Controlling morphology and enhancing electrochemical performance of cobalt oxide by addition of graphite

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Co_3O_4 has been intensively studied as battery anode materials due to its high theoretical capacity of 890 mAh/g. However, Co_3O_4 suffers from poor conductivity and large volume change during the insertion and extraction of Li ions. It has been well proven that introduction of carbon material to metal oxide is very helpful on improving conductivity and remaining structure stability. Among those widely studied carbon additives (e.g. graphene, carbon nanotubes/ fibers), the currently applied commercial anode material—graphite, not only possesses merits of other carbon materials like high electronic conductivity, superior mechanical properties, excellent chemical tolerance, but also are naturally abundant. Therefore, it is promising and economic to make Co_3O_4/graphite composite as anode material. This strategy combines the properties of two individual materials and avoids steps necessary for modification or preparation of other carbon-based materials. For example, the Hummer method, one of the most popular methods for the preparation of graphene, involves strong oxidant and acid, while catalysts and chemical vapor deposition are often required for making CNTs or CNFs.

Here, we synthesized Co_3O_4 nanowire, Co_3O_4 nanoparticle network, and Co_3O_4/graphite nanocomposite via a simple hydrothermal route and compared their electrochemical performance. We found the addition of graphite not only influenced the morphology of Co_3O_4, but also enhanced its electrochemical performance. In detail, the Co_3O_4 nanowire was formed without adding graphite; after introducing graphite, the morphology of the Co_3O_4 nanocomposite changed to a network through the partial overlapping of nanoparticles. When studied as anode material in lithium-ion batteries, the Co_3O_4/graphite nanocomposite outperforms two different pure Co_3O_4 samples by showing superior Li-ion battery performance with dramatically enhanced cyclic stability and excellent rate performance. Its reversible capacity remains as high as 551 mAh/g after 50th cycle at a current density of 500 mA/g while that of the other two pure Co_3O_4 samples drops below 400 mAh/g.