

Experimental Considerations Involving Aluminum and Beryllium Battery Development
John Rogosic and Donald R. Sadoway
Massachusetts Institute of Technology
77 Massachusetts Avenue, 4-229
Cambridge, MA, 02139, U.S.A.

The study of alternative-ion intercalation materials has attracted great interest in recent years. A range of possible applications including low-cost and niche energy storage has led to the investigation or re-investigation of intercalant ion candidates. Ions such as sodium, potassium, magnesium, calcium and aluminum have been explored as possible ion candidates. In this work we will present some preliminary results with aluminum and beryllium systems with ionic liquid based electrolytes.

Metallic aluminum is well-known to be able to be reversibly electrodeposited and electrostripped in aluminum chloride-based ionic liquids. A half-cell system consisting of such an electrolyte with a metallic aluminum anode thus easily enables the study of electrochemistry of cathode material reactions involving aluminum.

Aluminum deposition in imidazolium chloride based ionic liquids, presented previously by ORNL, is examined. The morphology of such deposits is unique in that the aluminum deposits are platelet like, indicating a preferred growth direction during deposition.

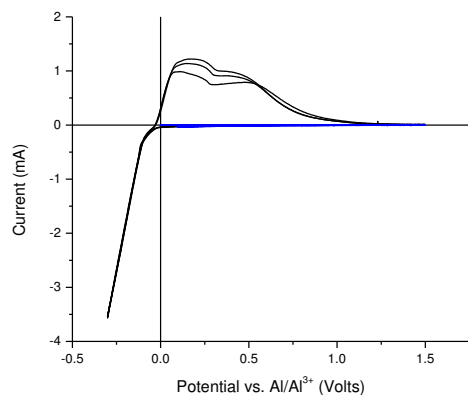


Figure 1. Cyclic voltammogram of aluminum deposition and stripping on vitreous carbon substrates, sweep rate 1 mV/s.

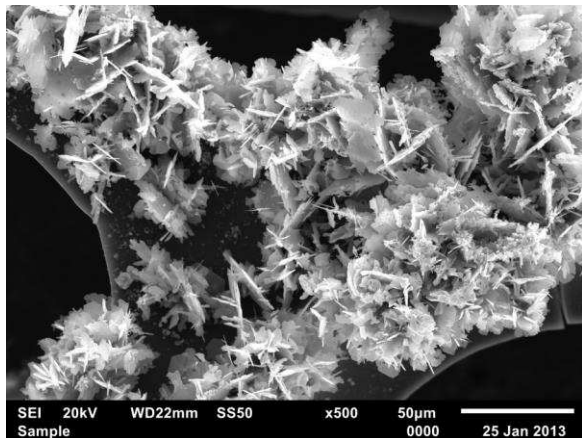


Figure 2. Morphology of aluminum deposit on vitreous carbon substrate produced by galvanostatic deposition.

Judging by the morphology, it is obvious that such electrolytes are unsuitable for operation of a metallic anode in a battery, however the reversibility of the process enables the study of other electrode materials in half-cell configuration.

One such cathode explored is the Mo_6Se_8 Chevrel phase, which is observed to have substantial electrochemical signal (near theoretical capacity) when cycled in aluminum ionic liquid electrolytes at low rates.

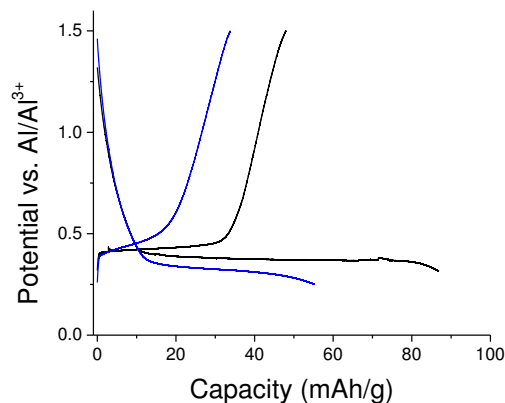


Figure 3. Galvanic charge and discharge curves for Mo_6Se_8 composite electrodes cycled at C/8.5 (blue) and C/85 (black) rates.

The mechanism of charge storage and origin of the electrochemical signal is questionable, however the discharged material does show a distinct aluminum signal observed by EDS measurements.

An analogous system to the imidazolium chloride system used for aluminum deposition is explored with analogous beryllium chemistry. Electrochemical signal consistent with the electrodeposition and stripping of beryllium deposits is obtained, and will be further explored along with consideration of possible beryllium-based faradaic processes within cathode materials.