Three-dimensional iron sulfide-carbon interlocked graphene composites for high-performance sodium-ion storage

Three-dimensional (3D) carbon-wrapped iron sulfide interlocked graphene (Fe₇S₈@C-G) composites for high-performance sodium-ion storage are designed and produced through electrostatic interactions and subsequent sulfurization. The iron-based metal–organic frameworks (MOFs, MIL-88-Fe) interact with graphene oxide sheets to form 3D networks, and carbon-wrapped iron sulfide (Fe₇S₈@C) nanoparticles with high individual-particle conductivity are prepared following a sulfurization process, surrounded by interlocked graphene sheets to enhance the interparticle conductivity. The prepared Fe₇S₈@C-G composites exhibit not only improved individual-particle and interparticle conductivity to shorten electron/ion diffusion pathways, but also enhanced structural stability to prevent the aggregation of active materials and buffer large volume changes during sodiation/desodiation. As a sodium-ion storage material, the Fe₇S₈@C-G composites exhibit a reversible capacity of 449 mA h g⁻¹ at 500 mA g⁻¹ after 150 cycles and a retention capacity of 306 mA h g⁻¹ under a current density of 2000 mA g⁻¹. The crucial factors related to the structural changes and stability during cycles have been further investigated. These results demonstrate that the high-performance sodium-ion storage properties are mainly attributed to the uniquely designed three-dimensional configuration.

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