MM 43: Nanomaterials

Applications

Time: Wednesday 17:00–18:00 Location: H 0106

MM 43.1 Wed 17:00 H 0106

Exploiting Electrocapillary Coupling at Metal Surfaces for Active Strain Sensing with Nanoporous Gold — •Charlotte Stenner[1], Li-Hua Shao[2], Nadiia Mameka[3], and Jörg Weissmüller[1,3] — [1]Institute of Materials Physics and Technology, Hamburg University of Technology, Germany — [2]Institute of Solid Mechanics Beihang University, China — [3]Institute of Materials Research, Materials Mechanics, Helmholtz-Zentrum Geesthacht, Germany

We inspect a hybrid material consisting of two separate phases, nanoporous gold (NPG) and electrolyte. The metal acts as an electrode, which is polarized against the electrolyte. NPG has a large surface-to-volume ratio therefore the properties of the hybrid material are particularly determined by the metal-electrolyte interface. Our experiments show that space charge and potential couple to mechanical deformation of the hybrid material, so that external loading induces either an electric current or a potential variation. The generated electric signals are strain-dependent, robust, and strong. We introduce a theoretical strain-sensing actuation relation to connect both effects measured on the NPG-based hybrid material. The theoretical relation leads to excellent agreement with the experimental results. [1]

[1] C. Stenner, L.-H. Shao, N. Mameka, and J. Weissmüller, Adv. Funct. Mater. 26 (2016) 5174

MM 43.2 Wed 17:15 H 0106

Ideal Dimers of Gold Nanospheres for Precision Plasmonics: Experiment and Theory — •Jun Hee Yoon, Florian Selbach, Ludmilla Langolf, and Sebastian Schlücker — Department of Chemistry, University of Duisburg-Essen, Universitätsstraße 5, 45141 Essen, Germany

A dimer of two noble metal nanoparticles is the simplest system in which electronic coupling between the particles via plasmon hybridization occurs. Theoretical predictions are typically based on ideal dimers comprising two perfectly spherical particles. Here, we present the synthesis and characterization of single ideal dimers of spherical gold nanoparticles with control over both gap distance and gap morphology. Electron microscopic and optical microspectroscopic experiments at the single-particle level show an excellent structural uniformity and an unprecedented homogeneity of their optical scattering spectra. In contrast, non-ideal dimers, i.e., dimers of non-spherical/nanocrystalline particles, with the same gap distance exhibit highly non-uniform properties. Interestingly, non-ideal dimers generate blue-shifted longitudinal plasmon peaks compared with the ideal dimers. We therefore performed FDTD calculations on non-ideal dimers with different gap morphologies using icosahedral particles. The calculations clearly demonstrate that plasmonic coupling in non-ideal dimers strongly depends on the gap morphology, i.e., the orientation of the crystal facets of the particles in the gap.

MM 43.3 Wed 17:30 H 0106

Hotspot-mediated non-dissipative and ultrafast plasmon passage — Eva-Maria Roller[1], Lucas V. Besteiro[2], Claudia Pupp[1], Larousse Khosravi Khorashad[2], Alexander O. Govorov[2], and •Tim Liedl[1] — [1]Ludwig-Maximilians-Universität München, Germany — [2]Ohio University, Athens, Ohio, USA.

Charge oscillations between two spatially separated entities via a virtual middle state are examples of electron-based population transfer but their realization requires precise control over nanoscale assembly of heterogeneous plasmonic particles. We here show the assembly and optical analysis of a triple particle system consisting of a chain of two Au nanoparticles with an inter-spaced Ag island [1]. We observe strong plasmonic coupling between the spatially separated Au particles mediated by the connecting Ag particle with almost no dissipation of energy. This is a result of the too high excitation energy of the Ag island compared to that of the Au particle leading to only quasi-occupation of the transfer channel. We describe this effect both with exact classical electrodynamic modeling and qualitative quantum-mechanical calculations. We identify the formation of strong hot spots between all particles as the main mechanism for the loss-less coupling between the remote partners. The observed spectra are consistent with a description of coherent ultra-fast energy transfer and could thus prove useful for applications such as quantum gate operations but also for classical charge and information transfer processes [2].

[1] Roller et al. Nat. Phys. 13 (2017) 761
[2] Maier, S. A. et al. Nat. Mater. 2 (2003) 229

MM 43.4 Wed 17:45 H 0106

Fabrication, Encapsulation and Characterization of Transparent Heaters Based on Solution-Processed Copper Nanowires — •Christian Bogner[1], Marco Bobinger[1], Josef Mock[1], Paolo Lugli[2], and Markus Becherer[1] — [1]TU München, Lehrstuhl für Nanoelektronik — [2]Freie Universität Bozen

Solution processed copper nanowires (CuNWs) possess significant economic advantages over indium tin oxide (ITO). However, the biggest issue, for copper nanowires (CuNWs) is the degradation of the copper due to ambient gases. In this work, encapsulation methods for transparent conducting electrodes based on solution processed copper nanowires applied as thin film heaters have been studied. The protective effect of the encapsulation layer has been investigated at temperatures ranging from approximately 80°C to 150°C. A model description allows to factor out side effects influencing the measurement.

With PMMA a 10 times longer life time of a protected heater in comparison to a pristine copper nanowire heater has been achieved. Furthermore, it has been pointed out that the protective effect of PMMA is significantly reduced above the glass transition temperature of PMMA at 105°C.

Next to the temperature induced degradation it has also been shown in this work that copper nanowire thin films are severely affected by UV-light. This work provides an additional step for establishing efficient encapsulations on CuNWs in order to utilize the promising material properties for transparent conducting electrodes.