Acoustic graphene plasmon nanoresonators for field enhanced infrared molecular spectroscopy

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Graphene plasmons (GPs) have shown strong potentials for many interesting applications, such as tunable metamaterials, optical modulators, molecular sensors, among others [1]. When a graphene sheet is placed above a metallic substrate separated from graphene by a dielectric spacer, it can support a particularly interesting GP mode – acoustic graphene plasmons (AGPs) [2]. AGPs can provide strong electromagnetic field confinement and enhancement in the dielectric spacer, thus being promising candidates for field enhanced infrared molecular spectroscopy, particularly for probing small amounts of molecules. Here we propose and demonstrate numerically an AGP nanoresonator for sensing, consisting of a GP nanodisk separated from a metallic film by a nanometric spacer (Fig. 1) [3]. Compared to conventional GPs, AGPs exhibit a much higher spontaneous emission rate, higher sensitivity to the dielectric permittivity inside the AGP nanoresonator and remarkable capability to enhance molecular vibrational fingerprints of nanoscale analyte samples (Fig. 1). Our work opens novel avenues for sensing of ultra-small volume of molecules, as well as for studying enhanced light-matter interaction, e.g. strong coupling applications.

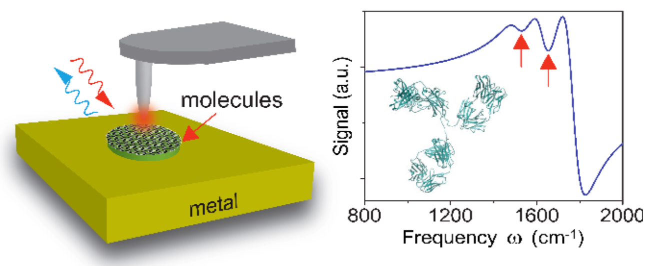

Figure 1. Left panel: schematic of proposed AGP nanoresonator for sensing, namely, graphene nanodisk above a metallic substrate separated by a thin molecular layer, probed by a scattering-type scanning near-field optical tip. Right panel: simulated near-field spectrum of an AGP nanoresonator with a protein layer (sketch of the protein molecule is shown in the inset) in the spacer. The arrows show two vibrational bands of the protein.

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