HL 67: Perovskites, Hybrid Photovoltaics and Plasmonics

Time: Thursday 9:30–11:15 Location: POT 81

HL 67.1 Thu 9:30 POT 81

Analytical representation of dynamical quantities in *GW* from a matrix resolvent — •Jan Gesenhues[1], Dmitrii Nabok[2], Michael Rohlfing[1], and Claudia Draxl[2] — [1]Institut für Festkörpertheorie, Westfälische Wilhelms-Universität, 48149 Münster, Germany — [2]Theoretische Festkörperphysik, Humboldt-Universität zu Berlin, 12489 Berlin, Germany

A common problem in *GW* calculations is the treatment of the energy dependence of the screened coulomb interaction *W*. While the state of the art approach is the contour deformation technique, plasmon-pole models are often employed to allow for an analytical frequency convolution in calculating *GW*. In this talk we discuss a third alternative, which calculates the frequency dependent screening by determining the resolvent, which is set up from a matrix representation of the dielectric function. On the one hand this poses great educational insight into the topic, because it refrains from a numerical frequency convolution and allows one to actually write down the frequency dependence of *W*. On the other hand, the approach enables the exact description of plasmonic features in the spectral function, since it goes beyond plasmon-pole models. We present results for common materials and discuss some of the issues that appear when dealing with the spectral function (i.e. Im $G(\omega)$).

HL 67.2 Thu 9:45 POT 81

Ultrafast photo-switching of hybrid polaritons in black phosphorus heterostructures — •Fabian Sandner[1], Markus A. Huber[1], Fabian Mooshammer[1], Markus Plankl[1], Leonardo Viti[2], Lukas Z. Kastner[1], Tobias Frank[1], Jaroslav Fabian[1], Miriam S. Vitiello[2], Tyler L. Cocker[1], and Rupert Huber[1] — [1]University of Regensburg, 93040 Regensburg, Germany — [2]NEST CNR, 56127 Pisa, Italy

In recent years, special attention has been paid to surface polaritonics in van der Waals layered materials and their heterostructures. In particular, graphene has been intensely studied, as it exhibits strongly confined and widely tunable mid-infrared Dirac plasmons. However, the absence of an energy gap inhibits high switching contrasts, which are desired for nano-polaritonic devices. Here, we design and fabricate a SiO_2/black phosphorus/SiO_2 heterostructure and demonstrate ultrafast switching of a mid-infrared hybrid polariton by femtosecond near-infrared laser excitation. We trace the mode in energy, time, and space using pump-probe near-field microscopy and spectroscopy, providing us with real-space snapshots of the mode as well as its dispersion. In our heterostructure, surface phonons on the SiO_2 layers couple to transient surface plasmons on the photoexcited black phosphorus layer. The resulting hybrid interface polariton exhibits exceptional coherence properties and features a well-defined frequency and wavevector for the entire lifetime of the mode. Our results, which can be fully reproduced by theoretical calculations, show that the hybrid mode holds significant potential for future ultrafast nano-optical devices.

Coffee Break

HL 67.3 Thu 10:15 POT 81

Hierarchical Anodic Aluminum Oxide Membranes as Promising Platform for Constructing Plasmonic Structure — •Yi Wang[1,2], Shuping Xu[2], Weiqing Xu[2], Huaping Zhao[1], and Yong Lei[1] — [1]Institute for Physics and IMN MacroNano, Ilmenau University of Technology, Ilmenau 98693, Germany — [2]State Key Laboratory of Supramolecular Structure and Materials, Jilin University, Changchun, China

Attributing to the ordered and uniform porous structure, anodic aluminum oxide (AAO) membranes are widely used as templates in preparation of ordered nanostructure arrays of functional materials for various device applications. In particular, different plasmonic structures have been fabricated based on AAO membranes for sensing and energy-related device applications. Here, we demonstrate the fabrication of hierarchical AAO membranes with unique and controllable patterns, which provide a promising platform for constructing plasmonic structures. By precisely controlling the potential during the anodization process, the sophisticated structure of AAO membranes can be regulated into many distinctive patterns. After replicating the hierarchically structural AAO membranes with polymer and noble metal, hierarchical nanostructures with unique surface plasmon resonance (SPR) properties can be obtained, which can be developed as a dynamic plasmonic device or SERS substrate. The elaborate regulation of hierarchical AAO membranes broadens the scope for the functional nanostructure design, as well as applications in the fields of plasmonic switchers, microfluidic engineering, and nanophotonic devices.

HL 67.4 Thu 10:30 POT 81

Investigation of Surface Plasmons on β-Sn Segregations of GeSn-Nanostructures — •Felix Reichmann[1,2], Viktoria Schlykow[1], Subhajit Guha[1], Peter Zaumseil[1], David Stolarek[1], and Thomas Schröder[1,2] — [1]IHP, Im Technologiepark 25, 15236 Frankfurt (Oder), Germany — [2]BTU Cottbus-Senftenberg, Konrad-Zuse Straße 1, 03046 Cottbus, Germany

GeSn is a promising candidate for future optoelectronic applications compatible with the current Si based technology. The band gap is tuneable by varying the Sn content in the GeSn alloy. However, the lattice/thermal mismatch of Ge/ α-Sn and Ge/Si leads to defects and the low solubility of Sn in Ge leads to β-Sn segregations during growth and post growth process. High quality growth of GeSn on Si for future high performance devices can be achieved by nanoheteroepitaxy. Furthermore, β-Sn segregations could support surface plasmons (SP) and then be used as antennas for the GeSn nanostructures. SPs on β-Sn are expected for excitation energies in the visible range, in particular for an energy of 2 eV. The dielectric function of β-Sn then fulfils the condition for SPs at a metal-dieletric interface. For very small β-Sn structures, localized SPs should lead to an extraordinary absorbance/scattering of light compared to their size. When cooling down the β-Sn below 13 °C it transforms to α-Sn, resulting in a change of the dielectric function, not supporting the SPs anymore. The goal of our study is to evaluate the SP activity of β-Sn to enhance light emission in GeSn nanostructures for photodetection enhancement.

Invited Talk HL 67.5 Thu 10:45 POT 81

2D Quasicrystals from Semiconducting Perovskite Oxides — •Wolf Widdra[1,2] and Stefan Förster[1] — [1]Martin-Luther-Universität Halle-Wittenberg, Halle, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Halle, Germany

During the last decade, the fields of interface-driven 2D materials have gained tremendous attention, often due to their promising new structural or advantageous transport properties. One of these are the interface-driven 2D oxide quasicrystals (OQCs) which exhibit perfect, long-range dodecagonal rotational symmetry [1]. Such symmetry is forbidden for periodic structures. However, it can form in systems that are describable by 2D tiling patterns, which follow self-similarity supporting inflation rules. For the class of Perovskite oxides, we show that ultrathin films restructure into 2D quasicrystals on top of a threefold metallic substrate: $BaTiO_3$ as well as $SrTiO_3$ form stable and long-range ordered dodecagonal OQCs on Pt(111) that are characterized by brilliant 12-fold diffraction patterns [1]. Scanning tunneling microscopy resolves the aperiodic structure of surface atoms forming tiling patterns based on triangular, quadratic, and rhombic elements that are self-similar on length scales of $(2+\sqrt{3})^n$ times 0.68 nm. Concept and details of the interface-driven structures will be discussed in context of phason strain and formation of competing approximant structures [2]. First results on the electronic bandstructure will be presented.

[1] S. Förster et al., Nature 502, 215 (2013). [2] S. Förster et al., Phys. Rev. Lett. 117, 095501 (2016).