Low-Corrosivity and Moisture Insensitive Ionic Liquid Electrolyte for Rechargeable Aluminium Batteries

Jagabandhu Patra (潘卓督)[1,2], Chi Li (李馳)[3], Jeng-Kuei Chang (張仍奎)[1,2,3*]

[1] Department of Materials Science and Engineering, National Chiao Tung University, Hsinchu, Taiwan
[2] Hierarchical Green-Energy Materials (Hi-GEM) Research Center, National Cheng Kung University, Tainan, Taiwan
[3] Institute of Materials Science and Engineering, National Central University, Taoyuan, Taiwan
jpatra2014@gmail.com; jkchang@nctu.edu.tw

Abstract

Rechargeable aluminum batteries (RABs) have been extensively developed due to their cost-effectiveness, eco-friendliness, and low flammability and the earth abundance of their electrode materials. However, the commonly used RAB ionic liquid (IL) electrolyte, based on $Al_2Cl_7^-$, is highly moisture-sensitive and corrosive. This can complicate cell assembly, increase the risk to safety, and cause dissolution of the battery components. Therefore, a novel $Al_2Cl_7^-$-free 4-ethylpyridine/$AlCl_3$ IL is first proposed in this work. *In situ* synchrotron X-ray diffraction together with XPS and EDS mapping confirmed that a stage-3 graphite intercalation compound formed at the end of charging and that the deintercalation of $AlCl_4^-$ occurred upon discharging, allowing a reversible capacity of 95 mAh/g and great cycleablility. Using $[AlCl_2(4\text{-ethylpyridine})_n]^+$ to replace $Al_2Cl_7^-$, the 4-ethylpridine–$AlCl_3$ IL shows low corrosivity toward Al, Cu, Ni, and carbon-fiber paper electrodes. Most importantly, this IL is moisture-insensitive and thus allows charge-discharge of the Al//graphite open cell under an ambient atmosphere. The results clearly indicate the great potential of this electrolyte for practical RAB applications.

Keywords - Al/graphite cell, air-stable electrolyte, electrolyte design, corrosion, in situ X-ray diffraction