TiO$_2$ Nanostructures: Synthesis and Electrochemical Mg$^{2+}$ Intercalation

Yongchang Liu, Lifang Jiao,* Jun Chen,* Huiqiao Liu, Kangzhe Cao and Yijing Wang

Key Laboratory of Advanced Energy Materials Chemistry (MOE), Nankai University, Tianjin, 300071, P.R. China, E-mail: jiaolf@nankai.edu.cn

With the increasing energy crisis, the development of alternative energy storage/conversion devices has gained wide concern during recent years. Owing to their high theoretical specific capacity (2205 mAh g$^{-1}$), considerably negative electrode potential, good operational safety, environmental friendliness and low price, rechargeable Mg batteries are considered to be the most promising green power sources for electric vehicles. In this abstract, TiO$_2$ hollow spheres and microtubes assembled by nanoparticles have been successfully synthesized via facile solvothermal methods, and we first use TiO$_2$ as cathode for rechargeable Mg batteries with good electrochemical performance.

In a typical synthesis, hollow spheres were obtained by a hydrothermal reaction of TiF$_4$ with the assistance of SiO$_2$ templates. While, through the alcoholysis reaction of TiOSO$_4$ in alcohol, ether and glycerol mixed solvent, TiO$_2$ microtubes were prepared. The electrolyte used was (PhMgCl)$_2$-AlCl$_3$/THF solution, and the reference and counter electrode material was polished AZ31 Mg alloy. Electrochemical performance was carried out using a two-electrode cell assembled in an argon-filled glove box.

From the XRD patterns of as-prepared TiO$_2$ hollow spheres and microtubes (Fig. 1), we can see that all the strong sharp diffraction peaks can be readily indexed to anatase TiO$_2$ (JCPDS No. 21-1272) and there are no other peaks of the impurities.

When used as cathode for rechargeable Mg batteries, the results show that both of the two kinds of TiO$_2$ nanostructures could be good hosts for Mg$^{2+}$ intercalation (Fig. 3). What’s more, the specific capacity of hollow spheres is higher than the microtubes, which can reach 170 mAh g$^{-1}$ in the initial cycle and maintain over 50 mAh g$^{-1}$ in the subsequent cycles. We are currently extending our work to improve the cycling stability of such batteries by combining TiO$_2$ with functional materials such as carbon-coating, and TiO$_2$ may be a promising electrode material for the next generation of rechargeable Mg batteries.

![Fig.1 XRD patterns of the as-prepared TiO$_2$ hollow spheres and microtubes.](image1)

![Fig.2 SEM and TEM images of the as-prepared TiO$_2$ (a) hollow spheres and (b) microtubes.](image2)

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References