

Aluminum Chloride-Natural Graphite Battery and its Energy Density

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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.¹ Although previous studies have focused on graphitic cathodes, we analyzed the practicality of achievable energy densities and found that the AlCl_3 -based ionic liquid is a capacity-limiting anode material. By focusing on both the graphitic cathode and the AlCl_3 -based anode, we improved the overall energy density.^{3,4} First, high cathodic capacities of $\leq 150 \text{ mAh g}^{-1}$ 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 AlCl_3 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 $\leq 65 \text{ Wh kg}^{-1}$.

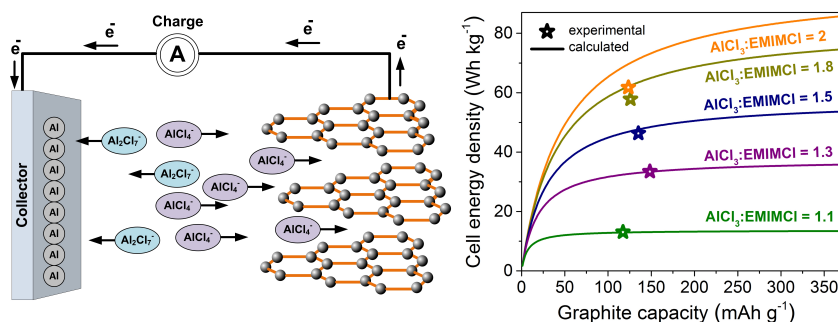


Figure 1. An aluminum chloride-graphite battery. (a) Schematics of the charging process. (b) Comparison of the calculated (curves) and experimental (data points) cell-level energy densities.

[1] Meng-Chang Lin, Ming Gong, Bingan Lu, Yingpeng Wu, Di-Yan Wang, Mingyun Guan, Michael Angell, Changxin Chen, Jiang Yang, Bing-Joe Hwang Hongjie Dai, *Nature* **2015**, 520, 324-328.

[2] Kostiantyn V. Kravchyk, Shutao Wang, Laura Piveteau and Maksym V. Kovalenko, *Chem. Mater.* **2017**, DOI: 10.1021/acs.chemmater.7b01060.

[3] Shutao Wang, Kostiantyn V. Kravchyk, Frank Krumeich and Maksym V. Kovalenko. *Chem. Mater.* **2017**, submitted.