Solid State Institute
המכון למצב מוצק

TECHNION
Israel Institute
of Technology

הטכניון
מכון טכנולוגי
לישראל

SPECIAL SEMINAR

סמינר מיוחד

Short yet eventful life of hot carriers in plasmonic metals

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Abstract

The field of plasmonics in recent years has experienced a certain shift in priorities. Faced with undisputable fact that loss in metal structures cannot be avoided, or even mitigated (at least not in the optical and near IR range) the community has its attention to the applications where the loss may not be an obstacle, and, in fact, can be put into productive use. Such applications include photo-detection, photo-catalysis, and others where the energy of plasmons is expended on generation of hot carriers in the metal. Hot carriers are characterized by short lifetimes, hence it is important to understand thoroughly their generation, transport, and relaxation in order to ascertain viability of the many proposed schemes involving them.

In this talk we shall investigate the genesis of hot carriers in metals by investigating rigorously and within the same quantum framework all four principle mechanisms responsible for their generation: interband transitions, phonon-and-defect assisted intraband processes, carrier-carrier scattering assisted transitions and Landau damping. For all of these mechanisms we evaluate generation rates as well as the energy (effective temperature) and momenta (directions of propagation) of the generated hot electrons and holes. We show that as the energy of the incoming photons increases towards the visible range the electron-electron scattering assisted absorption becomes important with dire consequences for the prospective "hot electron" devices as four carriers generated in the process of the absorption of a single photon can at best be characterized as "lukewarm" or "tepid" as their kinetic energies may be too small to overcome the potential barrier at the metal boundary. Similarly, as the photon energy shifts further towards blue the interband absorption becomes the dominant mechanism and the holes generated in the d-shell of the metal can at best be characterized as "frigid" due to their low velocity. It is the Landau damping process occurring in the metal particles that are smaller than 10nm that is the most favorable on for production of truly "hot" carriers that are actually directed towards the metal interface.

We also investigate the relaxation processes causing rapid cooling of carriers. Based on our analysis we make predictions about performance characteristics of various proposed plasmonic devices.

*Refreshment at 12:15

*כיבוד ב-12:15

ההרצאה תתקיים ביום ראשון, ה-19.1.20 בשעה 12:30*

באודיטוריום המכון למצב מוצק, קומת כניסה

The lecture will take place on Sunday,19.1.20 at 12:30*

at the Solid State Institute auditorium, entrance floor

Host: Professor Gadi Eisenstein