NIST Obtains the World's First Aberration-corrected, Monochromated Analytical Electron Microscope

NIST installed the world's first commercial aberration-corrected, monochromated analytical electron microscope (AEM). This instrument establishes NIST as one of the foremost laboratories in the world at atomic resolution chemical analysis.

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Since the early days of transmission electron microscopy (TEM) in the 1940s, the resolution of the technique has not been limited by diffraction physics or the wavelength of the electrons, but by the large residual lens defects in the optics, especially spherical and chromatic aberration. Light microscopists solved this problem in the 1820s, and it led immediately to a series of breakthroughs in microbiology and medicine. Duplicating this success has proven extremely difficult for electron microscopy because of the nature of the lenses, and this critical problem remained unsolved for more than 60 years. Recently, solutions for both of these problems have been found and commercialized in a very short span of time, and the field of analytical electron microscopy (AEM) is undergoing the most exciting revolution since its birth. The spatial resolution achievable has already improved to the order of 100 picometers, and will hopefully continue to fall towards the diffraction limit of around 2 picometers in the decades to come.

NIST installed the world's first commercial aberration-corrected, monochromated AEM. The information transfer limit for this instrument is below 1 nm in both scanning mode and TEM mode, and dramatically extends NIST's capabilities in atomic resolution chemical analysis.

NIST seeks to play a central role in the dramatic advances in electron microscopy and develop new analytical and imaging techniques to extend the nation's measurement infrastructure in the area of chemical analysis at very high spatial resolution.

As expected, application of this technology (even at current levels of performance) has an unusually broad impact on industry, government science and technology functions, and academic research. The areas of advanced materials science and engineering, semiconductor manufacturing, nanotechnology, structural biology, and nanomedicine will benefit immediately from this work.

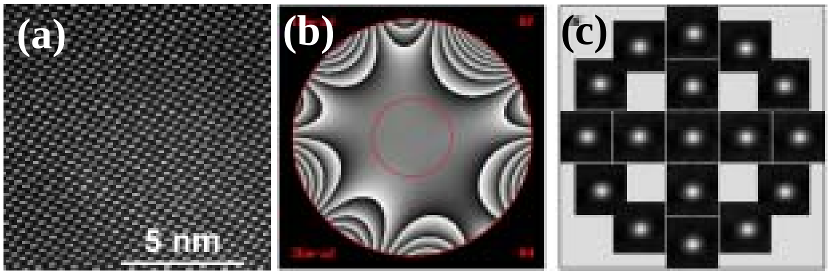

Figure 1: **a) Atomic resolution STEM image of silicon b) calculated phase map showing residual lens aberrations, c) Zemlin tilt tableau of the STEM beam used to measure aberrations**

Photograph of the microscope in the Advanced Measurement Laboratory (AML).

Future Plans: In addition to further work with the manufacturer and the broader microanalysis community to develop the full potential of this new technology, the microscope will be applied to practical problems such as gate dielectric thickness metrology and the characteristics of dendrimers and heterogeneous nanoparticles for drug delivery.