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REVIEW

Effect of PPy/PEG conducting polymer film on electrochemical performance of $LiFePO_4$ cathode material for Li-ion batteries

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Rechargeable lithium-ion batteries (LIBs) have been the most commonly used batteries in the portable electronics market for many years. Polypyrrole (PPy) was now investigated as a conducting addition agent to enhance the cathode and anode materials performance in LIBs. Actual development in the synthesis and modification of the most promising cathode materials, $LiFePO_4$, is described in this mini-review. The main aim of this mini-review is to highlight the effect of PPy based conducting polymer films on the electrochemical efficiency of $LiFePO_4$ based cathode materials for LIBs summarizing our own research. Influence of the polyethylene glycol (PEG) additive in the PPy coating layer was evaluated. The improved electrochemical performance can be attributed to the enhanced electronic conductivity, higher solubility of ions originating from the electrolyte, higher movability of dissolved Li^+ ions, and improved structural flexibility resulting from the incorporation of the PPy or PPy/PEG conducting polymer layer. The stabilizing effect of PEG in PPy was reflected in lowered cross-linking and reduced structural defects and, in consequence, in higher specific capacity of PPy/PEG–$LiFePO_4$ cathodes compared to that of PPy–$LiFePO_4$ cathodes and bare $LiFePO_4$ cathodes.

Keywords: Li-ion batteries, polypyrrole, $LiFePO_4$ cathode material, poly(ethylene glycol)

Lithium-ion batteries

Lithium-ion batteries (LIBs) have shown a continuous and remarkable improvement in the efficiency and life time as well in the quantity of produced units in the last 15 years. LIBs are light-weight, attractive, efficient, and rechargeable batteries with good cycle life and high power and energy density with the tendency to substitute nickel–cadmium and nickel–metal hydride power-storage devices. Recently, rechargeable LIBs have been used for a large number of applications such as portable, entertainment, computing, and telecommunication electronic devices (e.g., digital cameras, laptop computers, mobile telephones), as well as hybrid and electric vehicles (Li et al., 2009; Wang & Cao, 2008; Armand, 1994).

The cost and performance of the batteries generally results from the characteristics of the cathode material. Although the most extensively used commercial cathode material was lithium cobalt oxide in the past, it is restricted by its unsafeness owing to overcharge as well as by the deficiency of cobalt resources (Wang & Cao, 2008; Fedorková et al., 2010a, 2010c).

Olivine type $LiFePO_4$, which was first introduced by Padhi et al. (1997a, 1997b), represents a prospective candidate for the cathode material in new generation of low cost LIBs with reasonable cell voltage (Andersson & Thomas, 2001; Kuwabata et al., 1999; Ravet et al., 2001; Yamada et al., 2001; Wang et al., 2007).

The material shows a substantial charge–discharge voltage (about 3.4 V vs. Li/Li^+ that is matched to polymer electrolytes), relatively high theoretical capacity (170 mA h g^{-1}), long cycle life owing to small volume changes, high thermal stability, and low cost. Moreover, it is nontoxic, environmentally benign, and appropriate to be used together with polymer-based electrolytes (Andersson & Thomas, 2001; Croce et al.,

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