Highly-lithiophilic film to Suppress Dendrite Formation on Cu Substrate in Anode-free Lithium Metal Batteries

Zewdu Tadesse Wondimkun, [1] Wodaje Addis Tegegne,[2] Jiang Shi-Kai,[1] Chen-Jui Huang,[1] Niguse Awoke Sahalie,[1] Misganaw Adigo Weret,[1] Jui-Yu Hsu,[1] Pei-Lun Hsieh,[1] Yu-Shan Huang,[4] She-Huang Wu, *,[2,3] Wei-Nien Su, *, [2, 3] and Bing-Joe Hwang *, [1, 4]

[1]NanoElectrochemistry Laboratory, Department of Chemical Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan
[2] NanoElectrochemistry Laboratory, Graduate Institute of Applied Science and Technology, National Taiwan University of Science and Technology, Taipei, Taiwan.
[3] Sustaniable Energy Development Center, National Taiwan University of Science and Technology, Taipei, Taiwan.
[4]National Synchrotron Radiation Research Center (NSRRC), Hsinchu, Taiwan

Abstract

In recent years, rechargeable metal batteries have attracted numerous researches due to the increasing demand for high energy density. The anode-free lithium metal battery is an emerging system with high energy density, high safety, and low cost, which is a potential novel system, it will become the next generation battery system in the future. However, since the anode-free directly uses the current collector as the anode, the Li directly deposed on the anode surface, there has some risk by Li dendrite growth and dead Li generation. Therefore, controlling Li growth is a great challenge in the anode-free battery. Herein, a highly constructed current collector with a stable artificial solid electrolyte interphase (SEI), and the lipophilic matrix is highly effective for achieving uniform lithium deposition. In this work, lipophilic films were coated on a Cu current collector to be used as a nucleation seed, and graphene oxide (GO) was coated on top to act as an artificial SEI to buffer the lithium-ion distribution in Anode-free lithium metal batteries (AFLMB). After 60 cycles in 1 M LiPF6 EC/DEC (1:1 vol%), modified Cu // NMC full battery has higher average coulombic efficiency (~98.6%) and higher capacity Retention rate (~55.7%). + 5% FEC at 0.5 mA cm-2.In addition, we introduced high-resolution small-angle X-ray scattering (SAXS) techniques to confirm the situation of nucleation and Li growth, it shows that the average Li core radius of exposed Cu // Li, lipophilic film // Li and Cu | lipophilic film/GO // Li batteries are respectively 43.6 nm, 46.2 nm and 47.5 nm. Therefore, compared to those formed on bare Cu, the coated cell helps to form a more uniform and relatively larger Li core size and results in uniform Li deposition. Therefore, the lipophilic matrix integrated with the artificial SEI coating on the Cu substrate provides a feasible method for inhibiting the lithium dendrites and electrolyte decomposition in AFLMB , at the same time we can combine the characteristic of SAXS to further understanding our technique development is quite, we hope these tools and techniques can provide the future possibility for the anode-free battery.

.***Keywords- Lithiophilic, Lithium nucleation, Silver nanoparticles, Polydopamine, Graphene oxide, Artificial SEI***