Nanomaterials Research Laboratory

A Transmission Electron Microscope used for imaging nanostructures

The NanoLab: What do we study?

Most physical and chemical properties of matter change, often quite drastically, when the physical size of the sample is made smaller than 10-100 nanometer (nm). We are interested in finding out how and why different properties change ("finite size effects") in nanostructured solids. We try to address and understand simple questions such as:

- Does a superconducting material in the form of a nanoparticle retain superconductivity?
- What is the colour of Silver in the form of nanoparticles?
- How can one make a solar cell out of an array of nanorods?
- Does crystal structure change when particle size is reduced?

Experimental Techniques

We make nanoparticles, nano-crystalline thin films and arrays of aligned nanorods by high pressure sputtering, chemical and electrochemical techniques. The nanostructured samples are characterized by high resolution electron microscopy, x-ray diffraction, etc. Physical property measurement techniques involve Raman and optical spectroscopy, electrical transport, magnetism, thermal analysis, and so on.

GROUP MEMBERS:

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Selected results from the NanoLab

Simultaneous ferromagnetism & ferroelectricity in Se microtubes

Multiferroic materials, in which ferromagnetism and ferroelectricity are intrinsically coupled, have generated much interest. We have observed a coexistence of magnetic and ferroelectric ordering in single crystalline Selenium microtubes (Fig. 1) below ≈40K. This is the first time that multiferroicity has been observed in a simple element. This unexpected behavior arises from Selenium being a 'surface topological insulator'. Reference: Pal *et al.*, **Scientific Reports 3** (2013) 2051

A new form of Silver stabilized by small particle size

By carefully controlling the particle size, we have made a new form of silver with a hexagonal crystal structure (normal silver is cubic) and surprisingly different properties. Hex silver is golden in colour (Fig. 2) and has a high electrical resistance. It is chemically reactive, hard and brittle. Reference: Chakraborty *et al.*, **J. Physics Con. Mat. 23** (2011) 325401; **J. Physics Con. Mat. 26** (2014) 025402

Clustered metal nanorod arrays: Exciting applications

We have shown that an array of parallel, metallic nanorods (Fig. 3) can act as an electrode for ultra-low voltage gas discharge [**Nanotechnology 19** (2008) 445713], is an excellent source for field-induced electron emission, as well as laser-induced emission of pulsed, hard x-rays [**Physical Review B 83** (2011) 035408].

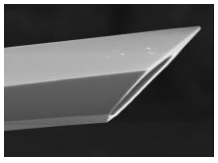
Fig. 1 

Fig. 2 

Fig.3