Aluminum Chloride-Natural Graphite Battery and its Energy Density

K. V. Kravchyk^{1,2}, S. Wang^{1,2}, L. Piveteau^{1,2}, F. Krumeich^{1,2}, M. V. Kovalenko^{1,2}*

¹Institute of Inorganic Chemistry, Department of Chemistry and Applied Biosciences, ETH Zürich, CH-8093 Zürich, Switzerland, ²Empa – Swiss Federal Laboratories for Materials Science and Technology, CH-8060, Dübendorf, Switzerland

Non-aqueous, ionic liquid-based aluminum chloride-graphite batteries emerge as a highly promising post-Li-ion technology for low-cost and large-scale storage of electricity, because it features exclusively highly abundant chemical elements and simple fabrication methods. In this work, we examined the recently proposed aluminum-ionic liquid-graphite architecture. Although previous studies have focused on graphitic cathodes, we analyzed the practicality of achievable energy densities and found that the AlCl₃-based ionic liquid is a capacity-limiting anode material. By focusing on both the graphitic cathode and the AlCl₃-based anode, we improved the overall energy density. First, high cathodic capacities of ≤ 150 mAh g⁻¹ and energy efficiencies of 90% at high electrode loadings of at least 10 mg cm⁻² were obtained with highly crystalline natural graphite flakes or with synthetic kish graphite flakes, which were subjected to minimal mechanical processing. Second, the AlCl₃ content in the ionic liquid was increased to its maximal value, which essentially doubled the energy density of the battery, resulting in a cell-level energy density of ≤ 65 Wh kg⁻¹.

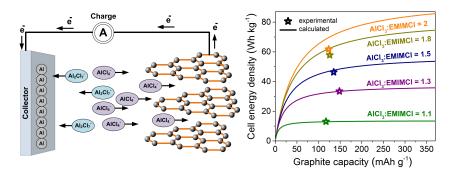


Figure 1. An aluminum chloride-graphite battery. (a) Schematics of the charging process. (b) Comparison of the calculated (curves) and experimental (data points) cell-level energy densities.

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