mid-infrared surface plasmons on epitaxial semiconductors

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abstract

Here we explore highly doped InAs as a mid-infrared plasmonic material. Using an Otto geometry, we can couple directly to surface plasmons. We then tune the spp resonance via doping. We also suggest additional mid-ir epitaxial plasmonic materials

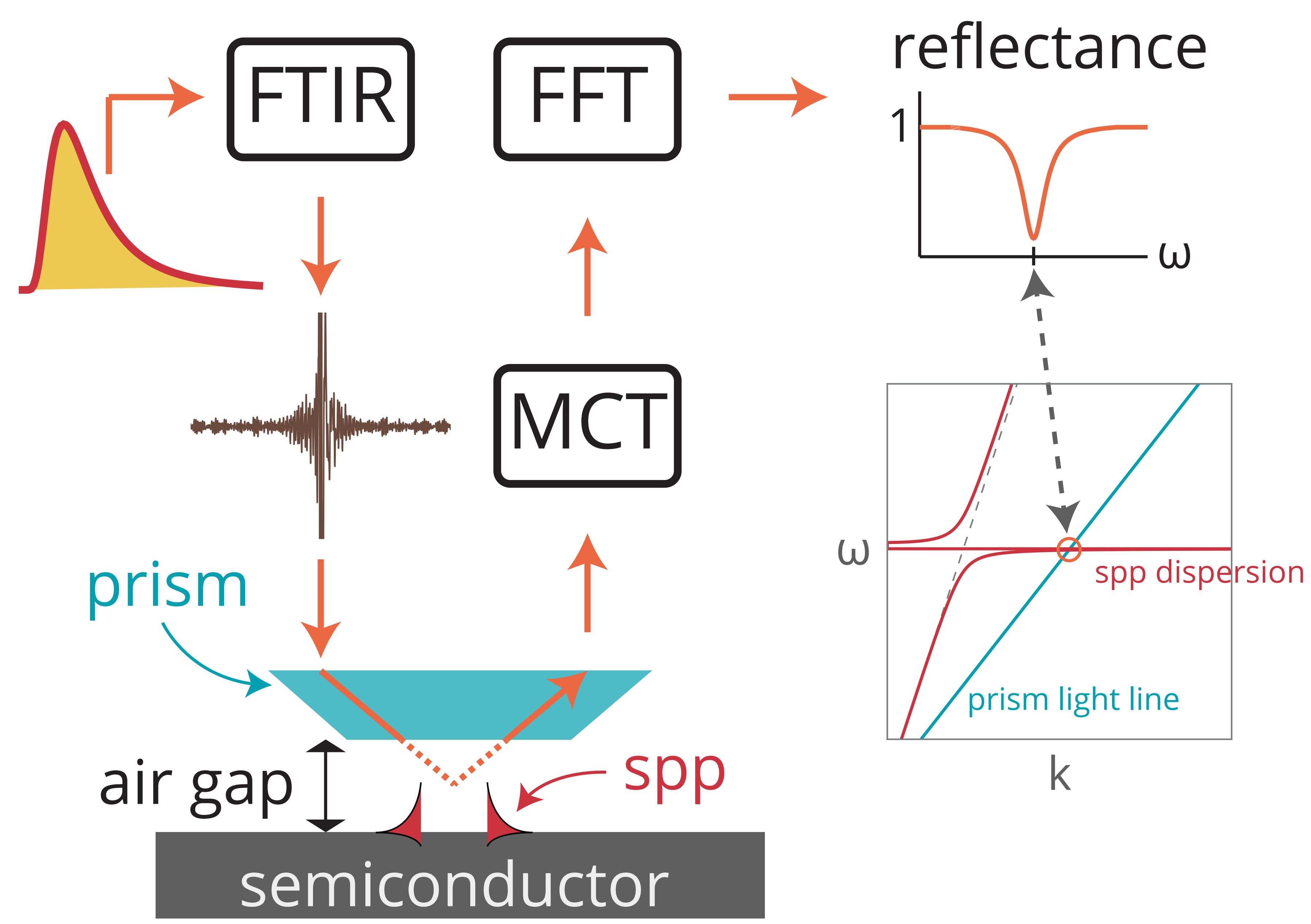
why mid-infrared?

Mid-infrared light has many scientifically and technologically important applications. These include molecular spectroscopy, chemical monitoring, and thermal imaging.

why semiconductors?

Typical plasmonic metals have too high an electron density to scale to the mid-ir. Epitaxial semiconductors offer better optical properties plus advantages in purity, tunability, and compatibility with common technological materials systems, as compared with metals.

surface plasmon coupling via an Otto configuration



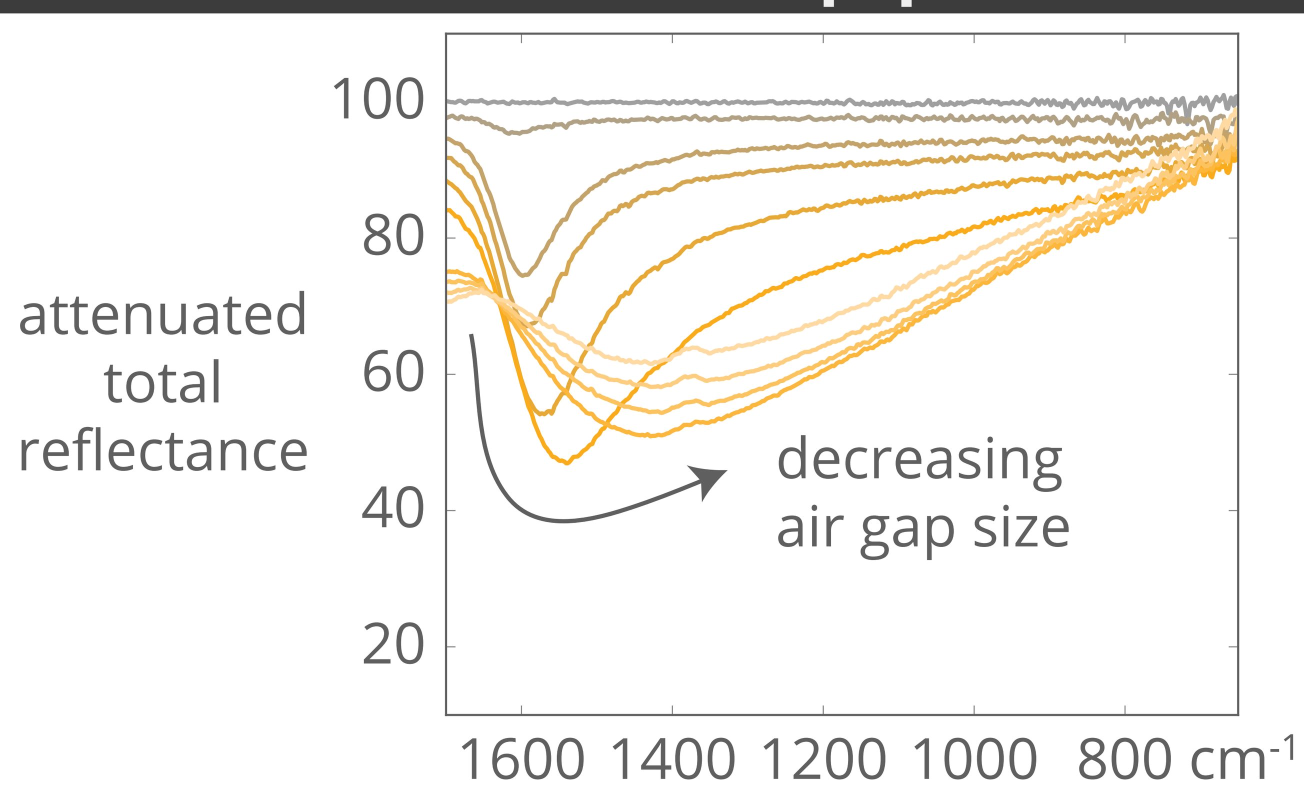
An evanescent wave from total internal reflection in a prism excites surface plasmons.

A dip in reflectance corresponds to spp coupling.

The air gap size critically determines coupling efficiency.

The width of the reflectance dip corresponds to loss.

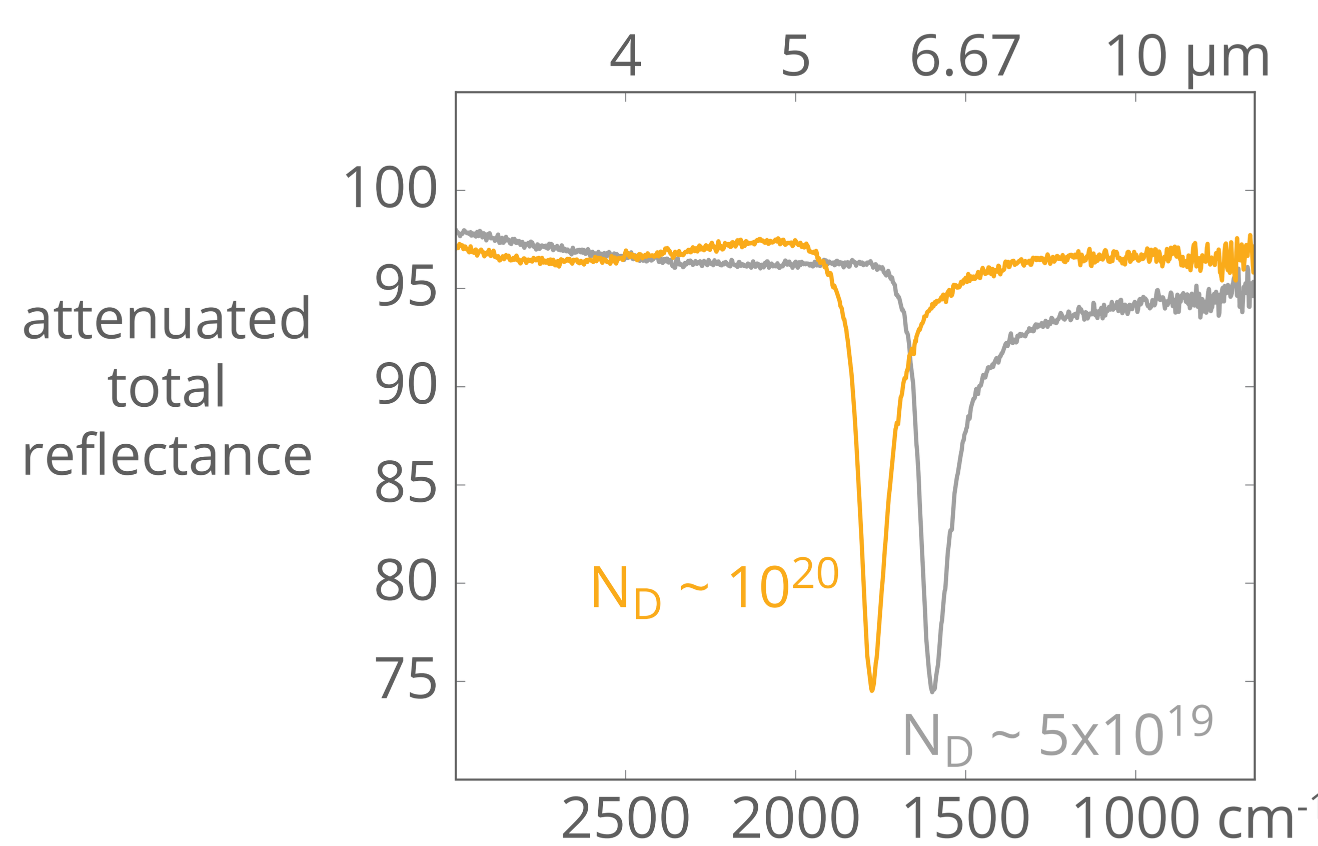
excitation of spp's in InAs



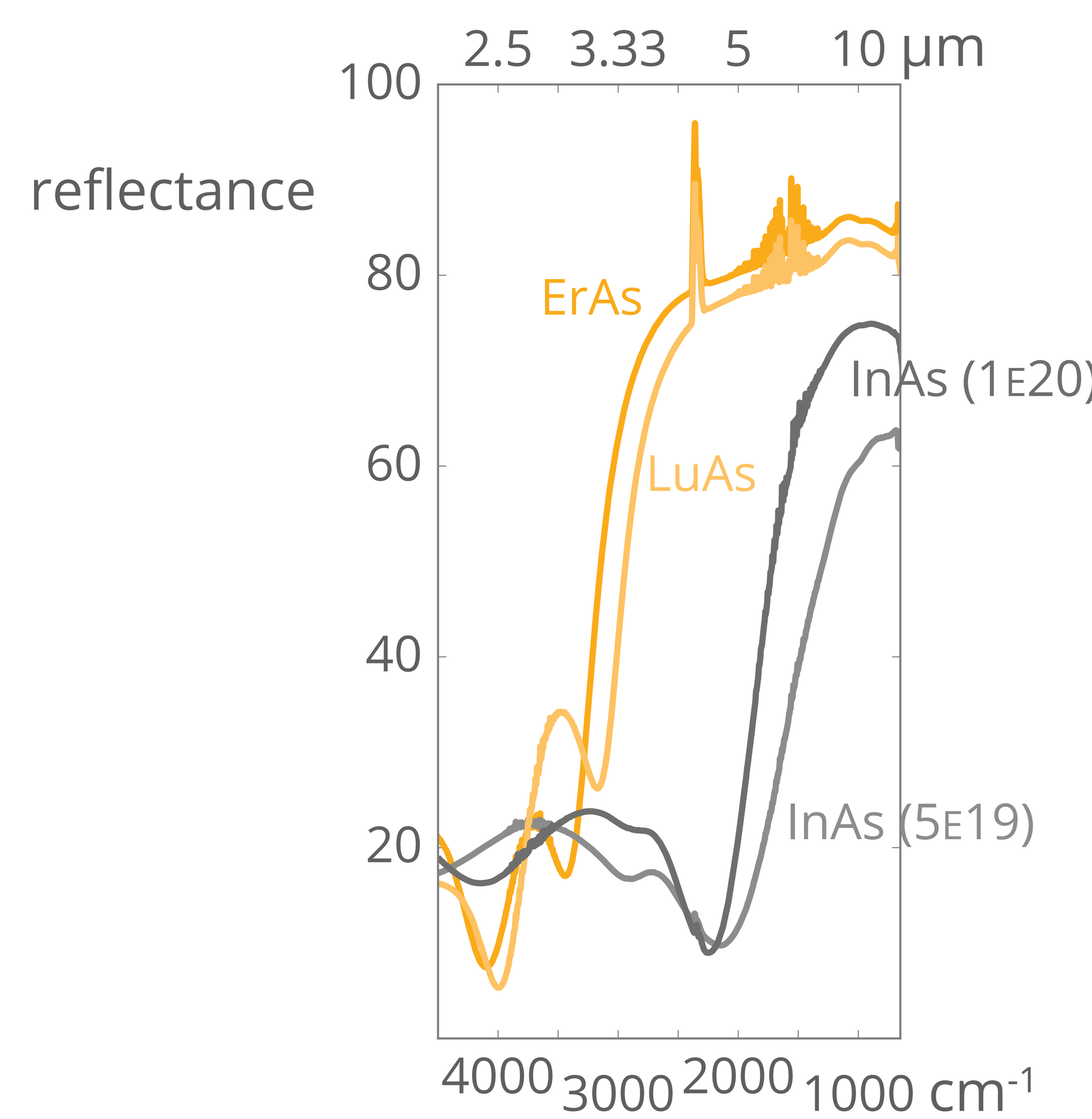
As we move the sample closer to the prism, we increase the local refractive index resulting in a red-shift of the peak. We find that an optimal air-gap size maximally couples light to the spp.

doping tunes the resonance

By altering the dopant concentration, thus changing the electron density, we can shift the spp resonance. A higher electron density results in a blue-shift in the peak.



other interesting materials



In addition to doped InAs, rare-earth / arsenic alloys also exhibit plasma frequencies in the mid-infrared. These semi-metals are also compatible with the GaAs materials system