influenced by electrolyte composition and crystallinity of the cathodic graphite structure, demonstrated in this work by electrochemical analysis methods. Additionally, Raman spectroscopy was used to relate Al complexation in the electrolyte to changes in battery performance.

The practical applicability of the Al-graphite battery with urea/AlCl₃ electrolyte was demonstrated using cycling experiments with >6,000 cycles, exhibiting a specific capacity of 50 mAh/g at a current density of 10 A/g.

References:

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