**2D-Metal Metasurfaces for Refractive Index Sensing**

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As one of the most attractive research frontiers, the study of plasmonics, which explores the nanometer-scale strong light-matter interaction offered by plasmonic nanostructures, has led to a series of new technologies such as surface-enhanced Raman spectroscopy (SERS) and surface-enhanced fluorescence (SEF). Field concentration associated with the optically induced collective oscillation of electrons at a metal/dielectric interface, i.e., surface plasmons, is the key to most plasmonic devices. However, it has been demonstrated that the field confinement effect originating from plasmonic resonances in conventional (thickness > 30 nm) nanostructures is primarily determined by the bulk material properties of metals, which intrinsically limits the performance of plasmonic devices.

On the other hand, recent studies have shown that due to the thickness effect, ultrathin and two-dimensional (2D) metals can support strong plasmons, with concomitant tight field confinement and large field enhancement. Accordingly, 2D-metal nanostructures exhibiting plasmonic resonances are highly sensitive to the environment and intrinsically suitable for optical sensing. In this work, by performing a proof-of-concept study, we numerically demonstrate 2D-metal nanostructures as a new and transformative platform for refractive index detection. In particular, for 3-nm-Au nanoribbons exhibiting plasmonic resonances at wavelengths around 1600 nm, a RI sensitivity of SRI > 650 nm per refractive index unit (RIU) is observed for a 100 nm thick analyte layer.

A parametric study of the 2D-Au system indicates the strong dependence of the RI sensitivity on the 2D-metals’ thickness. Furthermore, for an analyte layer as thin as 1 nm, a RI sensitivity up to 110 nm/RIU (90 nm/RIU) is observed in atomically thin 2D-In (2D-Ga) nanoribbons exhibiting highly localized plasmonic resonances at mid-infrared wavelengths. Exhibiting strong plasmonic energy dispersion due to the thickness effect, the plasmonic sensors demonstrated in this work indicate the potential of 2D metals for an entire family of plasmonic devices with enhanced functionalities in the infrared.