Russell Berrie Nanotechnology Institute
Technion - Israel Institute of Technology

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"Ultrafast electron microscopy and diffraction using nanoscale photoemitters"

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12:00 refreshments
12:30 lecture

Wang Auditorium
The Dalia Maydan Building
Faculty of Materials Science and Engineering

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TECHNION
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Ultrafast electron microscopy and diffraction using nanoscale photoemitters

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Novel methods in time-resolved electron microscopy, diffraction and spectroscopy promise unprecedented insight into the dynamics of structural, electronic and magnetic processes on the nanoscale. A key to the realization of such technologies is the generation of high-quality beams of ultrashort electron pulses. In this talk, our recent development of imaging and spectroscopy capabilities using localized electron sources will be discussed. Specifically, two approaches employing the enhanced spatial coherence in the photoemission from nanotips will be presented, namely Ultrafast Low-Energy Electron Diffraction (ULEED) and Ultrafast Transmission Electron Microscopy (UTEM).

ULEED allows for the study of structural dynamics with high temporal resolution and ultimate surface sensitivity. In a first application of this technique, we used a transmission geometry to study the order-to-disorder transition in an ultrathin polymer layer on freestanding graphene. Presently, we investigate the transformation between charge-density wave phases at the surface of the transition metal dichalcogenide 1T-TaS_2, and we are continuously improving the temporal resolution of our ULEED system by implementing nanobricated electron guns.

UTEM yields access to the dynamical structural and electronic response of matter with the imaging capabilities of electron microscopy. Besides materials science applications, the approach also provides for unique possibilities to harness the interaction of swift electrons with local optical modes. In particular, the spectroscopic study of electrons interacting with optical near-fields facilitates quantum-coherent manipulations of the momentum distribution in ultrashort electron pulses. Further ongoing investigations with the UTEM involve spatio-temporal dynamics in nanostructured materials or the imaging of optically-induced magnetic structures.

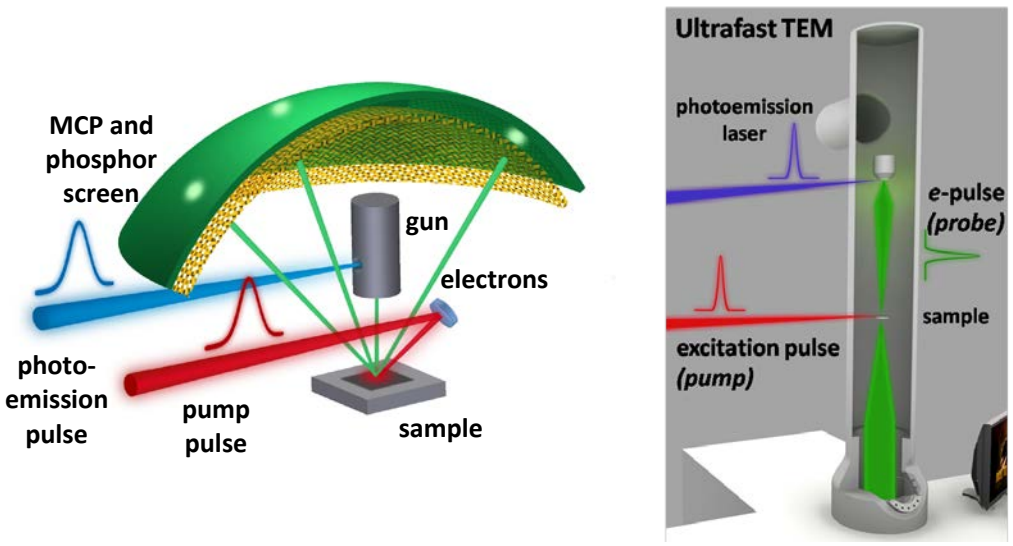

Figure: Two complementary approaches to the study of ultrafast dynamics in solids, at surfaces and nanostructures: Ultrafast Low-energy electron diffraction (ULEED, left) probes structural dynamics at surfaces with electron pulses at kinetic energies of 20-200 eV. Ultrafast transmission electron microscopy (UTEM, right) allows for ultrafast imaging, diffraction and spectroscopy of thin films and nanostructures using high-energy electron pulses (100-200 keV).