HREM of Nanoscale Materials as a Driving Force for the TEAM Project

Ulrich Dahmen

National Center for Electron Microscopy, Lawrence Berkeley National Laboratory, University of California, Berkeley, California, USA

e-mail:UDahmen@LBL.gov

The atom-by-atom analysis of individual nanoparticles is an important goal in nanoscience that was first formulated by Richard Feynman in his famous 1959 lecture *"There's Plenty of Room at the Bottom"* [1]. Feynman proposed that one could analyze any substance simply by looking to see where the atoms are: *"I put this out as a challenge: Is there no way to make the electron microscope more powerful?"* Advanced electron microscopes show us unprecedented views of materials and their unusual behavior on the nanoscale. It is possible to observe how a nanocrystal grows or melts or changes its structure atom by atom, or to investigate the structure of nanocrystals embedded in microcrystals. However, until now, electron microscopes have remained limited by unavoidable aberrations in round electromagnetic lenses [2]. The TEAM (Transmission Electron Aberration-corrected Microscope) project was initiated as a collaborative effort to redesign the electron microscope around aberration corrected optics [3].

The vision for the TEAM project is the idea of providing a sample space for electron scattering experiments in a tunable electron optical environment by removing some of the constraints that have limited electron microscopy until now. The resulting improvements in spatial, spectral and temporal resolution, the increased space around the sample, and the possibility of exotic electron-optical settings will enable new types of experiments. The TEAM microscope will feature unique corrector elements for spherical and chromatic aberrations, a novel AFM-inspired specimen stage, a high-brightness gun and numerous other innovations that will extend resolution down to the half-Angstrom level.

This talk will highlight some recent discoveries in nanoscale materials science using high resolution imaging and dynamic observations. It will be shown that nanocrystals come in magic sizes and display a fascinating range of behaviors, which get stranger with smaller size. Examples of such materials research will include observations of the relationship between particle size and melting point, the direct measurement of the mechanism and rate of Brownian motion of liquid inclusions inside a solid matrix, and the critical need for 3D tomography to understand the shape and unique behavior of precipitates at grain boundaries in solids. Finally, this talk will provide an outline of opportunities for the TEAM project to investigate these and related scientific challenges [4].

References:

[1] R.P. Feynman, Engineering and Science, 23 22 (1960)
[2] O. Scherzer, Z. Phys. 101, 593 (1936)
[3] http://ncem.lbl.gov/TEAM-project/
[4] this work is supported by DOE, Office of Science, Basic Energy Sciences