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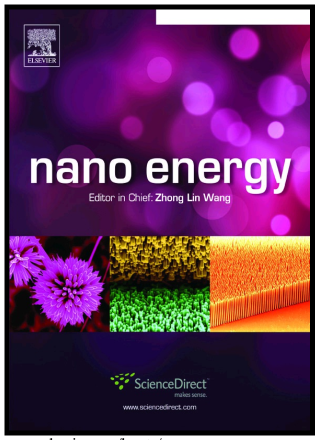

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Sealing ZnO nanorods for deeply rechargeable high-energy aqueous battery anodes

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Abstract

Rechargeable Zn-based batteries are a safe alternative to Li-ion for compatibility with aqueous electrolyte. Also, theoretical volumetric energy density of Zn-based batteries (e.g. Zn-air) is ~85% of lithium-sulfur battery. However, the rechargeability and specific capacity of Zn anodes are limited by passivation and dissolution. Here we report a ZnO@TiN_xO_y core/shell nanorod structure for deeply rechargeable Zn anodes. The small diameter (<500 nm) of ZnO prevents passivation and allows full utilization of active materials, while the thin and conformal TiN_xO_y coating mitigates Zn dissolution in alkaline electrolyte, mechanically maintains the nanostructure, and delivers electron to nanorods. As a result, the ZnO@TiN_xO_y core/shell nanorod anode achieves superior specific capacity and cycle life compared with bulk Zn foil and uncoated ZnO nanorod anodes. The discharge capacity of this anode is twice as large as that of the uncoated ZnO nanorod anode. Remarkably, our ZnO@TiN_xO_y nanorod anode achieves a much higher specific discharge capacity of 508 mAh/g(Zn) than that of many previously reported zinc anodes. It can deeply cycle >640 times (64 days) in a beaker cell and deliver excellent long-term electrochemical performance (more than 7,500 cycles) when cycled under start-stop conditions. The nanoscale design principles reported here is an important step towards practical deeply