Physics Colloquium

Thursday, February 19th at 3:40PM in SC 234

Featuring:

Dr. Ayrton Bernussi

Nano Tech Center, Electrical and Computer Engineering Department

Texas Tech University

Optical properties of vanadium dioxide at terahertz (THz) and near-infrared (NIR) frequencies

Materials which optical and electrical properties can be dynamically tuned have potential applications in many areas including smart windows, ultrafast switches, spatial light modulators, reconfigurable metamaterials and frequency selective filters. Vanadium dioxide (VO_2) has been envisioned as one of the most promising material to realize tunable optical devices for THz and NIR applications. VO_2 exhibits a well-known reversible insulator-metal transition (IMT) which is accompanied by change in the electrical conductivity by several orders of magnitude. For photon energies below the bandgap, VO_2 exhibits high optical transmittance in the insulating phase and low optical transmittance in the metallic phase, leading to a large optical contrast. This is particularly important at THz and NIR frequencies where transmission amplitude modulation depths as large as 85% has been recently demonstrated using thin film VO_2 grown on sapphire substrates.

In this talk we will present our recent studies on temperature and photo-induced VO_2 IMT in the NIR and temperature induced IMT in W-doped and undoped VO_2 thin films and tunable frequency selective filters and polarizers at THz frequencies. Abrupt characteristic IMT and narrow temperature hysteresis loop width was determined from undoped VO_2 samples grown on sapphire substrates with different orientations. These attributes are critical for digital modulation applications. In contrast, continuous tuning of the characteristic IMT can be achieved with W-doped VO_2. This tuning facilitates precise control of the transmission properties of the VO_2 films to realize active THz devices for analog applications. Dual band bandpass filter and polarizer were realized by incorporating VO_2 bridges in specific regions of the patterned structures. Raising the temperature across the phase transition shifted the resonance frequency of the band pass filter by ~32% and increased the extinction ratio between vertical and horizontal polarization states to ~25 dB of the tunable polarizer due to changes in the electrical conductivity of the VO_2. Single and double side deposited VO_2 layers were investigated in the NIR. Temperature and photo-induced IMT revealed large optical contrast for double sided deposited VO_2 films. We show that the photo-induced IMT can be prospectively used to generate rewritable patterns in the NIR using a combination of pump-probe technique, a scanning mirror and an IR camera.

Refreshments at 3:00PM in SC 103