Electron Optics for a Monochromatic, Aberration-Corrected, Dual-Beam Low Energy Electron Microscope

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Monochromatic, aberration-corrected, dual-beam low energy electron microscopy (MAD-LEEM, [1]) is a novel technique that is directed towards imaging nanostructures and surfaces with sub-nanometer resolution. The technique combines a monochromator, a mirror aberration corrector, an energy filter, and dual beam illumination in a single instrument (Fig. 1). The monochromator reduces the energy spread of the illuminating electron beam, which significantly improves the spectroscopic and spatial resolution. The novel aberration corrector eliminates the second rank chromatic and third and fifth order spherical aberrations, thereby improving the resolution into the sub-nanometer regime at landing energies below one hundred electron-Volts. The energy filter produces a beam that can extract detailed information about the chemical composition and local electronic states of non-periodic objects such as nanoparticles, interfaces, defects, and macromolecules. The dual flood illumination eliminates charging effects that are generated when a conventional LEEM is used to image insulating specimens. MAD-LEEM is designed for the purpose of imaging biological and insulating specimens, which are difficult to image with conventional LEEM, Low-Voltage SEM, and TEM instruments. The low impact energy of the electrons is critical for avoiding beam damage, as high energy electrons with keV kinetic energies used in SEMs and TEMs cause irreversible change to many specimens, in particular to biological materials. In addition, the high contrast that is generated at low landing energies eliminates the need for staining or labeling biological specimens. Last, the MAD-LEEM instrument can also be used as a general purpose LEEM instrument with significantly improved resolution.

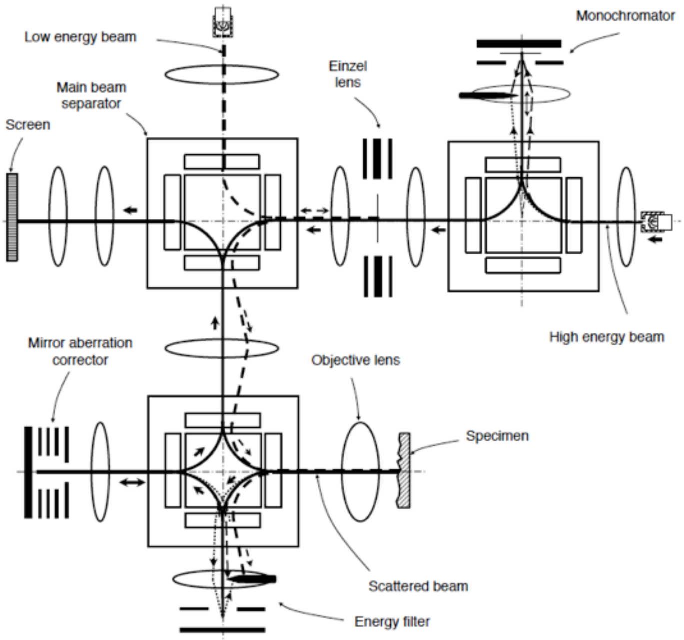

Figure 1. Electron-optical layout of the MAD-LEEM.

References

[1] M. Mankos et al., A Novel Low Energy Electron Microscope for DNA Sequencing and Surface Analysis, *Ultramicroscopy* in press (online available January 31, 2014).