3D Current Collector for Stable Lithium Metal Anode

By

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Abstract

Lithium metal battery is one of the lightest battery systems with extremely high theoretical specific capacity (3860 mAh g⁻¹), low density (0.59 g cm⁻³), and the lowest negative electrochemical potential (-3.040 V vs. the standard hydrogen electrode). However, for the past 40 years, lithium metal batteries have been investigated but still un-commercialized due to the low coulombic efficiency and the safety concerns accompanied by dendrite growth of lithium metal anode.

To optimize the electrochemical performance of lithium metal anode, we designed two types of 3-dimensional (3D) current collector. The first copper (Cu) based 3D current collector was synthesized by first employing the chemical reaction between copper and ammonium ion, hydroxide ion to produce copper hydroxide nanosheet on copper foam skeleton, then further dehydration and reduction. The 3D Cu current collector exhibited a high Columbic efficiency (CE) above 97% for lithium stripping and plating after 400 cycles and a much less dendrite forming. The improvement may trace back to the increased surface area and the decreased areal current density. The second carbon nanofiber (CNF) based current collector with two different sides’ composition was synthesized by electrospinning and magnetron sputtering. The upper side (face to the separator) with un-conductive zinc oxide (ZnO) which can effectively prevent the lithium dendrite further growth and the bottom side with high conductive Cu layer was aimed to induce the lithium ion depositing. The CE performance was much enhanced by using this CNF based current collector and the cell assembled with lithium titanate (LTO) revealed a reversible capacity above 160 mAh g⁻¹ under 1C current density for 100 cycles.