2023 Departmental Poster Competition

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Active Mid-Infrared Polarization Control by a Coupled Surface Plasmon-Phonon Polariton Cavity on VO2-SiC Metasurface

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Content :

Polarimetry is an invaluable tool for investigating material properties under the influence of polarized light. Long-wave infrared polarimetry is often limited due to a lack of polarization-sensitive optical components at mid- and far-infrared (MIR and FIR). Here, we experimentally demonstrate a MIR active and highly efficient polarization-control nanostructure. We measure the polarization rotation and ellipticity induced from gold subwavelength grating structures on top of vanadium dioxide (VO2) film on silicon carbide. The proposed structure has a resonance at 840 cm-1 due to the Fabry-Perot cavity array of coupled surface plasmon-phonon polaritons. The insulator-metal phase transition of VO2 at 55C causes a 25 cm-1 resonance shift. The polarized light parallel to the grating reflects when on resonance, while the light polarized perpendicular to the grating is strongly absorbed. Off resonance, the reflected light gains an additional scattering phase and intensity from the cavity, changing its polarization. A custom, high-resolution polarimetric spectrum microscope was developed to measure the IR polarization spectra of samples as small as 100x100-micron. This work demonstrates a novel polarimetry apparatus, enabling researchers to do precise polarimetric studies of small samples at FIR wavelengths.

Summary :

This work demonstrates that an active metasurface can be used to control the polarization of infrared light. The effect of the device on polarization is dependent on temperature. Two methods were used to measure the effects on optical rotation and phase (ellipticity), the first being a novel double modulation technique capable of producing polarization spectra, and the second is a classic two polarizer method which measures the extent of the effects on monochromatic light at the resonant wavelength. The results show that the effect is spectrally localized near the resonance and that the device is capable of producing an optical rotation of

approximately 10 degrees and a phase shift of 20 degrees between two perpendicular components of the electric field, resulting in an ellipticity imparted to the light by the device.

Primary authors : BROWN, Zach (What)

Co-authors : Prof. KIM, Myoung-Hwan (Texas Tech University)

Presenter : BROWN, Zach (What)

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