The Waterloo Institute for Nanotechnology and the Department of Applied Mathematics

Monday, July 29, 2019
2:30 p.m. - 3:30 p.m.
QNC 1501

Seminar Series

Dr. George W. Hanson

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Gyrotropic Graphene and Substrate Models, and Faraday Rotation with Nonreciprocal Quasi-Two-Dimensional Structures

Nonreciprocal two-dimensional (2D) and quasi-2D materials are of great current interest, as their development will pave the way toward small, lightweight nonreciprocal devices necessary for a range of applications (e.g., optical circulators and isolators). One important signature of optical nonreciprocity is the polarization rotation experienced by transmitted (Faraday rotation (FR)) or reflected (Kerr rotation) of light. In this work, we are interested in the far infrared/low THz regime, using graphene as a tunable nonreciprocal material. We consider two biasing methods to achieve nonreciprocity. The first is a traditional external magnetic field, used to induce a gryotropic response in graphene. The second is a magnetless approach, consisting of a 2D layer of ferrimagnetic $Tm_3Fe_5O_{12}$ (TIG) on a $Gd_3Ga_5O_{12}$ (GGG) substrate. The TIG layer provides an out-of-plane magnetic bias for the graphene, and should sufficiently bias the graphene for nonreciprocal effects. We have performed experiments on Faraday rotation, based on time-domain terahertz spectroscopy, and model development and simulation, for a graphene/GGG heterostructure. The GGG substrate itself is found to have a gyrotropic response at low temperatures, which affects the FR of the hetrostructure. Results show a giant magneto-optic effect from monolayer graphene with a Verdet coefficient greater than 100 rad/Tm, in excellent agreement with theoretical modeling based on experimentally obtained THz response parameters.

George Hanson has been a leading figure in the field of nanoelectromagnetics and metamaterials. His models have shown that some experimental claims of nanoparticle heating for cancer applications were wrong, further advancing understanding of this emerging field.

Professor Hanson studied Electrical Engineering, obtaining his Bachelor's degree at Lehigh University, then going on to Master' studies at Southern Methodist University, and completing his PhD degree at Michigan State University. At the University of Wisconsin-Milwaukee, his research focuses on electromagnetics and nanoelectromagnetics of carbon nanotubes and graphene, quantum optics and quantum plasmonics, metamaterials, nonlocal phenomena, and electromagnetic wave phenomena in layered media.