# HL 20: Optical Properties

Time: Tuesday 14:00–15:15 Location: H31

HL 20.1 Tue 14:00 H31

**Second-Order Nonlinear Susceptibility of $KNbO_3$** — •Nils Mengel[1], Florian Dobener[1], Simone Sanna[2], and Sangam Chatterjee[1] — [1]Institute of Experimental Physics I and Center for Materials Research, Justus-Liebig-Universität Giessen, D-35392 Giessen — [2]Institute of Theoretical Physics and Center for Materials Research, Justus-Liebig-Universität Giessen, D-35392 Giessen

Nonlinear effects offer numerous scientific and economic usability. From low-cost applications, e. g., laser pointers, to complex systems, such as optical parametric amplifiers, nonlinear materials play an important role in almost any spectroscopy related field. Some materials are able to convert the photon energies of available laser sources to photons of higher energy, thus making them key to extend laser excitation to the blue, UV and X-ray regions. The second-order ($\chi^{(2)}$) is the first and, generally, strongest nonlinear term emerging from the Taylor extension of the susceptibility, describing the doubling of the incident frequency. However, its wavelength dependency is somewhat unclear, since most of the materials are only characterized at standard wavelengths such as 532, 1064 or 808nm, as corresponding laser sources were early available.

Here, $\chi^{(2)}$ of potassium niobate ($KNbO_3$) is measured in a relative setup, corrected by the well-characterized nonlinear effects of alpha-quartz. $KNbO_3$ is an interesting material showing high second-order susceptibilities and resonances in the spectral excitation range of a Ti:sapphire laser. The measured spectra are in agreement with corresponding DFT calculations.

HL 20.2 Tue 14:15 H31

**THz nonlinear optics in graphene ribbons** — M. Mehdi Jadidi[1,2], Kevin M. Daniels[1], Rachel Myers-Ward[3], D. Kurt Gaskill[3], Jacob König-Otto[4,5], •Stephan Winnerl[4], Andrei Shushkov[1], H. Dennis Drew[1], Thomas E. Murphy[1], and Martin Mittendorff[1,6] — [1]University of Maryland, College Park, USA — [2]Columbia University, New York, USA — [3]U. S. Naval Research Laboratory, Washington DC, USA — [4]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [5]Technische Universität Dresden, Dresden, Germany — [6]Universität Duisburg-Essen, Duisburg, Germany

Graphene plasmonics is an emerging field due the unique combination of spectral tunability, strong plasmonic resonance and low losses. Here we study the nonlinear optical properties of graphene bilayer ribbons, featuring a plasmonic resonance at 3.9 THz, in time resolved experiments. A redshift of the plasmonic resonance is observed upon excitation with picosecond THz pulses. The unconventional nonlinear effect is explained by the optical response of hot carriers. Already at fairly low fluences in the $\mu J/cm^2$ range strong changes in transmission in the 10 % range can be induced. This strong response, together with the fast recovery determined by the electron cooling time (∼10 ps), makes the system promising for optical switching applications.

HL 20.3 Tue 14:30 H31

**Nonlinear Optical Properties of Group-IV-Tetraphenyls** — •Marius Müller, Florian Dobener, and Sangam Chatterjee — Institute of Experimental Physics I and Center for Materials Research, Heinrich-Buff-Ring 16, Justus-Liebig-University Giessen, D-35392 Giessen, Germany

Tetraphenyl compounds of adamantane-like organic and inorganic clusters show strong nonlinear optical properties. For some habitus, they generate a supercontinuum by infrared cw-laser pumping. However, the underlying mechanism for the nonlinear optical effect is not completely understood. Tentatively, delocalized $\pi$-electron systems promote the white light generation. Also, amorphous habitus exhibit supercontinuum generation, while crystalline habitus feature second harmonic generation.

Group-IV-tetraphenyls ($Ph_4X$) are an alternative group of compounds to examine the influence of the crystallinity on the nonlinear optical properties. These compounds were prepared as single crystals and microcrystalline powders and their nonlinear optical properties are investigated. The compounds are known to show second-harmonic generation, but white-light generation is also observed. We investigated the cause for the change of behavior. The molecules show photo degradation at higher excitation power, which was analyzed using Raman spectroscopy.

HL 20.4 Tue 14:45 H31

**Nonlinear white-light generation driven by far infrared light in the broad region from 20 $\mu$m to 240 $\mu$m** — •Nils W. Rosemann[1,2], Florian Dobener[2], Robin C. Döring[2], Eike Dornsiepen[3], Stefanie Dehnen[3], and Sangam Chatterjee[2] — [1]Division of Chemical Physics, Department of Chemistry, Lund University, Sweden — [2]Institute of Experimental Physics I, Justus-Liebig-Universität Giessen, D-35392 Giessen, Germany — [3]Faculty of Chemistry and Materials Sciences Center, Philipps-Universität Marburg, D-35043 Marburg, Germany

The far infrared response of an amorphous cluster compound which exhibits highly nonlinear optical properties is presented. The extreme nonlinearity enables white-light generation using excitation wavelengths in the range from 20 $\mu$m to 240 $\mu$m. The emitted light is found to cover a range from the visible to mid-infrared region. Additionally, changes of the emission characteristics for pump energies close to vibrational resonance of the cluster compound are explored. The results support prior developed model that assigns the white-light generation to the anharmonic movement of electrons in the clusters ground state potential and excludes simple photon upconversion.

HL 20.5 Tue 15:00 H31

**Tunable optical resonance effects from a tailored hyperbolic metamaterial based on an oxide semiconductor** — •Evgenij Travkin[1], Thomas Kiel[1], Sergey Sadofev[1], Kurt Busch[1,2], Oliver Benson[1], and Sascha Kalusniak[1] — [1]Institut für Physik, Humboldt-Universität zu Berlin, 12489 Berlin, Germany — [2]Max-Born-Institut, 12489 Berlin, Germany

The versatile hyperbolic metamaterials (HMMs) can be utilzed for e.g. negative refraction, spontaneous emission enhancement and thermal heat control. Recently, we have studied also the impact of the HMM on optical resonances by embedding an HMM based on stacked layer pairs of dielectric ZnO and metallic highly doped ZnO:Ga into a planar optical microcavity. In this configuration, we have observed anomalous resonance effects, some of which demonstrated strong potential for the realization of subwavelength cavity resonances (Travkin et al., Phys. Rev. B 97, 195133, 2018). We explore this potential by experimentally realizing cavities in which the HMM core is tailored to support the anomalous modes spectrally below any permitted conventional cavity mode. Subsequently, we experimentally confirm the existence of subwavelength resonances in the near infrared spectral range. The experimental and numerical study of different-sized HMM-cavities reveals a surprising behavior of the individual mode dispersion with decreasing cavity length, showing among other mode separation and a reversal in dispersion monotony. Further, we compare the results between cavities with different metal fill factors of the HMM core and study the plasmonic nature of the observed effects in detail.