Tin-based Nanoparticles as Anode Material for Lithium Ion Batteries

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The need for high capacity and long-term stable energy storage technologies such as lithium ion batteries require electrode materials with a high ability to store lithium ions. At the same time, it is important to have materials, which can stand the mechanical stress caused by the great volume expansion during lithiation. Tin is a promising anode material with a theoretical reversible capacity of 994$\frac{mAh}{g}$ forming the highest stoichiometric alloy of tin and lithium $Li_{22}Sn_5$. Using nanoparticles instead of bulk material minimizes the mechanical stress whereby the electrode is more stable. Tin forms alloys with many other metals, which allows further modification and fine-tuning of its properties.[1,2] Especially, combining tin with metals that do not form alloys with Li(Co, Ni) helps to buffer the volume expansion and increases the mechanical stability of the electrode.

In our work, we synthesized spherical tin nanoparticles with a narrow size and shape distribution.[3] What is more, we altered this synthesis by adding several metal salts to obtain bimetallic metal-tin nanoparticles such as SnCo and Ni3Sn4. For electrochemical measurements, we can modify the surface of the nanoparticles with various polar ligands like hydroxide, chloride, sulfide ions or polyvinylpyrrolidone, which form a stable co

lloidal solution in ethanol. By measuring the zeta potential of this solution, we can determine the surface charge of the nanoparticles surrounded by the different ligands. We characterize the size and shape of the particles via high resolution transmission electron microscopy (HRTEM), X-ray diffraction (XRD) and dynamic light scattering (DLS) measurements. Using these methods, we can describe the growth and formation of the transitional phases during the synthesis of the bimetallic tin nanoparticles.

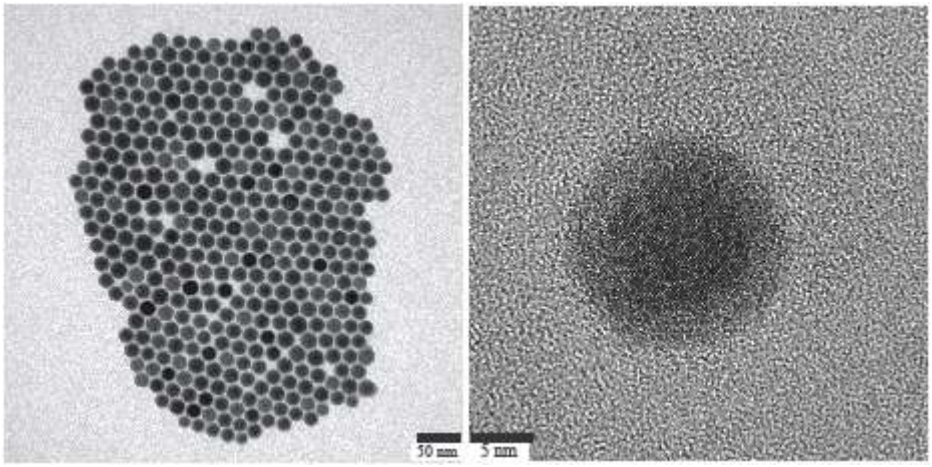

Figure 1: TEM image of an assemble of tin nanoparticles with an average particle size of 20nm. On the right a HRTEM image of a spherical tin nanoparticle.

[1]X. Wang et al., *Chem. Mater*., **2013**, *25 (8)*, pp 1400–1407.

[2]N. Oehl et al., *J. Phys. Chem. C*, **2015**, *119 (25)*, pp 14450–14454.

[3] K. Kravchyk et al., *J.Am.Chem.Soc.,* **2013**, *135*, 4199-4202.