Processes of different nature in femtosecond-laser-induced electron emission from ultrasharp metal tips

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Abstract: We present energy-resolved measurements of femtosecond-laser-induced electron emission from ultrasharp metal tips. We have evidence that we are entering in the regime of strong-field photoemission.

We report on energy-resolved measurements of electron emission observed at metal tips of different materials triggered by 6fs laser pulses from a titanium:sapphire oscillator. An electron spectrometer enables identification of these processes.

At low laser intensities (< 10^{12} W/cm^2), multiphoton absorption and subsequent over-barrier emission occur (3-photon process). We can tune the effective workfunction by applying a static electric field to the tip, and thus are able to decrease the number of photons necessary to overcome the potential barrier (2-photon process). At high DC electric fields, additionally tunneling of photo-excited electrons out of the tip is observed (photo-assisted field emission, 1-photon process).

If high laser intensities on the order of 10^{12} W/cm^2 are used, electrons with energies corresponding to absorption of up to 6 photons are visible in the spectra (above-threshold photoemission). The experimental parameters show that we are in the non-adiabatic tunneling regime. Here, an emission process should set in which resolves the laser electric field in the temporal structure of electron emission. We discuss the measured spectra and report on the current status of the experiment.