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Carbon nanotubes/metal-sulfide composite flexible electrode for quantum dot-sensitized solar cells and super-capacitor

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Carbon nanotubes (CNT) and metal sulfides have attracted considerable attention owing to their outstanding properties and multiple application areas, such as electrochemical energy conversion and energy storage. Here we describe a cost-effective and facile solution approach to the preparation of metal sulfides (PbS, CuS, CoS, and NiS) grown directly on CNTs, such as CNT/PbS, CNT/CuS, CNT/CoS, and CNT/NiS flexible electrodes for quantum dot-sensitized solar cells (QDSSCs) and supercapacitors (SCs). X-ray photoelectron spectroscopy, X-ray diffraction, and transmission electron microscopy confirmed that the CNT network was covered with high-purity metal sulfide compounds. QDSSCs equipped with the CNT/NiS counter electrode (CE) showed an impressive energy conversion efficiency (η) of 6.41% and remarkable stability. Interestingly, the assembled symmetric CNT/NiS based polysulfide SC device exhibited a maximal energy density of 35.39 W.h.kg⁻¹ and superior cycling durability with 98.39% retention after 1,000 cycles compared to the other CNT/metal-sulfides. The elevated performance of the composites was attributed mainly to the good conductivity, a high surface area with mesoporous structures and stability of the CNTs and the high electrocatalytic activity of the metal sulfides. Overall, the designed composite CNT/metal-sulfide electrodes offer an important guideline for the development of next level energy conversion and energy storage devices.

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