EFFECTS OF ELECTRODEPOSITED LITHIUM PHOSPHATE ON THE ELECTROCHEMICAL PROPERTIES OF SELF ORGANIZED TITANIA NANOTUBES

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Solid electrolyte interfaces are crucial for the development of lithium-ion batteries. An alternative approach is to coat the electrodes with a convenient ionic conductor that warrants lithium ion diffusion from the electrolyte. Thin film electrodes prepared directly onto current collectors are particularly suitable to this approach. The compound Li_3PO_4 is known to be a potential candidate for thin film lithium electrolyte due to its light weight, wide potential range of stability vs. lithium and also because of its thermal and mechanical stability.[1]

The aim of this work is to prepare nanoarchitectured electrodes containing a thin layer of Li_3PO_4. The covering effect of Li_3PO_4 can be observed for 1 min of electrodeposition at 37.5 mA cm^{-2} as the nanotubes are filled (Fig. 1). Firstly, self organized TiO_2 nanotubes are used to improve their electronic and ionic conductivity. The annealing condition allowed preparing β–Li_3PO_4 (R.T. – 300 ºC) and γ–Li_3PO_4 (≥ 500 ºC).[2] The discharge and charge plateau of Li_3PO_4–free $ntTiO_2$ samples were at approximately 1.75 and 1.9 V, respectively. For β–Li_3PO_4/$ntTiO_2$ and γ–Li_3PO_4/$ntTiO_2$ samples deposited 1 min at 3.75 mA cm^{-2} a discharge/charge plateaus are observed at 1.78 and 1.86 V, which is ~0.1 V lower in energy as compared with uncoated samples. The best capacity value of 500 µA h cm^{-2} was achieved for TiO_2/γ–Li_3PO_4.

The optimum parameters for electrodeposition to achieve γ-Li_3PO_4 coating on the entire $ntTiO_2$ array are 1 min and 3.75 µA cm^{-2}. The performance of the $ntTiO_2$/γ-Li_3PO_4 ($LiPF_6$ in EC:DEC)/ $LiFePO_4$ rocking-chair microbattery delivered a maximum capacity of 110 mA h g^{-1} at 5C rate when imposing a cathode-limited active mass ratio to the electrodes.[2] The obtained low-voltage microbattery (<2.0 V) could fit to applications demanding small-scale electrical power.

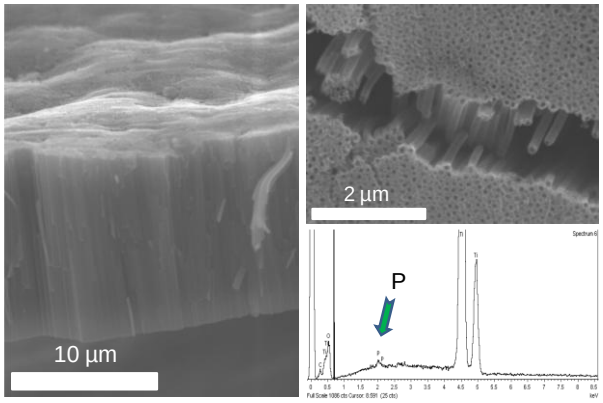

Figure 1. SEM image of nt-TiO_2 with electrodeposited Li_3PO_4.

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