Philip E. Batson Extended Abstract

During the past 10 years we have witnessed an exciting, noisy revolution in instrumentation for electron microscopy, driven by new capability in multipole electron optics, very high stability electronics, and workstation-based modeling and instrumental control. The result has been sub-Angstrom spatial resolution, and ever more precise access to electron scattering phase space. After a brief introduction to methods of aberration correction, the resulting imaging improvement will be described, emphasizing a comparison of High Angle Annular Dark Field and Bright Field imaging modes with implications for tomographic analysis. With the new control of the electron beam, image contrast is much enhanced, allowing more rapid acquisition of single atom images, encouraging experimental investigation of dynamical behavior of nanometer-sized objects. More efficient utilization of source brightness allows two dimensional EELS maps of Near Edge Fine Structure for composition, bonding and valence ordering in highly correlated transition metal oxides. Aberration correction methods are also poised to extend EELS performance to the sub-100 meV level, allowing more detailed mapping of plasmonic and photonic behavior in both real and reciprocal space for structures ranging in size from microns down to single atoms. Along the way, atomic and nanoscale movement of structures under the electron beam will provide information about accompanying forces. Ultimately, very low energy excitations – phonons in extended structures, plasmons in low dimensional structures, carrier plasmons, magnetic excitations, vibrational excitations associated with impurities or in single molecules, and perhaps pseudogaps which bear on mechanisms for high temperature superconductivity may all be accessible with sub-nanoscale definition