Making the Mid-IR Nano: The Challenges and Opportunities of Mid-Infrared Plasmonics

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Abstract: Surface plasmon polaritons and their localized counterparts, surface plasmons, are widely used at visible and near-IR frequencies to confine, enhance, and manipulate light on the subwavelength scale. At these shorter wavelengths, surface plasmons have the potential to enable future on-chip communications architectures, high-performance sensors, and high-resolution imaging and lithography systems. Plasmonics-inspired structures and devices at longer wavelengths, in the mid-infrared (mid-IR), would benefit a number of highly important technologies in health- and defense-related fields including, but not limited to, trace-gas detection, heat-signature sensing, mimicking, and cloaking, and source and detector development. However, the behavior of visible/near-IR frequency plasmonics cannot be easily transferred to the mid-IR due to the fundamentally different material response of metals in these two frequency ranges. For this reason, mid-IR plasmonic architectures for subwavelength light manipulation require both new materials and new geometries. In this presentation I provide a review of recent approaches to realize nano-scale plasmonic devices and structures operating at mid-IR wavelengths.

I will first discuss the motivation for the development of the field of mid-IR plasmonics and the fundamental differences between plasmonics in the mid-IR and at shorter wavelengths. This will be followed by a discussion of early plasmonics work in the mid-IR using traditional plasmonic metals, illuminating both the impressive results of this work, as well as the challenges arising from the very different behavior of metals in the mid-IR, when compared to shorter wavelengths. Finally, I will introduce a new classes of mid-IR plasmonic materials, capable of mimicking the behavior of traditional metals at shorter wavelengths, with the potential for true subwavelength, and ultimately, nano-scale confinement at long wavelengths.