Nano-sized vs. Micro-sized Powders Agglomerated $LiFePO_4$ for Lithium Ion Batteries

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Lithium iron phosphate ($LiFePO_4$) is an attractive cathode material for lithium ion batteries with a high safety, low costs, excellent electrochemical performance and good cycling stability [1]. The limiting factors of this cathode material are the low electronic and ionic conductivity of the lithiated ($LiFePO_4$) and delithiated ($FePO_4$) form. The electronic conductivity can be increased by additives e.g. different types of carbon which can be coated on the surface of the material during / after synthesis or added to the electrode composition [2]. In order to overcome the obstacle of low ionic it is crucial to reduce the particle size of $LiFePO_4$ to nanometer scale.

Nano-sized $LiFePO_4$ with carbon coating can reach capacities close to the theoretical value of 170 mAh g^{-1} at a redox potential of 3.5 V vs. Li/Li^+. The small diffusion length of the lithium ions (nanometer range) inside the $LiFePO_4$ grains allows a fast charge and discharge while maintaining most of the capacity ($\geq$120 mAh g^{-1} at 10C). To achieve an excellent electrochemical performance a lot of efforts have to be made to process nano-sized $LiFePO_4$ during electrode preparation compared to micro-sized ones. Additionally the volumetric density of a nano-sized material is generally less than the same material formed from micrometer-sized particles. Thus the volumetric energy density of the electrode is reduced limiting total energy of the lithium ion cell [3].

Different $LiFePO_4$ samples were prepared in order to combine the advantages of nano-sized materials (high capacity, fast charge / discharge…) with the good preparation properties and high volumetric densities of micro-sized. This was realized by an agglomeration of nano particles to micro-sized spheres. Recently developed agglomerated $LiFePO_4$ samples are compared with a commercial $LiFePO_4$ material P2 from Clariant. The different physical properties affect the electrode preparation e.g. viscosity, solid content, electrochemical properties and volumetric densities.

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