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Dr. Tino Hofmann
ECE Seminar
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11:30AM-12:30PM, 202 ECEC

Probing Optical Properties at the Nanoscale at THz Frequencies: New Approaches for Metrology and Device Design

Abstract: The precise measurement of electromagnetic material properties at THz frequencies is essential for the development of electronic components operating in the THz frequency range as well as a prerequisite for the design and manufacturing of optical elements for increasingly advanced THz optical systems. The accurate knowledge of material THz dielectric functions furthermore provides new insights into fascinating excitation mechanisms such as spin-transitions, collective modes of biological molecules, local free-charge carrier oscillations and may allow exploration of novel physical phenomena as observed in nanostructured metamaterials. Over the last few years THz ellipsometry has been demonstrated as a powerful tool to measure accurate THz dielectric function data including anisotropy.

In this talk, I will give an overview of applications where THz ellipsometry contributed valuable insights into phenomena at the nanoscale and I will discuss possible future directions. The combination of THz ellipsometry with external magnetic fields allows the accurate measurement of the optical Hall effect which will be discussed in detail. The optical Hall effect gives contact-free, optical access to the free charge carrier properties effective mass, mobility, and density in semiconductor heterostructures at THz frequencies. It thereby provides crucial parameters for the design of future THz electronic devices. Results obtained for GaN-based high electron mobility transistor structures and epitaxial graphene will be presented and discussed. Recent developments where cavity-enhancement effects were used to facilitate accurate optical Hall effect measurements at small magnetic fields will be emphasized.

In the second part of my talk I will focus on surfaces with self-organized, spatially coherent arrangements of nanostructures which have unique optical, mechanical, and electrical properties that differ dramatically from the host material. The optical and transport properties of such sculptured thin films have attracted recent interest because of their potential to achieve novel optical sensing and separation mechanisms. Although being orders of magnitude smaller than the probing wavelength, metamaterials composed of highly-ordered 3-dimensional metal nanostructures exhibit a strong anisotropic optical response at THz frequencies. I will demonstrate that this THz optical response can be

described using effective medium dielectric function approaches and can be exploited in novel sensing mechanisms. My presentation will be concluded with examples showing that such THz metamaterials may provide an interesting new pathway for the design of optical devices and sensors.

Bio: Dr. Tino Hofmann is a Research Assistant Professor at the Department of Electrical and Computer Engineering at the University of Nebraska-Lincoln specializing in semiconductor THz optics and optical instrumentation design and development for the far infrared and THz spectral regions. He published more than 90 reviewed journal articles and holds 9 U.S. patents. Dr. Hofmann worked as postdoctoral research assistant at UNL (2006-2008) and at the Department of Physics at University of Leipzig, Germany (2004-2005). He received his Diploma and Ph.D. in Physics from the University of Leipzig, Germany in 2000 and 2004, respectively.