Nb_2O_5 Nanoparticles Loaded Nitrogen-Doped Graphene Anode Materials for Sodium Ion Batteries

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Sodium ion batteries have been regarded as promising next-generation energy storage devices. For the insertion-type anode materials with high-performance, the low capacity, poor stability, and big volume effect still limit their further applications. Here, homogeneous Nb_2O_5 nanoparticles loaded nitrogen-doped graphene anode materials (Nb_2O_5/NG) are prepared by using hydrothermal treatment and followed by heating treatment, in which Nb_2O_5 with a size of around 10-15 nm are uniformly loaded on the surface of graphene, indicating that the graphene could effectively hinder the growth and aggregation of Nb_2O_5 nanoparticles. Meanwile, the doped nitrogen enhance the connection of Nb_2O_5 nanoparticles to the graphene nanosheets, and leading to Nb_2O_5 nanoparticles better distribute the surface of graphene nanosheets. The doped nitrogen in graphene can not only increase the conductivity of the graphene, but also improve its performance. The Nb_2O_5/N-rGO electrode exhibits superior rate capability (64 mAh g^{-1} even at 2 A g^{-1}) and good cycling life (104 mAh g^{-1} at 0.2 A g^{-1} for 200 cycles and 83 mAh g^{-1} at 1 A g^{-1} for 950 cycles), they are better than those of Nb_2O_5/G and Nb_2O_5 electrodes. This result suggests that the the doped nitrogen and uniform N_2O_5 nanoparticles are favorable for developing anode materials with high-performance for sodium ion batteries.

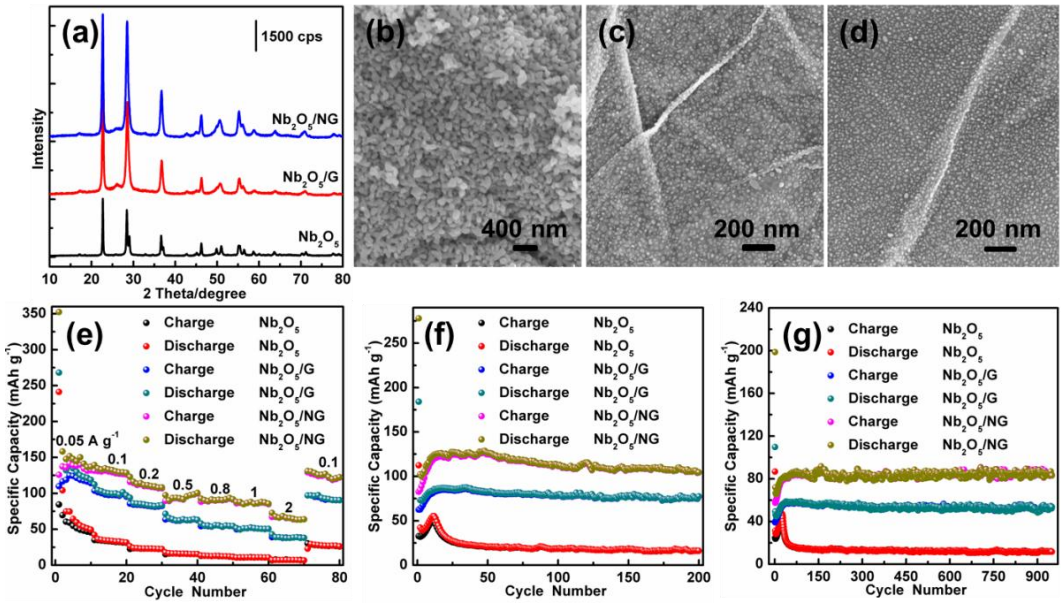

Figure 1. XRD patterns of Nb_2O_5, Nb_2O_5/G and Nb_2O_5/NG (a); FESEM images of Nb_2O_5 (b), Nb_2O_5/G (c), and Nb_2O_5/NG (d); rate capability of Nb_2O_5, Nb_2O_5/G and Nb_2O_5/NG at various current densities from 0.05 to 2 A g^{-1} (e), and cycling performance of Nb_2O_5, Nb_2O_5/G and Nb_2O_5/NG at 0.2 A g^{-1} and 1 A g^{-1} (f, g).