HL 2: Organic Semiconductors (joint session HL/CPP)

Time: Monday 9:30–11:15 Location: POT 361

HL 2.1 Mon 9:30 POT 361

Field-induced Seebeck voltage in disordered semiconductors — •Anton Kompatscher and Martijn Kemerink — IMSEAM, University Heidelberg

For disordered semiconductors it is theorized that finite electric fields can heat up the charge carrier distribution to effective temperatures that can significantly exceed the lattice temperature. Here, we argue that this effective temperature should be able to efficiently drive a thermoelectric generator (TEG) based on the Seebeck effect.(1) Utilizing kinetic Monte-Carlo simulations we were able to show similar results when driving a TEG with temperature or field. As a model system we choose the Seebeck ratchet introduced by Büttiker, replacing temperature- with field-driven effective temperature modulation. This allowed us to compare the current predicted by theory with the simulation currents resulting in good functional agreement. Effective temperature drive offers interesting advantages. Since only the electron distribution but not the lattice itself is heated, one of the mayor loss channels in TEG, lattice thermal conductivity, can be suppressed. Additionally, there is no need for n- and p-type materials (nor for heat exchangers) and a single material is sufficient. The main issue for concrete realization lies in the very high necessary field strengths at which effective temperature becomes relevant and that somehow need to be coupled into the TEG.

1. "On the concept of an effective temperature Seebeck ratchet", Appl. Phys. Lett. 119, 023303 (2021) https://doi.org/10.1063/5.0052116

HL 2.2 Mon 9:45 POT 361

Momentum dependent investigation of electronic excitations in β-metal-phthalocyanines — •Louis Philip Doctor and Martin Knupfer — Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, Helmholtzstraße 20, 01069 Dresden

This work presents an investigation of the electronic excitations of β-metal-phthalocyanines. We prepared 120 nm thick thin films by physical vapour deposition, which afterwards underwent an annealing process. Infrared spectroscopy revealed that the annealed films were in the β-phase. The films were further characterised in the visible regime. The prominent feature in this regime is the Q-band, which consists of four peaks arising from the HOMO to LUMO transition split by solid state effects. Furthermore the dispersion of the Q-band was measured using electron energy loss spectroscopy. We found a complex momentum dependent behaviour. Most interesting is the negative dispersion of the lowest lying excitation, which also has a tremendous effect on the performance of optoelectronic devices. This redshift partially correlates with the intermolecular distance and the charge carrier transfer integrals. The latter were determined by a theoretical model, which describes the interaction of Frenkel and charge transfer excitons in metal-phthalocyanines. Our results clearly indicate a prominent influence of charge transfer excitons to the lowest electronic excitations.

HL 2.3 Mon 10:00 POT 361

Photovoltaic and nonlinear optical properties of complex self-assembled liquid crystal structures — •Ahmad Murad[1], Alexey Eremin[1], Martin Feneberg[1], Maximilian Baumann[2], Matthias Lehmann[2], and Mohamed Alaasar[3] — [1]Otto-von-guericke-Universität, Magdeburg,Deutchland — [2]Julius- Maximilians - Universität Würzburg — [3]Martin Luther University Halle-Wittenberg, Halle (Saale),

We explore conducting and photovoltaic properties in a series of two classes of semiconducting liquid crystals. BTBT-derived polycatenary mesogens doped with fullerenes show helical network phases exhibiting a strong photovoltaic effect in a broad range of light spectrum from UV to VIS. The second class is star-shaped mesogens with subphthalocyanine core that forms self-assembled ferroelectric columnar phases. We characterise the polar order using polarisation-resolved measurements of Second Harmonic Generation (SHG). Dynamical SHG studies provide information about the switching rates and the stability of the ferroelectric states. The photovoltaic effect is demonstrated under UV exposure.

HL 2.4 Mon 10:15 POT 361

What's special about Y6; working mechanism of Neat Y6 organic solar cell — •Elifnaz Saglamkaya[1], Artem Musiienko[2], Mohammad Saeed Shadabrooa[1], Bowen Sun[1], Sreelakshmi Chandrabose[3], Giulia Lo Gerfo M.[4], Niek F. van Hulst[4], Dieter Neher[3], and Safa Shoaee[1] — [1]University of Potsdam Disordered Semiconductor Optoelectronics Karl-Liebknecht-Strasse 24-25 14476 Potsdam-Golm — [2]Department Novel Materials and Interfaces for Photovoltaic Solar Cells, Helmholtz-Zentrum Berlin für Materialien und Energie, Kekuléstraße 5, 12489 Berlin, Germany — [3]University of Potsdam Physik und Optoelektronik weicher Materie Karl-Liebknecht-Straße 24-25 14476 Potsdam-Golm — [4]Institut de Ciencies Fotoniques, The Barcelona Institute of Science and Technology, 08860 Castelldefels, Barcelona, Spain

In this study, we analyse the working mechanism of single component small molecule acceptor Y6 solar cells with power conversion efficiencies reaching up to 4.5% and short circuit currents up to 8.4 mAcm-2.Using Hall effect, photo-Hall, and photoinduced absorption (PIA) measurements, we show that the charge photo-generation occurs in the bulk of Y6. With the aid of space charge limited current (SCLC) measurements we show that Y6 has an ambipolar charge carrier mobility. Our data shows that the limiting factor for the power conversion efficiency is fast charge recombination, which can be suppressed in presence of the transport layers, or modifying the morphology with a solvent additive.

15 min. break

HL 2.5 Mon 10:45 POT 361

Ultrastrong light-matter coupling of J-aggregated squaraine in a room temperature open cavity — •Christoph Bennenhei[1], Lukas Lackner[1], Moritz Gittinger[1], Heiko Knopf[2], Falk Eilenberger[2], Jennifer Zablocki[3], Arne Lützen[3], Martin Silies[1], Christoph Lienau[1], Martin Esmann[1], and Christian Schneider[1] — [1]Institute of Physics, University of Oldenburg — [2]Fraunhofer-Institute for Applied Optics and Precision Engineering IOF, Jena — [3]Kekulé Institute of Organic Chemistry and Biochemistry, University of Bonn

Organic molecule exciton-polaritons in artificial lattices are an emerging platform to emulate complex electronic Hamiltonians at ambient conditions. We present J-aggregated squaraine dye (SQ) thin films [1] as a promising candidate for exciton-polaritons in optical cavities due to the high oscillator strength and tunable resonance. Using white light reflection spectroscopy, we demonstrate tunable ultrastrong coupling of light to the SQ thin film in an open cavity at room temperature [2] which we support by transfer matrix calculations. In ongoing experiments, we introduce structured photonic lattices to the open cavity to investigate the coupling of the polaritons to tailored potential landscapes. [1] M. Schulz, et al., Nat Commun 9, 2413 (2018). [2] L. Lackner, et al., Nat Commun 12, 4933 (2021).

HL 2.6 Mon 11:00 POT 361

Room-temperature polariton lasing in anisotropic optical microcavities — •Christoph Bennenhei[1], Nils Kunte[1], Marti Struve[1], Heiko Knopf[2], Falk Eilenberger[2], Jürgen Ohmer[3], Utz Fischer[3], Martin Esmann[1], and Christian Schneider[1] — [1]Institute for Physics, Universität Oldenburg, Germany — [2]Fraunhofer-Institute for Applied Optics and Precision Engineering IOF, Jena, Germany — [3]Department of Biochemistry, Universität Würzburg, Germany

Organic molecule exciton-polaritons in artificial photonic potentials are an emerging platform to emulate electronic Hamiltonians at ambient conditions and for realizing low-threshold microlasers. In this work, we probe the polarization of polariton lasing in microcavities composed of dielectric Bragg reflectors with anisotropic indentations, enclosing the fluorescent protein mCherry. This material has been previously presented as a promising material for room-temperature polariton condensation [1,2]. Here, we experimentally show that lasing above the threshold differs distinctly for the two linearly polarized, energetically non-degenerate cavity eigenmodes. This effect leads to a drastic increase in the degree of linear polarization for the coherent photoluminescence emitted from the cavity. Our devices have relevant applications both for new types of polarized coherent light sources on chip and for accessing additional degrees of freedom in the emulation

of topological electronic lattice Hamiltonians at room temperature.

[1] S. Betzold et al. ACS Photonics 7, 384 (2020).

[2] M. Dusel et al. Nano Lett. 21, 6398 (2021).