Facile Fabrication of CuO Nano-Structures as Anodes for Sodium-Ion Batteries: A Study on the Morphology-Dependent Performance

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Abstract:

The quest for energy due to endless consumption of non-renewable energy sources and severe environmental pollution pushes the researchers to find the alternatives in terms of sustainable, clean, and green energy.[1] Lithium-ion batteries (LIBs) have been successful in various applications ranging from consumer electronics to powerful electronic vehicles due to their high energy density, long cycle life, and environmental benignity.[2,3] However, concerns on limited availability of lithium resources and uneven geographical distribution severely restrict a large-scale application of LIBs.[4] Sodium-ion batteries (SIBs), on the other hand, are the promising candidates to potentially substitute LIBs, due to the cost effectiveness and virtually inexhaustible and ubiquitous resources of sodium around the world. In this work, a facile and environment-friendly hydrothermal approach is employed to successfully synthesize CuO with three different nanostructures, i.e., nanoflake, nano-ellipsoid, and nanorod. The morphological influence on the electrochemical performance of CuO nanostructures is comparatively investigated when they are applied as anodes in sodium-ion batteries. CuO nanorods display a higher reversible capacity and better cycling stability as compared to CuO nano-ellipsoids and CuO nanoflakes. The superior performance of CuO nanorods can be attributed to its slim nanorod morphology with smaller particle size that provides a short diffusion path and maximized electrochemical surface area. The superior electrochemical properties of CuO nanorods in terms of cycling stability, rate capability, and diffusion coefficient in comparison to the CuO nanoflake and nano-ellipsoid structures are presented in detail. The comparative analysis of these materials can provide valuable insights to design hierarchical nanostructures with distinct morphologies by using different structure directing agents to achieve better electrode materials for sodium-ion batteries.

Reference:

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