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CNTs@NC@$CuCo_2S_4$ nanocomposites: An advanced electrode for high performance lithium-ion batteries and supercapacitors

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Abstract: The design and fabrication of the materials to improve their performance are crucial for energy storage of lithium-ion batteries and supercapacitors. Herein, the $CuCo_2S_4$ nanocrystallites grown on N-doped amorphous carbon coated CNTs are synthesized via a facile solvothermal method (CNTs@NC@$CuCo_2S_4$). The N-doped amorphous carbon layer with functional groups can effectively strengthen the adhesion between CNTs matrix and $CuCo_2S_4$ nanocrystallites. The combination of nanocrystallites and the CNTs not only shortens the diffusion path of the electrolyte, but also enhances the electrical conductivity of the electrode. As a result, the CNTs@NC@$CuCo_2S_4$ displays excellent electrochemical performance both in lithium-ion batteries and supercapacitors. The reversible capacity can be retained at 783 mAh g^{-1} after 100 cycles at the current density of 100 mA g^{-1}. And the discharge capacity of 507 mAh g^{-1} is still maintained after 60 cycles even at high rate of 5000 mA g^{-1}. As the electrode for supercapacitors, the CNTs@NC@$CuCo_2S_4$ delivers good capacitive performance with high capability (1604 F g^{-1} at 1 A g^{-1}), good rate capability, and enhanced cycling stability, with 93.6% capacitance retention after 2000 cycles at the current density of 2 A g^{-1}.