Nanoprocessing and Device Fabrication

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Presentation

Abstract: This talk presents recent work at the Laser Thermal Laboratory. Pulsed lasers were coupled to near-field-scanning optical microscopes (NSOMs) for nanoprocessing, nanomachining, nanolithography and nanodeposition. Experiments have been conducted on the surface modification of metals, polymers and semiconductor materials, including the localized activation of electrical and ferromagnetic domains. Ablation nanolithography and patterning has been demonstrated. NSOM-based ablation is also applied to nanoscale chemical analysis. Interactions of pulsed laser radiation with nanostructures are investigated and shown to substantially improve contact resistance and device performance compared to furnace annealing. Probing of the electronic transport in semiconductor nanowires and nanoparticles has been done with scanning probe photoelectron emission spectroscopy. Nano-bio-electronic devices have been fabricated on silicon nanowire platform.

In-situ SEM monitoring of the samples under laser processing was achieved, fully integrated into the dual beam system composed of the focused ion beam (FIB) and the electron beam (SEM). To understand the microstructural evolution of a sample under laser processing we have carried out *in-situ* nanoscale laser materials processing inside a TEM where the evolving microstructure could be monitored in real time. New concepts are being explored for the high throughput, directed growth and assembly of nanostructures.

Maskless fabrication of passive and active functional devices on flexible substrates is conducted by utilizing nanoparticles in conjunction with laser processing and nanoimprinting. Low power, short-pulsed laser ablative material removal enabled finer electrical components to overcome the resolution limitation of inkjet deposition. Temporally modulated laser irradiation was utilized to locally evaporate the carrier solvent as well as sinter gold nano-particles, yielding low resistivity conductors. Selective multi-layered nanoparticle film processing was demonstrated. High-performance electronics, including OFETs (organic field effect transistors) and dye-sensitized solar cells have been demonstrated on flexible substrates.