Demonstration of Ultra-small MIR Acoustic-graphene-plasmon Cavities Based on Magnetic Resonators

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Abstract: Acoustic-graphene-plasmons (AGPs) are highly confined electromagnetic modes, which carry extreme momentum and low loss in the Mid-infrared (MIR) to Terahertz (THz) spectra. Here, we demonstrate a new way to excite highly confined AGPs from the far-field, with localized graphene-plasmon-magnetic-resonators (GPMRs). This approach enables the efficient excitation of single AGP resonators, which are able to confine MIR light to ultra- small mode-volumes that are $\sim 5\cdot 10^{+10}$ times smaller than their free-space wavelength.

The GPMRs are formed by fabricating specialized structures on top of a monolayer graphene capped with hBN, which support the generation of magnetic resonances. The gate dependent extinction spectra, as measured from a GPMR device in an FTIR spectrometer, is shown in Fig.1 (left panel). The AGP resonances and their tunable response with the change in the graphene Fermi-level can be clearly seen, together with their well-known hybridization with the surface-optical-phonons of the SiO2 substrate and h-BN layer. The calculated mode-volume normalized to free-space volume, $(\lambda_0)^3$, is shown in Fig.1 (right panel) for different graphene-structure distance "d", reaching a huge confinement factor of $\sim 5\cdot 10^{+10}$ at 1nm spacing.

Our approach provides direct access to the extremely small mode-volumes of AGPs, enabling a new platform for strong light-matter interaction and efficient AGP-based devices, such as photodetectors and sensors, in the long wavelength spectrum.

Figures

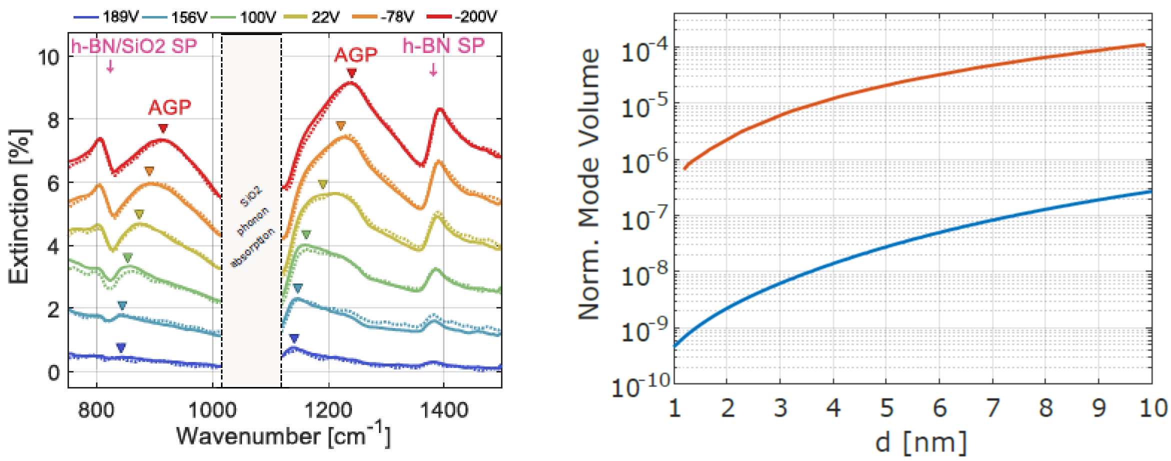

Figure 1: (a) Measured GPMR device extinction spectra for different gate voltages (colors). The triangle marks the AGP peak and the downward arrows mark the location of the h-BN and SiO2 surface-phonons. (b) Calculated normalized mode volume of the GPMR (blue curve) compared to its equivalent metal-based magnetic resonance in the visible spectrum (red curve), showing several orders of magnitude smaller confinement factor of MIR the GPMR system.