Control of heat anisotropy in plasmonic metasurfaces by pump-probe spectroscopy and imaging method of photodegradation at the nanoscale

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Plasmonics has a wide range of applications, from biomedical and environmental sensors to light emission control. Through several projects, we have studied plasmonic couplings, especially those between propagative plasmons in metal films and localized plasmons in nanostructures. The resulting hybrid mode [1,2] has demonstrated its interest in biosensing applications, notably in SPR and SERS (Raman spectroscopy) [3]. In addition, metal nanoparticles behave as sources of heat by absorbing and converting light into heat.

In this presentation, we will discuss on plasmonic modes and then investigate the photothermal heating of asymmetric nano-crosses by ultrashort light pulses. We focus on gold crosses on gold film atop a glass substrate. Samples are fabricated by e-beam lithography [4,5]. The crosses are 300/410 nm lengths, 60 nm height, 60 nm width with periods 530-640 nm. We show experimentally and numerically that non-thermal energy density and temperature inside the two arms of the crosses can be controlled with the polarization of the pump pulse, allowing us to adjust the optical delay. We also demonstrate the importance of considering non-thermal electron ballistic displacement to reproduce the measured experimental data in pump-probe spectroscopy [5].

Secondly, we investigate photodegradation phenomena. We report a new method for patterning and imaging surface chemistry with nanoscale resolution that relies on the precise control of the electronic temperature distribution on and around the gold nanostructures on a gold film under pulsed illumination (Fig1). This localized photothermal degradation can be used for sensing applications where molecules need to be localized only in areas of high electric field.

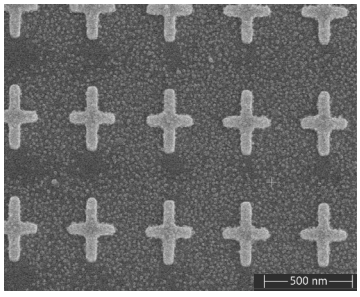

Figure 1. SEM pictures of local photodegradation between gold nanocrosses.

References

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