TECHNISCHE UNIVERSITÄT DRESDEN

Bereich Mathematik und Naturwissenschaften Fakultät Physik

PHYSIKALISCHES KOLLOQUIUM

Vortrag:

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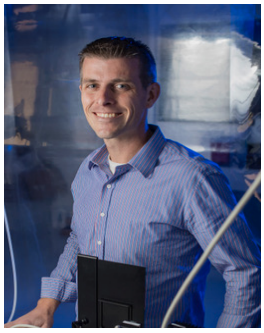

Thema: **Strong Coupling and Extreme Anisotropy in Infrared Polaritonic Media**

Zeit und Ort: Dienstag, 12.7.2022, 16:40 Uhr - **Online-Vortrag**
Zoom-Meeting: Meeting-ID: 640 0831 1215 / Kenncode: PK-22!-JC
https://tu-dresden.zoom.us/j/64008311215?pwd=SmpnQVJkYk8wL1VObklGbCtFeXl4dz09

Leitung: Prof. Lukas M. Eng

Kurzfassung: The field of nanophotonics is based on the ability to confine light to sub-diffractional dimensions. In the infrared, this requires compression of the wavelength to length scales well below that of the free-space values. While traditional dielectric materials do not exhibit indices of refraction high enough in non-dispersive media to realize such compression, the implementation of polaritons, quasi-particles comprised of oscillating charges and photons, enable such opportunities. Two predominant forms of polaritons, the plasmon and phonon polariton, which are derived from light coupled with free carriers or polar optic phonons, respectively, are broadly applied in the mid- to long-wave infrared. However, the short scattering lifetimes of free-carriers result in high losses and broad linewidths for the former, while the fast dispersion and narrow band of operation for the latter result in significant limitations for both forms. Here we will discuss the opportunity to implement polaritonic strong coupling between different media in an effort to dictate the polaritonic dispersion relation, and thus, the propagation and resonant properties of these materials. Further, by employing the extreme anisotropy of crystals ranging from two-dimensional materials such as hexagonal boron nitride and transition metal dichalcogenides to low-symmetry monoclinic to triclinic materials, novel optical phenomena such as hyperbolicity and shear polaritons are observed.
The talk will highlight ultra-strong coupling between both forms of polaritons in the context of infrared emitters, as a means to control planar propagation using hyperbolic polaritons, a modifying thermal dissipation at ultrafast time scales.

Biographie: Prof. Joshua Caldwell is the Flowers Family Chancellor Faculty Fellow and Associate Professor of Mechanical Engineering and the current Director of the Interdisciplinary Materials Science Ph.D.

Program at Vanderbilt University. He was awarded his Bachelor of Chemistry from Virginia Tech in 2000 before heading to the University of Florida where he received his PhD in Physical Chemistry in 2004. There he used magnetic resonance methods to investigate electron-nuclear spin coupling within low-dimensional quantum wells and heterostructures. He accepted a postdoctoral fellowship at the Naval Research Laboratory in 2005, using optical spectroscopy as a means of understanding defects within wide-band gap semiconductors. He was transitioned to permanent staff in 2007, where he began work in the field of nanophotonics, investigating coupling phenomena within plasmonic materials. Prof. Caldwell merged his prior work in wide band gap semiconductor materials with his efforts in nanophotonics, leading to his work exploiting undoped, polar dielectric crystals for low-loss, sub-diffractional infrared optics. He is a three-time recipient of the highly competitive NRL Nanoscience Institute grants and was promoted to senior (supervisory) staff at NRL in 2012. He was awarded a sabbatical at the University of Manchester with Prof. Kostya Novoselov in 2013-2014, investigating the use of van der Waals crystals such as hexagonal boron nitride for mid-IR to THz nanophotonics, where he demonstrated the natural hyperbolic response of this material. During his time at NRL he was a 4-time recipient of the Alan Berman Best Pure Science Paper Award and received the Thomas Edison Best Patent Award for his dry transfer technique for 2D materials. In 2017 he accepted a tenured Associate Professorship at Vanderbilt University within the Mechanical Engineering Department. He was elected as a Fellow of the Materials Research Society in 2020 and was promoted to Full Professor in 2022. He was named the Director of the Interdisciplinary Materials Science Graduate Program in 2021 and has published over 170 papers, > 8800 citations and 11 patents, with two more pending.