Three-Dimensional Octahedral Nanocrystals of Cu2O/CuF2 Grown on Porous Cu Foam Act as a Lithophilic Skeleton for Dendrite-Free Lithium Metal Anode

August 2023 · ACS Applied Materials & Interfaces · 15(36)

DOI: 10.1021/acsami.3c08892

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Abstract

Metallic-lithium (Li) anodes are highly sought-after for next-generation energy storage systems due to their high theoretical capacity and low electrochemical potential. However, the commercialization of Li anodes faces challenges, including uncontrolled dendrite growth and volume changes during cycling. To address these issues, we developed a novel three-dimensional (3D) copper current collector. Here, we propose a two-step method to fabricate Cu2O/CuF2 octahedral nanocrystals (ONCs) onto 3D Cu current collectors. The resulting Cu foam with distributed ONCs provides active electrochemical sites, promoting uniform Li nucleation and dendrite-free Li deposition. The stable Cu2O/CuF2 ONCs@CF metallic current collector serves as a reliable host for dendrite-free lithium metal anodes. Additionally, the highly porous copper foam with a preconstructed conductive framework of Cu2O/CuF2 ONCs@CF effectively reduces local current density, suppressing volume changes during Li stripping and plating. The symmetric cell using Cu2O/CuF2 ONCs@CF metallic current collector exhibits excellent stability, maintaining over 1600 h at 1 mA cm-2 and a highly stable Coulombic efficiency of 98% over 100 cycles at the same current density, outperforming Li@CuF metallic current collectors. Furthermore, in a full-cell configuration paired with nickel-rich layered oxide cathode materials (Li@Cu2O/CuF2 ONCs@CF//NMC-811), the proposed setup demonstrates exceptional rate performance and an extended cycle life. In conclusion, our work presents a promising strategy to address Li anode challenges and highlights the exceptional performance of the Cu2O/CuF2 ONCs@CF metallic current collector, offering potential for high-capacity and long-lasting lithium-based energy storage systems.

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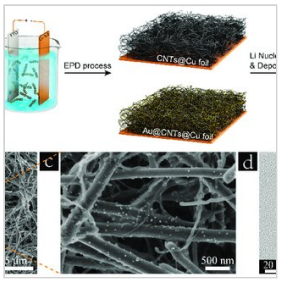

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