UNIVERSITÄT LEIPZIG

LASER MANIPULATION OF SURFACES AND NANOSTRUCTURES

Dinko Chakarov
Department of Applied Physics, Chalmers University of Technology, Göteborg, Sweden

The scope of our work is in understanding of the physical and chemical processes occurring when surfaces and nanostructures are subjected to electromagnetic radiation in the near infrared-visible - near UV range. The two important reasons for the choice to deal with such systems are: (i) the wealth of new, often of resonance character phenomena, observed when the object size and the electromagnetic field periodicity (wavelength) match. (ii) the energy of important chemical and structural transformations, e.g. bond breaking and bond formation, are in the range of incoming photons, 0.5 – 6.5 eV. Of key interest are the energy dissipation processes after the primary excitation and the effects on the nanostructure and on the surrounding. As a practical goal we want to identify and propose new scheme(s) for enhanced (solar) light absorption in nanostructured materials and utilization of the deposited energy into chemical and nanoparticle morphology transformations. This will be illustrated with the following examples:

(i) Observation of plasmon mediated photodesorption of NO from graphite (0001) surface [1]. The yield fluctuates with cluster size and reaches a maximum, up to 20 times higher compared to clean graphite surface; it is attributed to resonant excitation of plasmons in the silver particles and enhanced local fields in the vicinity of the nanoparticles.

(ii) Investigation of the confinement effects due to morphology and permeability of ice layers on photocatalytic water dissociation. [2].

(iii) Development of a process for fabrication of nanostructures on carbon surfaces with enhanced optical absorption [3]. Using hole-mask colloidal lithography we produce nanostructures with remarkably different shapes and sizes in the range 50-500 nm.

(iv) Discovery of a method for controlling the pattern into which nanoparticles in a disordered metal-nanoparticle layer organize themselves by a single light pulse. [4]. The phenomena behind formation of one- and two-dimensional grating patterns are attributed to interference effects between the incident light and waveguided modes. Such self-patterning behavior could be useful for the fabrication of complex nanostructures and advanced photonic devices.

References:

[1]. K. Mårtensson, and D. Chakarov, “NO photodesorption promoted by silver clusters” *Surface Sci.* **593**, 235 (2005).

[2]. J. Bergeld, B. Kasemo, and D. Chakarov, “Photocatalytic reactions at the graphite/ice interface”, *Phys Chem. Chem. Phys.* **10**, 1151 (2008).

[3]. H. Fredriksson, B. Kasemo, D. Chakarov, “Nanostructuring of carbon materials” submitted to *Carbon*.

[4]. L. Eurenius, C. Hägglund, E. Olsson, B. Kasemo and D. Chakarov, "Grating formation by metal nanoparticle-mediated coupling of light into waveguided modes", *Nature Photon.* **2,** 360 (2008).