MM 28: Nanomaterials I - Synthesis of advanced nanostructures

Time: Tuesday 12:00–13:15 Location: IFW A

MM 28.1 Tue 12:00 IFW A

An apparatus for the synthesis of cluster-based materials — •Arne Fischer, Robert Kruk, and Horst Hahn — Karlsruher Institut für Technologie, Institut für Nanotechnologie, 76344 Eggenstein-Leopoldshafen, Germany

A cluster deposition system for the synthesis of materials composed of mass-selected clusters embedded in various matrices as well as cluster-decorated surfaces was constructed and first deposition experiments were performed.

The system covers a large range of cluster sizes from single atoms up to clusters consisting of several thousands of atoms and provides a cluster beam with a narrow size distribution. Offering the ability to co-deposit matrix materials and mass selected clusters in well-defined ratios the system allows for studying material properties as a function of cluster size and density in the matrix. Hence this approach can open pathways to a new class of materials with tailored electronic, magnetic or catalytic properties.

In recent experiments the exchange bias was studied in thin films composed of ferromagnetic clusters and antiferromagnetic matrix materials.

MM 28.2 Tue 12:15 IFW A

Micro and nano-scale magnetic structures created by electron beam induced deposition — Johannes J.L. Mulders and •Daniela Sudfeld — FEI Electron Optics B. V., Eindhoven, The Netherlands

Electron beam induced deposition is a direct write patterning technique, using the electron beam of a scanning electron microscope (SEM) to locally dissociate injected precursor molecules adhered to a surface[1]. This dissociation results in a split of the precursor molecule into a volatile part (such as Fe) and a non-volatile part (such as CO), that is pumped out. The non-volatile part forms a deposit at the location of the electron beam and because the lateral patterning is done with nano-scale accuracy and the vertical growth is controlled by the dwell time, the technique offers a direct write patterning capability in 3 dimensions. Recently the material quality of the actual deposition of magnetic materials such as Co and Fe, has reached a level allowing for the creation of nano-scale magnetic structures that can be used for domain wall pinning, Hall sensors, and tips for magnetic force microscopy (MFM). The current status of the technology will be presented, including the practical limits and recent examples. In addition results using Co and Fe precursors, as well as a brief outlook into the near future will be presented. [1] Botman A., Mulders JJL, Hagen CW, Nanotechnology 20 (2009) 372001

MM 28.3 Tue 12:30 IFW A

Optical printing of gold nano resonators — •Andreas Graw, Spas Nedev, Theobald Lohmüller, and Jochen Feldmann — Photonics and Optoelectronics Group, Physics Department and CeNS, Ludwig-Maximilians-Universität München, Amalienstrasse 54, 80799 München, Germany

Plasmonic coupling between two closely apposed gold nanoparticles leads to a strong enhancement of the electromagnetic field in the nanoparticle gap. Such strongly coupled nanostructures, or plasmonic nanoantennas, offer outstanding capabilities for label-free sensing, spectroscopy, and optical manipulation at the nanoscale [1].

However, the exact positioning of individual nanoparticles right next to each other is challenging and requires high-end nanofabrication methods such as eBeam lithography or manipulation with an AFM tip. Here, we introduce an all optical approach to pattern gold nanoparticles with nanoscale accuracy by optical forces [2]. In this context, we will demonstrate how individual gold particles can be printed on a glass substrate with light and discuss strategies to apply this approach for the fabrication of plasmonic nanoantennas.

[1] Ringler, M.; Nano Lett. 2008, 8(2), 485-490
[2] Urban, A; Nano Lett. 2010, 10(12), 4794-4798

MM 28.4 Tue 12:45 IFW A

Multiple scribing via diffusion-assisted direct laser writing — •Ioanna Sakellari[1], Jae-Hyuck Yoo[2], David Gray[3], Maria Vamvakaki[3], Nikita Bityurin[4], Alexander Pikulin[4], Costas Grigoropoulos[2], and Maria Farsari[3] — [1]Univercity of Stuttgart, Stuttgart, Germany — [2]Univercity of California, Berkeley, USA — [3]Institute of Electronic Structure and Laser, Heraklion, Greece — [4]Russian Academy of Sciences, Nizhnii Novgorod, Russia

Direct Laser Writing by Two-Photon Polymerization is a versatile technique for the creation of solid 3D polymer nanostructures for photonics, biomedical and microfluidic applications. By employing laser intensities that are only slightly above the nonlinear polymerization threshold, structures with resolution of 100nm can be fabricated. In this work, we report our recent results on resolution improvement of DLW by exploiting the diffusion of a mobile quenching molecule in the scanned area. By employing a multiple scribing method, we exploit the resulted depletion of the multi-photon generated radicals in between the scans allowing the fabrication of high resolution structures. The material used is an organic-inorganic hybrid composite containing a zirconium based hybrid, while the quencher used is also a photopolymerizable monomer that becomes part of the polymer backbone upon fabrication. 3D woodpile structures with lateral spatial resolution of 70nm and rod spacing of 300nm are successfully fabricated. Optical characterization of the fabricated structures clearly shows that they exhibit stop gaps down to visible wavelengths, while well-ordered diffraction patterns obtained reveal high quality samples.

MM 28.5 Tue 13:00 IFW A

Thermal Curing of Polymers at the Nanoscale by Optothermal Manipulation of Gold Nanoparticles — •Jakob Lenz, Christoph Maier, Michael Fedoruk, Theo Lohmüller, and Jochen Feldmann — Photonics and Optoelectronics Group, Ludwig-Maximilians-Universität München, Amalienstraße 54, München

Light absorbed by small gold nanoparticles is very efficiently converted into heat on a picosecond timescale. Single particles can thus be used as a heat source on a very confined, nanoscopic area. Here we demonstrate how these properties can be utilized to trigger and control the heat induced polymerization reaction of thermosetting polymers at the nanoscale and show how this approach can be applied to fabricate polymer nanostructures such as particles and nanowires with a resolution well below the diffraction limit. Overall, this approach represents a new way of controlling polymerization reactions at the nanoscale by taking advantage of plasmonic heating.