Iron Oxide Nanostructures as High Performance Anode Materials for Lithium Ion Batteries

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Since the pioneer work of Tarascon in 2000, transition metal oxides MO_x (M = Cu, Mn, Fe, Co, Ni, etc.) have attracted increasing research interest because the metal oxides can store more than one Li-ion per M atom through a conversion reaction mechanism. Among the oxides, hematite, α-Fe_2O_3 is generally considered as one of the most promising anode materials, because it possesses the advantages of low cost, environmental friendliness and high theoretical capacity (1007 m Ah g^{-1}). However, α-Fe_2O_3 suffers from substantially mechanical volume changes and limited electron and Li^+ ions diffusion kinetics during Li-ion uptake and removal, thus resulting in severe loss of capacity and finally electrode fading. To circumvent these problems, one of the effective strategies is to encapsulate Fe_2O_3 using carbon coating or to decorate it with graphene, which can obviously increase the electrical conductivity, hence improving the electrochemical performance. Moreover, it has been observed that the morphology and size have profound effects on the electrochemical performance of electrode materials. And it has been found that the making of nanostructures can substantially improve the cycling performance because the nanostructures can alliviate the volume chagnes. Recently we have successfully prepared iron oxides having novel nanostructures like nanotube arrays, hierarchical multi-layered and flower-like assembles, etc. And superior capacity and cycling stability has been achieved on these nanostructues tested as anode materials for LIBs. The improved electrochemical performance could be attributed to the favorable diffusion of Li-ion, low resistance and adequate accommodation of volume change arising from the very special nanostructures. We hope that this kind of nanostructures could have promising application in next generation LIBs with high energy and power density.

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