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High Energy Focused Ion Beams: Technology and Applications

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Understanding the physical, chemical and mechanical properties of materials on a nano-dimensional scale, and the ability to alter those properties in a controlled manner, is a necessary precursor to developing useful technological applications of nanomaterials. Consequently, there is a continuing and critical need for novel instrumentation with which nanomaterials properties can be observed, measured, altered and utilized. High energy ions can penetrate well below surfaces of materials and, as a result, can offer a means by which sub-surface regions can be studied and/or manipulated. By focusing these ion beams to nanometer-sized regions and developing associated specialized techniques, unique analyses and manipulations of the nano-world are possible. High energy focused ion beam (HEFIB) technology has undergone significant evolutionary changes since the first operational system was utilized, but advances in computing, component technology and focusing systems theory have enabled the development of new applications and opened doors to potentially revolutionary possibilities. HEFIB microprobe systems operate very similar to scanning electron microprobes when utilized for materials analysis: A focused ion beam is scanned over a sample surface to generate images using emitted signals produced by ion-solid interactions. These signals can consist of detected electrons, ions, or photons along with corresponding emission angles, energies, or other pertinent identifying parameters. HEFIB microprobes can also be used to modify surface or near surface regions in predetermined patterns in a process defined as microlithography. This presentation will describe the background and history of HEFIB systems, the current and developing focusing technologies and some examples of applications.