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TEBAL: Nanosculpting devices with electrons in a transmission electron microscope[1]

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Manipulation of matter on the scale of atoms and molecules is an essential part of realizing the potential that nanotechnology has to offer. In this talk I will describe transmission electron beam ablation lithography (TEBAL), a method for fabricating nanostructures and fully integrated devices on silicon nitride membranes by nanosculpting evaporated metal films with electron beams. TEBAL works by controllably exposing materials to an intense and highly focused beam of 200 keV electrons inside the transmission electron microscope (TEM). The effect of electron irradiation can be used to controllably displace or ablate regions of the metal with resolution on the scale of tens of atoms per exposure. In situ TEM imaging of the ablation action with atomic resolution allows for real-time feedback control during fabrication. Specific examples presented here include the fabrication and characterization of nanogaps, nanorings, nanowires with tailored shapes and curvatures, and multi-terminal devices with nanoislands or nanopores between the terminals. These nanostructures are fabricated at precise locations on a chip and seamlessly integrated into large-scale circuitry. I will discuss how the combination of high resolution, geometrical control and yield make TEBAL attractive for many applications including nanoelectronics, superconductivity, nanofluidics and molecular (DNA) translocation studies through nanopore-based transistors. References: 1) M.D. Fischbein and M. Drndic, "Sub-10 nm Device Fabrication in a Transmission Electron Microscope", Nano Letters, 7 (5), 1329, 2007. 2) M. D. Fischbein and M. Drndic, "Nanogaps by direct lithography for high-resolution imaging and electronic characterization of nanostructures", Applied Physics Letters, 88 (6), 063116, 2006.

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