Fabrication Techniques of Mesoscopic Devices

Brian J. Simonds
Illinois Wesleyan University

Gabriel C. Spalding, Facutly Advisor
Illinois Wesleyan University

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FABRICATION TECHNIQUES OF MESOSCOPIC DEVICES

Brian J. Simonds and Gabriel C. Spalding*
Department of Physics, Illinois Wesleyan University

The mesoscopic scale divides the regime of single atoms and molecules, where much is understood from quantum theory, from the regime of the optical microscope, where quantum "weirdness" is typically averaged away, in the collective, ensemble behavior of huge numbers of atoms and molecules. We seek the experimental means to span these length scales.

Electron beam (e-beam) lithography is a fabrication process that uses a tightly focused beam of electrons to create patterns with features on the nanoscale. For this purpose, we are interfacing an external control to the beam of a scanning electron microscope (SEM), which is normally an *imaging* tool rather than a manufacturing tool. By connecting the scan coils of the microscope to a card providing programmable outputs, we can sweep the electron beam in predetermined patterns. These patterns can be used to "expose" an energy-sensitive layer that we spin-coat onto our samples (either silicon, for micromachining, or metal-coated silica, for the creation of diffractive optics or transparent nanofluidic devices). The wavelength of an electron accelerated through 30,000 Volts is .071 Å, which implies that high spatial resolution can be achieved by working with such beams. In practice, resolution is determined both by scattering within the sample, and by the degree to which one can correct for aberrations in the electron optics of the SEM, which is the focus of our discussion.