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Amplification of the discharge current density of lithium-ion batterieswith spinel phase Li(PtAu)0.02Mn1.98O4nano-materials

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Abstract

In this study the synergistic and catalytic properties of a novel nano-composite cathode material ofnominal composition Li(M)xMn2-xO4(M = Pt-Au; x # 0.2) has been explored. Li(PtAu)xMn2-xO4nano-material for use in lithium-ion batteries (LIB) was synthesized by incorporation of the Pt-Au (1:1)nanoparticles onto the spinel phase LiMn2O4.Ultra-low scan rate (0.01 mV s−1) cyclic voltammetryof the cathode material in 1 M LiPF6(in 1:1 EC:DMC), showed four sets of redox peaks, which reflectthe typical redox process of the active material in the spinel structure due to lithium intercalation anddeintercalation. The Li/Li(PtAu)0.02Mn1.98O4cell had less polarization as it effectively accommodates thestructural transformation during Li+ion charge and discharge. The Li(PtAu)0.02Mn1.98O4cathode showedan increase in discharge currents densities with an exchange current density, i0, value of 2.8 × 10−4Acm−2, which suggests increase in the rate of electron transfer compared to LiMn2O4(1.8 × 10−4A cm2).Li(PtAu)0.02Mn1.98O4exhibited excellent capacity retention upon extended cycling and can release 90mAh g−1at 10C with a capacity retention of 99% after 50 cycles. Faster charge transportation at high cur-rent rates proved to prevent the pronounced pile-up of Li+ions and undesired Mn3+ions on the surfaces.The electrochemical impedance spectroscopy (EIS) results showed a decrease in charge transfer resis-tance for LiMn2O4after surface coverage with conductive PtAu NP's. For the lithium diffusion coefficientin Li(PtAu)0.02Mn1.98O4thin film, its magnitude order is 10−11cm2·s−1.