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Carbon nanostructure modified lifepo4 cathodes for lithium ion battery applications

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Li-ion batteries (LIBs) are currently the leading energy storage technology. Owning to its electrochemical convenience, light weight and ease of fabrication, LIBs are used for portable power-hungry devices such as electric vehicles (EV) and hybrid electric vehicles (HEV). Specifically, Lithium Iron Phosphate ($LiFePO_4$) is an environmentally friendly material with superior electrochemical properties to serve as a cathode material in LIBs. Currently, $LiFePO_4$ is tied by its poor electrical conductivity in the order of 10^{-9} S/cm and sluggish ion diffusion coefficient in the order of 10^{-16} cm^2/s; both of which are key culprits in limiting its commercialization. In this work, Carbon nanostructures (CNS), which consist of a macrostructure of highly entangled MWCNTs in a networked form, are used as a conductive additive as well as microbinder for $LiFePO_4$. Results confirm that the 3D conductive network encapsulated the $LiFePO_4$ particles homogenously facilitating the charge transfer at the electrode-electrolyte interface and within the interior of the electrode. Consequently, composition, scan rate and porosity of the paper-like cathode were sequentially varied and their influence was systematically monitored by means of Linear Sweep Cyclic Voltammetry (CV) and AC electrochemical Impedance Spectroscopy (EIS) tests. A key finding in this portion of the work is that electrodes with 20 wt.% and 49±2.5% porosity had realized improvements of two folds and four folds in the electronic conductivity and diffusion coefficient, respectively, in comparison to conventional $LiFePO_4$/PVDF/C cathodes. As such, the developed $LiFePO_4$/CNS composite cathodes could potentially serve for high power density and microelectronic applications.

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