A high power and high energy sodium ion battery using $Na_{1.5}VPO_{4.8}F_{0.7}$ nanoparticles

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Room temperature Na-ion batteries are highly considered as an alternative technology to Li-ion batteries and are projected to be manufactured at a much lower cost. The development of high power and high energy density Na-ion batteries is contingent upon carefully choosing high performance positive and negative electrodes. In this work, $Na_{1.5}VPO_{4.8}F_{0.7}$ nanoparticles (NVPF NPs) synthesis using a modified Pechini process was demonstrated as a high-rate and high cycle life positive electrode material for Na-ion batteries. At various charging rates, NVPF NPs achieved a high capacity of 130 $mAhg^{-1}$ (C/10) and up to 80 $mAhg^{-1}$ (20C). The high rate capability of this material is owed to its nanometric size and its small volume expansion of 3% upon continuous charge-discharge cycles. For these reasons, the cycling behavior showed superior stability where after 100 cycles, 93% of the initial capacity was maintained. NVPF NPs was then paired with an Sb-reduced graphene oxide (Sb-RGO) negative electrode (Sb-RGO//NVPF NPs) and in its full cell format achieved a capacity of 115 $mAhg^{-1}$ (1C) and 68 $mAhg^{-1}$ (20C). This full cell devices represents a feasible Na-ion battery devices capable of performing on par with commercial Li-ion batteries ($LiCoO_2$//graphite).

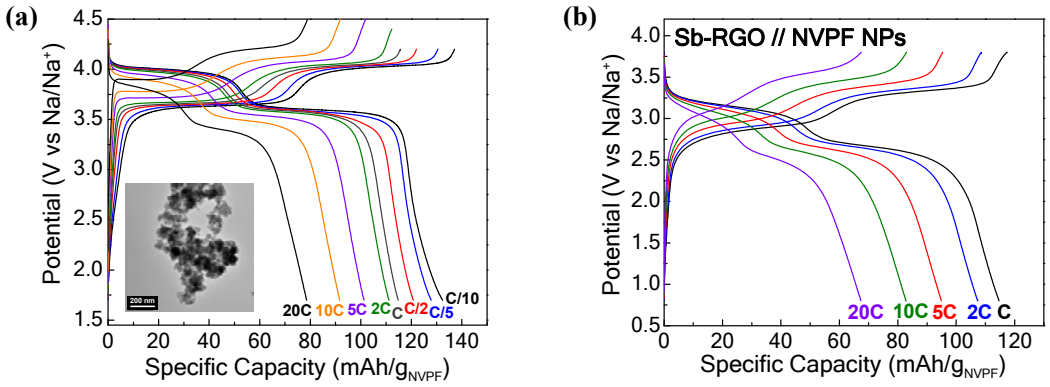

Figure 1. (a) Galvanostatic charge/discharge profiles of NVPF NPs at different C-rates (inset: A TEM image of NVPF NPs) (b) Galvanostatic cycling of Sb-RGO//NVPF NPs full cell at different C-rates