Production of silicon nanopowders for use in high-capacity lithium-ion batteries

Silicon is considered as one of the most promising next generation lithium-ion battery (LIB) anode material due to its exceptional gravimetric and volumetric capacities. Unfortunately, the lithiation of silicon comes with important swelling which causes mechanical stresses on the silicon particles in the anode. Upon charge-discharge cycles, these stresses induce cracking and a degradation of the capacity and voltage of the cells after a relatively short number of cycles. Nanometric features are less sensitive to such swelling effects. It has been reported that silicon nanoparticles with a diameter smaller than 150 nm do not suffer from cracking, therefore favoring stable battery performance upon cycling. Besides critical nanoparticle size considerations, the surface chemistry of the silicon nanoparticles also needs to be engineered so that it provides optimal interactions with adjacent anode materials. Finally, reaching the ambitious targets for LIB packs of about $100 per kilowatt hour requires high performance materials, along with high throughput production methods.

Tekna has developed a patented process that combines its core technology, the induction plasma, with silane gas precursor to produce silicon nanopowder consisting of spherical nanoparticles presenting a diameter of less than 150 nm. This unique process provides an excellent control over the surface chemistry of the silicon nanoparticles. More specifically, both the thickness of the surface layer and its chemical composition (oxide, nitride, oxynitride, etc.) can be adjusted independently so that the efficiency of the silicon nanopowder, and thus battery performance, is optimized. The automated production system is configured to operate continuously at large scale to produce the silicon nanopowder at low cost.

The details of Tekna's unique silicon nanopowder production system will be presented, together with the main characteristics of as-produced silicon nanopowders.