Study of Fe_2O_3 and TiO_2 molar ratio impact on lithium-ion battery anode performance

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Rapid development of portable electronic devices and electric vehicles demand batteries with higher energy density, greater safety and longer cycle life. Transition metal oxide Fe_2O_3 has become a promising anode material for Li-ion batteries due to its high theoretical capacity and low cost[1]. However, the poor conductivity and violent volume expansion of Fe_2O_3 during the discharge/charge process results in its poor rate capability and cycling performance. The addition of TiO_2 prevents these problems because TiO_2 has good cycling stability and a low volume expansion ratio[2]. Therefore, a ternary Fe_2O_3/TiO_2/rGO anode material showed better electrochemical performance compared to the binary Fe_2O_3/rGO and TiO_2/rGO electrodes[3]. In this work, we study the Fe_2O_3 and TiO_2 molar ratio impact on lithium-ion battery anode performance.

The electrode materials of iron oxide, titanium dioxide and reduced graphene oxide (rGO) for lithium-ion batteries were prepared by electrophoretic deposition and their applicability was evaluated. A composition, structure and morphology of the electrode materials were investigated by scanning electron microscopy, atomic force microscopy, X-ray diffraction analysis, Raman spectroscopy, microspectral X-ray analysis and X-ray photoelectron spectroscopy.

In this study obtained gravimetric capacities of the ternary Fe_2O_3/TiO_2/rGO composite anode material at the discharge current 0.5 mA are 571, 683, 729 mAh/g for the nanocomposite electrode materials Fe_2O_3/TiO_2 in molar ratios of 1:1 (FT11), 2:1 (FT21) and 3:1 (FT31), respectively. After 400 charge-discharge cycles at the current value 1 mA, the FT11, FT21 and FT31 nanocomposites retain 58 %, 81 % and 17 % of their initial gravimetric capacities, respectively. Based on the results of rate capability, cyclability and gravimetric capacity measurements, we conclude that the nanocomposite with a molar ratio of Fe_2O_3 to TiO_2 (2:1) has a potential as high-performance electrode material for lithium-ion batteries.

The results obtained in this work extend the understanding about interaction between two transition metal oxides for the preparation of high-performance electrode materials for lithium-ion batteries by using a cheap, simple and environmentally friendly method. The possibility to adjust the properties of electrode (rate capability, gravimetric capacity, cyclability) makes it promising for lithium-ion battery applications such as laptops, power tools, smartphones, drones, electric cars, etc.

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