Metal nanoparticles wire up nanowires for better battery materials

New materials are making advancements in higher power, longer life and faster charging batteries a reality. These improvements have been driven by the uptake in electric vehicles and a host of other applications that require long life or higher capacity. Take smart phones and tablets for instance. Fast charging is beneficial, so long as the battery can last more than a day under standard use. Extending typical usage of smartphones beyond a few days is also a 'grail' target for rechargeable batteries. One of the most importance applications of fast charging batteries before this capability was introduced for smartphones, was the power source in defibrillators. The material used in these life-saving devices is a form of silver vanadium oxide. This material can also be used in Li-ion rechargeable batteries.

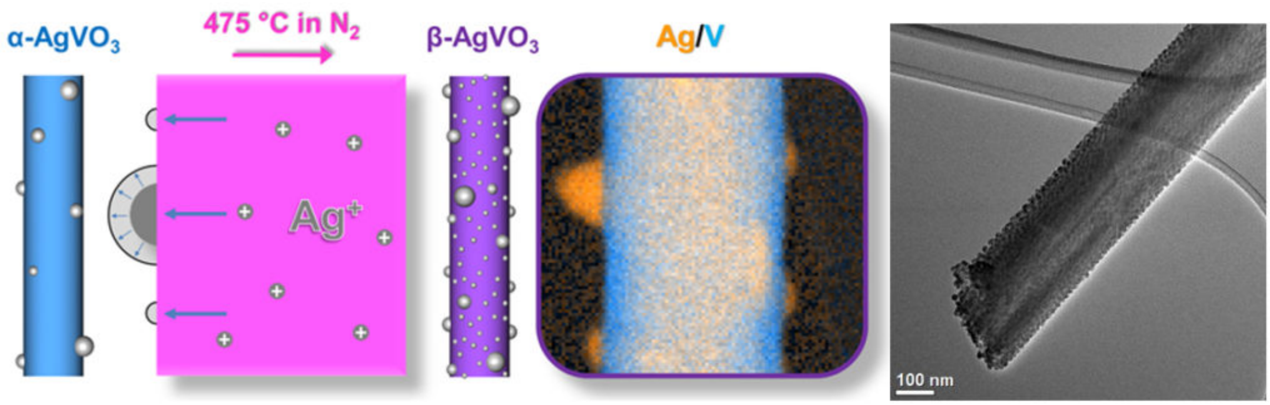

Fig. 1. How silver nanoparticle-decorated silver vanadate nanowires are converted from one phase to another, and simultaneously the surface is coated with a high density of nanoparticles to improve electrical connectivity in the battery material.

Battery material electrodes typically use a slurry, comprising the active energy storage material, some form of conductive additive, and a polymer binder to hold them together as they are case onto the flat electrode surface. If this mixture is not uniform, the overall cell performance can be compromised. Researchers led by Colm O'Dwyer at University College Cork in Ireland, demonstrated that silver vanadate ($AgVO_3$) nanowires coated with Ag nanoparticles form a uniform blend of battery materials that are well electrically wired up as a dense (all touching) network of material. Synthesizing these nanostructures with chemically bonded conductive nanoparticles is an elegant means of overcoming some intrinsic issues associated with electrode slurry production, as wire-to-wire conduction pathways are formed throughout the material.

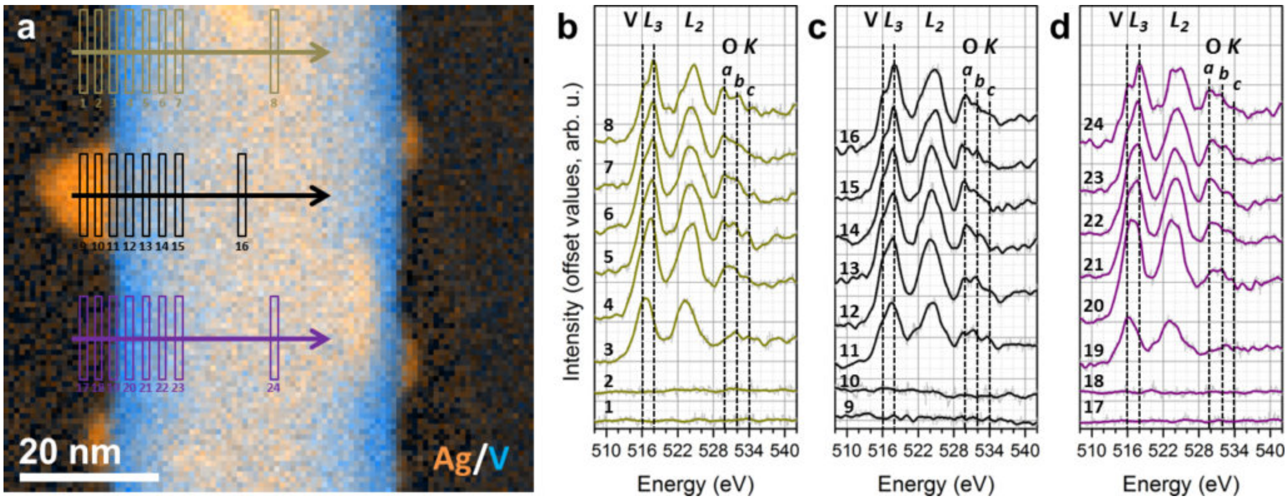

Fig. 2. An overlay image and corresponding spectra from high resolution microscopy and electron energy loss spectroscopy of the chemical bonding of vanadium and silver at the surface, and in the core, of the metal nanoparticle-decorated nanowires.

The most useful insight beyond the electrical wiring by the Ag nanoparticles, is that the Ag and Li work in tandem to enhance the performance of this battery material. As the Ag in soluble ionic form is converted to metallic nanoparticles on the vanadium oxide materials, the Li ions have extra space to insert into the material during operation (discharging and charging), boosting the overall capacity of the material. This understanding was gleaned by using very high resolution microscopy and spectroscopy at the SuperSTEM laboratory in Daresbury, UK, which provides exquisite sensitivity to help uncover the mechanism behind the performance and behavior of this promising battery material.

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