Hybridization-induced dual-band tunable graphene metamaterials for sensing

The infrared absorption spectrum due to structural vibrations in molecules has been widely used to resolve chemical identification. However, this method is limited by the weak molecule-light interaction. Graphene plasmon, having strong confinement and large field enhancement, provides a promising way to increase their interactions. Here we propose tunable hybridization-induced graphene nanostructures for sensing application. Our results reveal that when the symmetry of the graphene disk is broken by introducing a small circular defect, dual-band resonance can be excited at mid-infrared frequencies. The dual-band resonance peaks are produced by plasmon hybridization effect between two simple structures: graphene disks and circular defects. We investigate the influence of the size and position of the circular defect on the dual-band resonance peaks. We further explore the dual-band resonance peaks for sensing, and the sensitivity can reach 550 cm$^{-1}$/RIU and the FOM can reach 20.4. Compared to the original graphene disk structure, the results show stronger resonance intensity and higher frequency sensitivity. Our findings provide a new platform for sensing, and moreover the dual-band resonance structure feature enables us to promote the development of multi-substance detection.