Mid-IR to THz Polaritonics: 2D Materials for IR Nanophotonics

Joshua D. Caldwell[1,*]
[1]US Naval Research Laboratory, Electronic Science and Technology Division, Washington, D.C. 20375 USA
*joshua.caldwell@nrl.navy.mil

Due to the long free-space wavelengths and relatively poor dispersive optics in the mid- to far-infrared, there is a strong degree of promise for nanophotonic-based devices. Identifying low-loss, actively tunable polaritonic materials is therefore imperative. This talk focuses on the identification of alternative polaritonic materials and heterostructures that can be used to realize this goal.

The field of nanophotonics is based on the ability to confine light to sub-diffractional dimensions. Up until recently, research in this field has been primarily focused on the use of plasmonic metals. However, the high optical losses inherent in such metal-based surface plasmon materials has led to an ever-expanding effort to identify, low-loss alternative materials capable of supporting sub-diffractional confinement. Beyond this, the limited availability of high efficiency optical sources, refractive and compact optics in the mid-infrared to THz spectral regions make nanophotonic advancements imperative. One highly promising alternative are polar dielectric crystals whereby sub-diffraction confinement of light can be achieved through the stimulation of surface *phonon* polaritons within an all-dielectric, and thus low loss material system. Due to the wide array of high quality crystalline species and varied crystal structures, a wealth of unanticipated optical properties have recently been reported. However, these materials also have some limitations, primarily in the limited spectral bandwidth of operation for any given material. This talk will discuss recent advancements to improve the material lifetime and to induce additional functionality through isotopic enrichment and hybridization of polaritonic modes for realizing low-loss, actively tunable/modulated nanophotonic materials. Such hybridization approaches require the use of atomic-scale heterostructures, for which the class of 2D materials provide an exciting and modular approach.