Particle size effects on Mesoporous Carbon-SiO_2 composites as Lithium Ion Battery anodes

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Graphitic materials [1] represent the prototypical anodic material for today´s Lithium Ion Batteries (LIB), their high capacity in comparison to most of the cathodic materials, low cost and highly abundance make them very attractive. However, increasing the reversible capacity of anodic materials can help to provide a broader utilization of Lithium Ion batteries for example in electric cars. One of the strategies to increase the specific capacity is the formation of composite electrodes in which two components contribute with their best properties in order to enhance the electrode performance. In this work it is suggested a new simple synthesis route, combining different ratio of stabilizing agent (polycation) and hard template (SiO_2 with particle size of 8nm and 50μm) in order to obtain mesoporous carbons (MC) from carbonization of resorcinol-formaldehyde (RF). [1,2] Theses mesoporous carbon can provide the electric conduction paths, while the SiO_2 particles offer extra gravimetric capacity; moreover, if SiO_2 is trapped inside the carbonaceous network, it can resist the volume changes occurring during the reaction with Li ions. The as obtained materials were assembled as LIB anodes and tested at several C-rates, electrochemical impedance spectroscopy was utilized to gain understanding on the limiting processes and ^7Li Nuclear Magnetic resonance was utilized to identify the participation of species during the different lithiation stages. The analysis of the results indicates that at bigger particle size, the SiO_2 particles does not participate in the discharge process, while removing the SiO_2 lead to a very high irreversible capacity mostly due to the high surface area with dangling and oxygen terminations. On the other hand, small SiO_2 nanoparticles increase the reversible specific capacity around 10% in comparison to pure graphite's capacity, while the differences between first and 10th cycles capacity is almost eliminated *i.e.* the elimination of the irreversible capacity.

References:

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