IOCN 2023
The 4th International Online Conference on Nanomaterials
05–19 May 2023 | online

Reusable tin-modified biomass-derived carbon network interlayers for dendrite-free and flexible zinc anodes

Xinqi Zhao, Xiaohong Sun *, Song Wang
School of Materials Science and Engineering, Tianjin University, China
(*sunxh@tju.edu.cn)

nanomaterials MDPI

INTRODUCTION

Zinc ion batteries (ZIBs) with low cost, high safety and environment friendliness, are expected to be the promising candidates for energy storage. Unfortunately, their practical application is hindered by the Zn dendrites and hydrogen evolution reaction (HER). Zn dendrites can reduce the capacity and coulombic efficiency, even puncture separators and short-circuit the battery. The HER will corrode the Zn anode surface, and the generated gas exacerbate the battery inflation. The strategies to solve the above issues are categorized as anode design, interface modification, electrolyte adjustment and separator design. Among them, the multifunctional artificial interlayer is a competitive strategy for reversible and homogenous Zn deposition. The interlayer is required of rapid electron/ion transfer and superior zincophilicity to regulate the interfacial electrodeposition kinetics, which mainly focuses on the carbon materials. Herein, a Sn-modified carbonized bacterial cellulose network interlayer is proposed for dendrite-free and stable Zn anode. The low-cost CBC delivers a 3D porous network, providing abundant active sites. And its high mechanical properties and electrical conductivity can meet the requirements for independent interlayers. Besides, the Sn nanoparticles not only reduce the barrier of Zn nucleation and induce homogeneous Zn deposition, but also inhibit the HER and slow the corrosion of Zn anodes. Due to these merits, the independent CBC@Sn interlayer endows a superior cycle stability of Zn||Zn symmetric battery. This flexible and reusable interlayer demonstrates a feasible approach of commercial energy storage with cost-effectiveness and eco-friendliness.

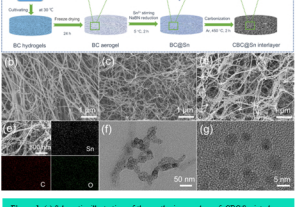

Figure 1. (a) Schematic illustration of the synthesis procedure of CBC/Sn interlayer. (b) SEM image of BC hydrogels, (c) CBC and (d) CBC/Sn. (e) TEM image and EDS mapping image of CBC/Sn. (f, g) HRTEM images of CBC/Sn.

RESULTS

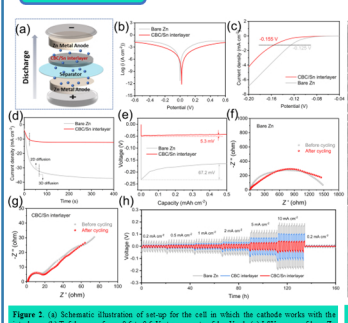

Figure 2. (a) Schematic illustration of set-up for the cell in which the cathode works with the interlayer. (b) Tafel curves from -0.6 to 0.6 V at a scan rate of 1 mV·s-1. (c) LSV curves of bare Zn and CBC/Sn interlayer. (f, g) Nyquist plots of cells. (h) rate performance of cells without interlayer, with CBC interlayer and CBC/Sn interlayer.

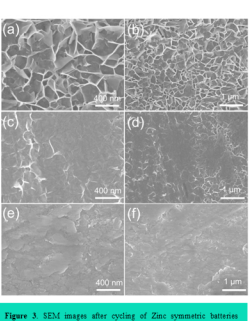

Figure 3. SEM images after cycling of Zinc symmetric batteries without (a, b) an interlayer, with the interlayer of (c, d) CBC, and (e,f) CBC/Sn.

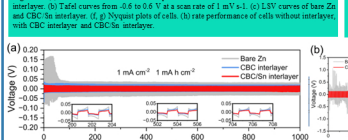

Figure 4. (a) Voltage profiles at 1 mA cm⁻² (1 mAh cm⁻²) and (b) 10 mA cm⁻² (10 mAh cm⁻²) at of Zinc symmetric batteries with the CBC/Sn interlayer, CBC interlayer and without an interlayer. (c) schematic illustration of CBC/Sn interlayer enhances the electrochemistry in ZIBs.

CONCLUSION

In summary, a Sn-modified carbonized bacterial cellulose network interlayer (CBC@Sn) is proposed for dendrite-free and stable Zn anode. The low-cost CBC delivers a 3D porous network, providing abundant active sites. And its high mechanical properties and electrical conductivity can meet the requirements for independent interlayers. Besides, the Sn nanoparticles not only reduce the barrier of Zn nucleation and induce homogeneous Zn deposition, but also inhibit the HER and slow the corrosion of Zn anodes. Due to these merits, the independent CBC@Sn interlayer endows a superior cycle stability of Zn||Zn symmetric battery, a low nucleation overpotential and a high coulombic efficiency of Zn||Cu asymmetric battery, and an excellent rate and cycle performance of Zn||VOPO4 full battery. This flexible and reusable interlayer demonstrates a feasible approach of commercial energy storage with cost-effectiveness and eco-friendliness.