Femtosecond surface plasmon polariton pulse tracking with pump-probe thermoreflectance

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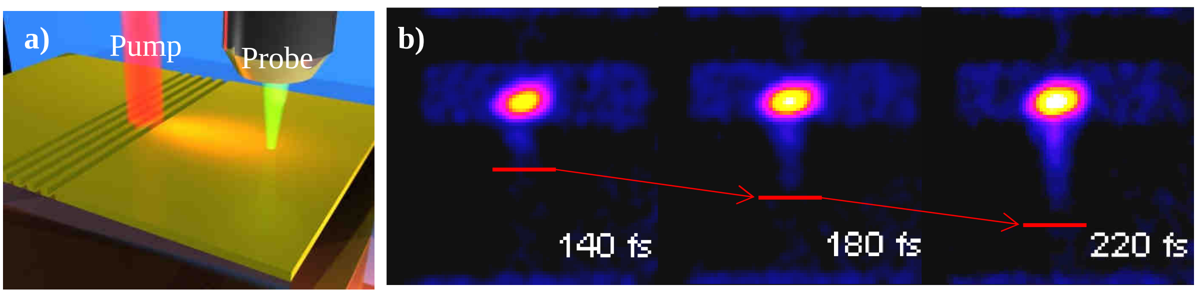
Research axis: *innovative imaging*

Semiconductor electronics and dielectric photonics have reached their critical limits in terms of device dimensions and operating speed. The further evolution in this direction is possible through *plasmonics*, which offers the opportunity to combine the size of nanoelectronics and the speed of dielectric photonic. Plasmons can be excited by electrons or photons at a metal/dielectric interface and consist of electrons oscillating en masse and have wavelengths measured in nanometers. These oscillations are called *surface plasmons*. The key property of plasmonic metallic structures is that they exhibit an unparallel ability to concentrate ligh and once they are set in motion, these 'surface plasmons'(SP), can pick up more light and carry it along the metal surface for comparatively vast distances.

The commonly used technique to study SP is near-field microscopy (NFM). However, when applied to nanoscale, the NFM is considered to be perturbative. In our experiment (fig.1.a) we apply, for the first time to our knowledge, femtosecond thermoreflectance [1] to detect indirectly SPs by imaging the heat dissipated by plasmons while they propagate. This represents a *far-field*, *noninvasive* way to detect the temperature increase due to energy deposited by the SP in the metal. Combined with the femtosecond temporal resolution of the experimental set-up, we study also the dynamics of SPPs (Fig.1b.), thus being capable to record phenomena which occurs at the speed of light. This work opens also new insight in the field of thermal energy transfer which has not yet been experimentally studied at time scales comparable with light propagation.



Filming Plasmon propagation at the rate of 25 Tera images per second
Fig.1 (a) Sketch of the experiment: a first laser incident on a nanoslit excites SPs, a second laser detects the plasmon dissipation (b) Thermoreflectance images of SPs taken at different delays after excitation: the bright spot is the excitation beam, the weak tail starting from the spot is the propagating SP.

Contrary to all the other techniques, which have access to the field component of SP in the dielectric. The particularity of our technique is that we image the profile of the absorbed plasmon energy *in the metal*. This allowed us to reveal an anomalous light absorption profile around a single sub wavelength slit [2, 3].

As a future perspective we plan to use metallic plasmonic structures to concentrate SPs in subdiffractional light spots and to use them to probe the heating of nanometrical objects.

References

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