Highly ordered mesoporous SnO_2 with residual silica for improved electrochemical performance of lithium ion battery

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Highly ordered mesoporous SnO_2 with residual silica were successfully synthesized from a mesoporous silica template (SBA-15) via nano-replication method. A tin precursor, $SnCl_2$•$2H_2O$, was infiltrated spontaneously within the mesopores of the silica templates by melting the precursor at 353 K without using a solvent. After the heat-treatment of composite materials at 973 K under static air conditions, the controlled removal of silica templates using NaOH or HF solutions with different concentrations results in the successful preparation of mesoporous SnO_2, where has the amounts of residual silica species. The residual silica species induce a nano-propping effect enabling the mesoporous SnO_2 to remain stable up to 973 K without any structural collapse. More importantly, the optimum amount of residual silica species results in a dramatic reduction in capacity fading after prolonged cycles in Li-ion battery. The mesoporous SnO_2 with 3.9 wt% of silica still exhibits a large capacity (about 600 mAh g-1) after the 30th cycle, which is probably because the residual silica species act as a physical barrier to suppress the aggregation of Sn clusters formed in the mesoporous SnO_2 during the lithium storage.