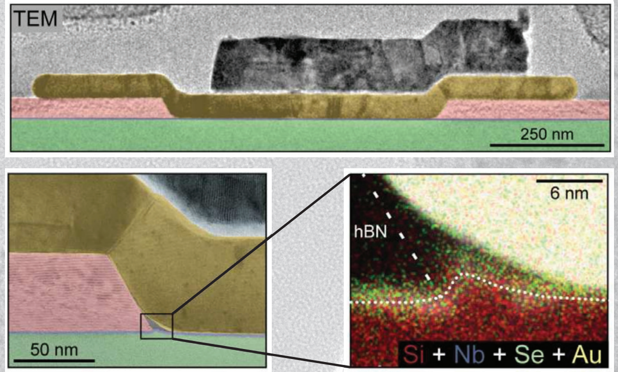
An Electron Microscope uses energetic electrons to obtain information about morphology, composition, and crystallography of almost any type of sample. A Transmission Electron Microscope (TEM) uses the image formed by electrons passing through the sample and diffracted by its microstructure. Since its invention in 1931 (E. Ruska et al. received a Noble Prize for this invention in 1986) Electron Microscopy has made a significant contribution to research in biological and medical applications as well as Materials Science, Geology, Environmental Science and more. Its impact on Biological Sciences was so significant that even after seven decades, Prof. J. Frank of Columbia University together with R. Henderson, and J. Dubochet won a Noble Prize for "developing cryo-electron microscopy for the high-resolution structure determination of biomolecules in solution."



TEM image of a cross-section from a gold via contact on monolayer $NbSe_2$. Courtesy of Prof. J. Hone

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http://cni.columbia.edu/smcl/

Non-Columbia users are welcome!

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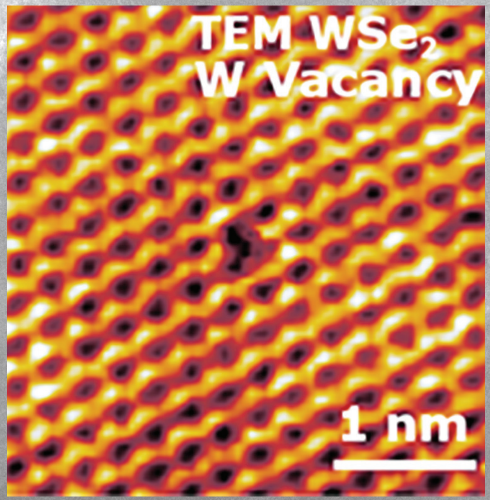
Electron Microscope Laboratory at CNI



The Columbia Nano Initiative (CNI) offers researchers access to one of the most advanced and state-of-the-art instruments with atomic resolution images at maximum magnification (10 million times!).

Atomic resolution image of WSe2. Courtesy of Profs. J. Hone and K. Barmak

POTENTIAL APPLICATIONS

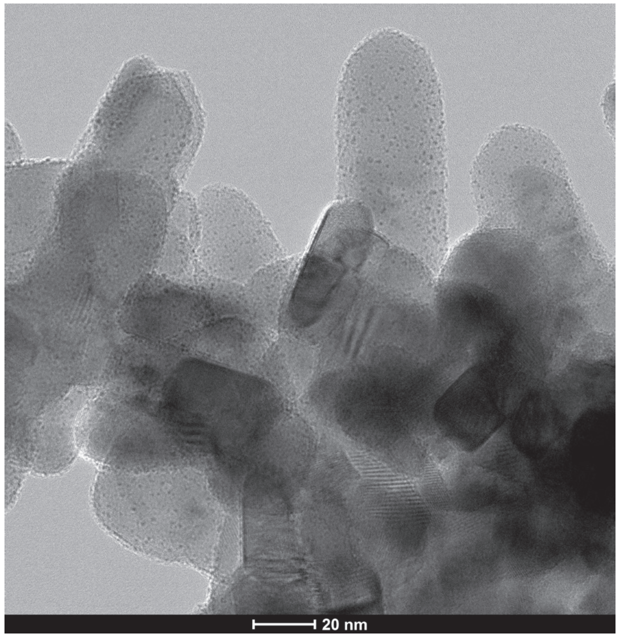
Biological Sciences

Organic samples whether consisting of a soft mass (such as live animal tissues) or a wet mass (such as cultured bacteria or viruses) can be prepared in our lab with different methods. The soft masses are fixed, dehydrated, polymerized, sliced with the Ultramicrotome and then stained. The wet masses are normally mounted on the grid and undergo Negative Staining.

Cholesterol crystals in mouse lung tissue. Courtesy of Prof. E. Tarling

Materials Science

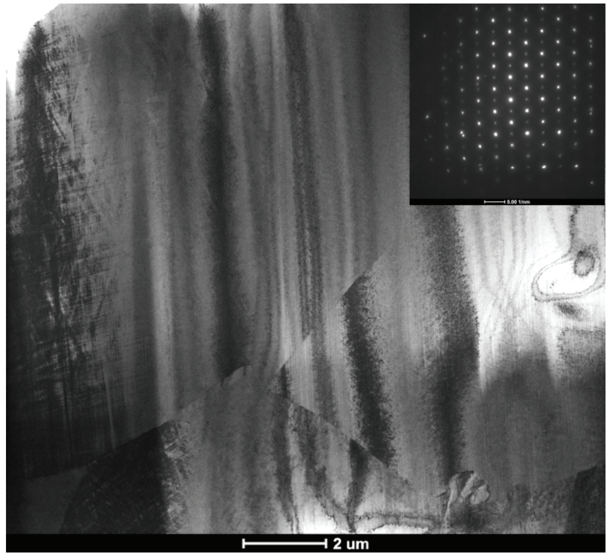
Materials Science encompasses a wide spectrum of inorganic materials from metals and alloys to polymers and ceramics. Depending on the samples, here at CNI we are capable of preparing thin foils (less than 100 nm thick) from the material by using a conventional method of mechanical thinning of the sample, dimple grinding, and polishing with Precision Ion Polishing System (PIPS II). With the introduction of newer methods such as Focused Ion Beam (FIB) we are also able to make very thin cross-sectional samples from solid/hard materials (including alloys, ceramics, etc.) in desired specific locations on the sample to answer various research questions.



High resolution image of TiO_2 nanoparticles. Courtesy of Profs. K Barmak and R. Austin

Electronic Devices and New Materials

With advances in Nanoscience and Nanotechnology, comes the drive towards new devices and materials for new applications. Here at Columbia University, researchers from various disciplines are continuously investigating new materials and fabricating new atomic scale devices such as graphene and other 2-D materials, and TEM is a very powerful technique for studying them.



Microstructure of a magnetic material (FePd) and its corresponding diffraction pattern. Courtesy of Prof. K. Barmak