CPP 29: Nanostructures, Nanostructuring and Nanosized Soft Matter I

Time: Tuesday 11:15–13:00 Location: C 230

CPP 29.1 Tue 11:15 C 230

Strain-induced formation of oriented plasmonic oligomers on elastomeric substrate — •Anja Maria Steiner[1,2], Martin mayer[1,2], Maximilian Seuss[1], Svetoslav Nikolov[3], Alexander Alexeev[3], Christian Kuttner[1,2], Tobias A.F. König[1,2], and Andreas Fery[1,2,4] — [1]Leibniz-Institut für Polymerforschung Dresden e.V., Germany — [2]Centre for Advancing Electronics Dresden, Germany — [3]Georgia Tech, Atlanta, United States — [4]Department of Physical Chemistry of Polymeric Materials, TU Dresden, Germany

We present the formation of oriented chains of few plasmonic nanoparticles,so called plasmonic oligomers, by controlled fragmentation of linear particle assemblies into finite sub-chains. Detailed investigations of the fragmentation process are conducted by in-situ atomic force microscopy (AFM) and correlated to UV-vis-NIR spectroscopy. By evaluation of the strain dependent optical properties we found a reversible, non-linear shift of the dominant plasmonic resonance. Based on the AFM measurements, the optical evaluation and mechanical modeling (lattice spring method), we prove a formation mechanism which provides experimental guiding lines. Following this strain-dependent fragmentation mechanism the chain length can be controlled depending on the ratio of cohesion between the particles and adhesion of the colloids to the supporting elastomeric substrate. We demonstrate, that mechanical stimulus is a powerful tool for the scalable fabrication of oriented linear plasmonic oligomers and opens new avenues for strain-dependent optical devises and mechanoplasmonic applications.
A.M. Steiner *et al.*,ACS Nano, **2017**, 11, 8871–8880

CPP 29.2 Tue 11:30 C 230

Plasmonic Broadband Absorbers for Hot Electrons Extraction — •Charlene Ng[1], Ann Roberts[2], Tim Davis[2], Daniel Gomez[3], Tobias König[1], and Andreas Fery[1] — [1]Leibniz-Institut für Polymerforschung, Instituite of Physical Chemistry and Polymer Physics, Dresden, Germany — [2]School of Physics, The University of Melbourne, Victoria, Australia 3010 — [3]RMIT University, Melbourne, VIC, 3000, Australia

Metallic nanostructures exhibit localized surface plasmon resonances (LSPR), a phenomenon where the confined electrons of the metal collectively oscillate in response to the interaction with light. Following the excitation of LSPRs, the energy flow out radiatively though reemitted photons or non-radiatively by generating highly energetic hot electrons. When in contact with a semiconductor, plasmonic nanostructures can form a Schottky junction and could emit these hot electrons to the conduction band of semiconductor, where various photo-induced chemical reactions can be induced. Most importantly, the generation of these hot electrons usually requires photon energies that are much lower than the band gap energy of typical semiconductors, allowing visible or near infra-red light to be harnessed. This emerging approach for harvesting solar energy essentially opens up new strategies to achieve high performance photocatalytic devices. Essentially, the first step to achieve high conversion efficiencies is to maximise the light absorption of plasmonic metal nanostructures. In this work, different strategies to maximise the light absorption of plasmonic nanostructures and efficient extraction of hot electrons will be discussed.

CPP 29.3 Tue 11:45 C 230

Systematic investigation of the coherent light coupling in various nanocavity geometries — •Fabian R. Gossler[1,2], Max J. Schnepf[1], and Tobias A.F. König[1,2] — [1]Institute of Physical Chemistry and Polymer Physics, Leibniz-Institut für Polymerforschung Dresden e.V., Hohe Str. 6, 01069 Dresden — [2]Cluster of Excellence Centre for Advancing Electronics Dresden, TU Dresden, Germany

We are interested in the interaction of light with self-assembled plasmonic cavities. In such film coupled nanoparticle structures, we will couple quantum emitters with plasmonic systems of various geometries such as spheres, cubes and anisotropic particles to study the coherent energy transfer. The self-assembly of metallic nanoparticles on a plasmonic film features a high optical quality in comparison to top-down lithography fabrication methods. Moreover, we tune the radiative process by modifying the cavity size through a polyelectrolyte multilayers approach with embedded Rhodamin B fluorophores. We employ atomic force microscopy, dark field scattering spectroscopy, fluorescence life-time imaging and TCSPC at the same cavity to show decreases in the fluorescence life-time as well as emission intensity enhancement of several orders of magnitude. Finally, we support the results with FDTD simulations for quantitative evaluation of the occurring plasmonic modes as well as the radiative and non-radiative decay rates. As an outlook, we present a robust self-assembly method supported by laser interference lithography templates to fabricate a plasmonic lattice for coherent energy transfer on macroscopic scales.

CPP 29.4 Tue 12:00 C 230

Coherent energy transfer in a plasmonic colloidal nanocavity — •Max J. Schnepf[1,2], Yannic Brasse[1,2], Fabian R. Gossler[1,2], Andreas Fery[1,2,3], and Tobias A.F. König[1,2] — [1]Leibniz Institute of Polymer Research (IPF), Institute of Physical Chemistry and Polymer Physics, Hohe Str. 6, 01069 Dresden, Germany — [2]Cluster of Excellence Center for Advancing Electronics Dresden (cfaed), Technische Universität Dresden, Germany — [3]Physical Chemistry of Polymeric Materials, Technische Universität Dresden, Germany

We present a film-coupled colloidal building-block, comprising of a plasmonic core surrounded by a dielectric shell containing a fluorophore emitter. Due to the small mode volume and the strong loss rate, the system is considered to be in a strong coupling regime. As a result, fluorescent lifetime of the emitter is significantly reduced and the emission rate is enhanced while the energy of the emitted photons remains unaffected.

We systematically study the energy transfer mechanism on the single particle level by employing electron microscopy, scattering spectroscopy, fluorescence life-time imaging (FLIM) and time-correlated single photon counting on the same cavity. Supported by finite-difference time-domain simulations, we examine the efficiency and nature of the energy transfer effects. Finally, we discuss the future direction in coupling of these building blocks into a plasmonic lattice.

CPP 29.5 Tue 12:15 C 230

Nanostructure and optical properties of spray-deposited metal-organic decomposition inks — •Stephan V. Roth[1,2], Björn Fricke[1], Calvin Brett[1,2], Wiebke Ohm[1], Andre Rothkirch[1], Matthias Schwartzkopf[1], and Tim Laarmann[1,3] — [1]DESY, Notkestr. 85, 22607 Hamburg — [2]KTH Royal Institute of Technology, 10044 Stockholm, Sweden — [3]CUI, Luruper Chaussee 149, 22761 Hamburg 22761, Germany

Metal-organic decomposition inks offer a facile route for preparing functional nanoparticle and conductive coatings based on precursor and solvent-based methods. Using spray deposition as roll-to-roll compatible coating method [1], we investigated the spray deposition of the silver nitrate precursor and the subsequent transformation into metallic silver layers via thermal annealing in situ and in real-time. We employed a combination of surface sensitive time-resolved wide- and small-angle x-ray scattering and optical spectroscopy. Thus, we followed the nanostructuring and the transformation of the deposited precursor into deposited metallic silver nanoparticles and correlate the occurring plasmon resonance to the nanoparticulate layer morphology. This is indispensable for optimizing the coating by tuning the deposition and annealing parameters for future use as sensors [2]. [1] S. V. Roth, J. Phys.: Condens. Matter 28, 403003 (2016) [2] G. Santoro et al., Appl. Phys. Lett 104, 243107 (2014)

CPP 29.6 Tue 12:30 C 230

From Single Particles to Coupled Plasmonic Systems — •Martin Mayer[1,2], Pavel Potapov[3], Anja Maria Steiner[1,2], Axel Lubk[3], Tobias A.F. König[1,2], and Andreas Fery[1,2,4] — [1]Leibniz-Institut für Polymerforschung Dresden e.V., Germany — [2]Center for Advancing Electronics Dresden, Germany — [3]Leibniz-Institut für Festkörper- und Werkstoffforschung, Dresden, Germany — [4]Department of Physical Chemistry of Polymeric Materials, TU Dresden, Germany

Despite being often considered as analogous plasmonic antennas, the behavior upon elongation as well as the nature of the near-field plasmonics of nanowires and coupled particle chains differ drastically. While nanowires shift linearly with elongation and build up standing surface charge waves, particle chains (plasmonic polymers) converge to a specific energy (infinite chain limit) at relatively few particles and

the resulting near-field plasmonics is dominated by the formation of an energy band.

By exploiting wet-chemical synthesis under living reaction conditions and template-assisted colloidal self-assembly, respectively, we compare the far-field (UV-vis-NIR) and near-field (EELS) behavior of these systems with the support of electromagnetic simulations.

M. Mayer *et al., Nano Lett.*, **2015**, 15, 5427–5437.
M. Mayer *et al., Angew. Chem.,* **2017**, DOI: 10.1002/anie.201708398.
A.M. Steiner *et al., ACS Nano,* **2017**, 11, 8871–8880.

CPP 29.7 Tue 12:45 C 230

Spray-mediated shear forces versus topographical confinement: controlling the orientation of silver nanowires — •Patrick T. Probst[1], Sribharani Sekar[1,2], Tobias A.F. König[1,3], Petr Formanek[1], Gero Decher[2], Andreas Fery[1,3], and Matthias Pauly[2] — [1]Leibniz-Inst. für Polymerforschung Dresden e.V., Germany — [2]Université de Strasbourg, CNRS, Inst. Charles Sadron, France — [3]Centre for Adv. Electronics Dresden, Germany

Grazing Incidence Spraying is known to enable linear arrangement of 1-dimensional nanoparticles facilitated by the arising shear forces. That way, optically and electrically anisotropic thin films of a vast variety of materials (metal, semiconductor, nanofibrils) can be readily produced on macroscopic scales ($>5\times5$ mm^2).

Surprisingly, parallel surface corrugations on the receiver substrate not only render the process more robust against rotational offsets during preparation, but, more interestingly, they can even reorient the particles by 90° to be parallel to the corrugations again. Controlling the balance between shear forces and topographical confinement opens new ways for constructing complex nano-patterns. We show how the microscopic linear arrangement of AgNWs evaluated by scanning electron microscopy (order parameter >0.9) reflects in a pronounced macroscopic optical anisotropy measured by conventional polarized UV-Vis-NIR spectroscopy.

S. Sekar, V. Lemaire, H. Hu *et al. Faraday Discuss.* **2016,** *191,* 373.
H. Hu, M Pauly, O. Felix *et al. Nanoscale* **2017,** *9,* 1307.
S. Sekar, P.T. Probst, M. Pauly *et al., submitted.*