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The comparison between nanostructure control and other modifications to improve the electrochemical performance of SnO₂

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With an advent of the ubiquitous era, the demand for rechargeable batteries with a higher energy density is getting more and more critical. It is because applications are emerging such as electric vehicles and various types of portable electronic devices. Carbonaceous materials are commonly adopted as the anode material for commercial lithium-ion secondary batteries because it can reversibly intercalate or de-intercalate Li ion. However, low capacity of carbon (theoretical capacity: 372 mAh·g⁻¹) has become a limiting factor in wider applications, and high capacity alternative to carbonaceous material has thus been sought for. Even if tin and silicon have been considered as one of the most attractive options for high energy density purpose, its poor cyclic properties have been delaying its commercialization.

In this presentation, novel synthetic ways using nanoscience will be introduced. Massive SnO₂ nanowires with tetragonal rutile structure have been successfully synthesized by a thermal evaporation method without traditional metal catalysts. The enhanced electrochemical performances of SnO₂ nanowires resulted from the combination of unique nanostructures with high length to diameter ratio and the absence of traditional metal catalysts. The electrochemical performance of nanowire will be compared with those of nanopowder and nanotubes. (Fig. 1) The strategy to improve the electrochemical performance of SnO₂ nanopowders is the encapsulation of carbon around SnO₂ nano-particles. Carbon encapsulated SnO₂ composites were prepared by a thermal evaporation and decomposition of malic acid (C₄H₆O₅) at low temperature. Thanks to the low-temperature process, the robust electron pathway could be formed without any disruption of its bulk structure. Finally, MOSN (Mesoporous organo silica nanoarray) was combined with SnO₂ particles to accommodate their volume expansion during Li⁺ insertion. This strategy turned out to be also very effective to improve the electrochemical properties of SnO₂.

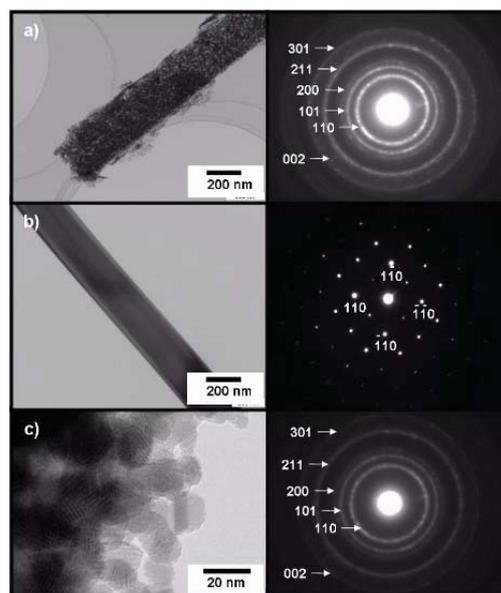


Fig. 1. TEM observations and selected area diffraction (SAD) patterns: (a) SnO₂ nanotubes, (b) SnO₂ nanowires¹, and (c) SnO₂ nanopowders.