An Effective Design for High Rate Performance of $LiMnPO_4$ in Lithium-ion Batteries

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$LiMn_{1-x}Fe_xPO_4$/C in the form of monodisperse microboxes was synthesized by a facile and scalable method. The microboxes were formed by densely packed carbon-coated $LiMn_{1-x}Fe_xPO_4$ nanocrystals and porosity in the packed structure. The conductive carbon layer ran continuously through the structure to form a connected three-dimensional network for electron transport. The pores in the microboxes were likewise continuous and formed the complementary network for Li^+ transport in the electrolyte. The use of nanosize primary particles to improve the efficiency of Li^+ insertion and extraction reactions, and an integrated electron and ion conductive networks to decrease the transport resistance external to the nanocrystals; yielded a Li storage host with outstanding rate performance (116 mAh/g and 88 mAh/g at 5C and 10C discharge rates respectively where 1C= 170 mAh/g) and good cycle stability (95 % retention of initial capacity after 50 cycles) for $LiMn_{1-x}Fe_xPO_4$. Electrochemical impedance spectroscopy and morphology examination of cycled microboxes revealed a robust packed structure with stable surfaces which sustained the satisfying application performance.