Atomic Resolution Electron Tomography

Jianwei Miao[1*], M. C. Scott[1], Chien-Chun Chen[1†], Rui Xu[1], Peter Ercius[2] and Ulrich Dahmen[2]

[1]*Department of Physics & Astronomy and California NanoSystems Institute, University of California, Los Angeles, CA 90095, USA.*
[2]*National Center for Electron Microscopy, Molecular Foundry, Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA.*
[†]*Present address: Department of Physics, National Sun Yat-sen University, Kaohsiung 80424, Taiwan.*
[*]*Email: miao@physics.ucla.edu*

Visualizing the arrangement of atoms has played an important role in the evolution of modern science and technology. Crystallography has long been used to reveal globally averaged 3D atomic structures. Scanning probe microscopes can determine surface structures at atomic level. Electron microscopes can resolve atoms in 2D projections of 3D crystalline samples. In this talk, we will present a general tomographic method for determining the 3D local structure of materials at atomic resolution. By combining scanning transmission electron microscopy with a novel data acquisition and image reconstruction method known as equally sloped tomography, we achieve electron tomography at 2.4 Å resolution and observe nearly all the atoms in a multiply-twinned Pt nanoparticle. We find the existence of atomic steps at 3D twin boundaries of the Pt nanoparticle and, for the first time, image the 3D core structure of edge and screw dislocations in materials at atomic resolution. We expect this atomic resolution electron tomography method to find broad applications in materials sciences, nanoscience, solid state physics, chemistry and biology.

1. J. Miao, F. Förster and O. Levi, "Equally Sloped Tomography with Oversampling Reconstruction", *Phys. Rev.* B. **72**, 052103 (2005).
2. M. C. Scott, C.-C. Chen, M. Mecklenburg, C. Zhu, R. Xu, P. Ercius, U. Dahmen, B. C. Regan and J. Miao, "Electron tomography at 2.4 Å resolution", *Nature* **483**, 444–447 (2012).
3. C. C. Chen, C. Zhu, E. R. White, C.-Y. Chiu, M. C. Scott, B. C. Regan, L. D. Marks, Y. Huang and J. Miao, "Three-dimensional imaging of dislocations in a nanoparticle at atomic resolution", *Nature* **496**, 74–77 (2013).