Low-loss bulk and edge plasmons in graphene heterostructures – a theoretical study

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Abstract

Terahertz (THz) fields are widely applied for sensing, communication and quality control. In future applications, they could be efficiently confined, enhanced and manipulated through the excitation of graphene plasmons. Graphene plasmons possess ultra-strong field confinement, enabling new classes of devices for deep subwavelength metamaterials, single-photon nonlinearities, extraordinarily strong light-matter interactions and nano-optoelectronic switches.
We theoretically investigate the properties of graphene plasmons in the bulk and at the edge. For bulk modes, we find that at room temperature the scattering against graphene's acoustic phonons is the dominant limiting factor for hBN/G/hBN stacks. At the edge, the presence of strain fields induces novel charged counter-propagating acoustic edge modes. In the limit of large pseudomagnetic fields, each of them involves oscillations of only one of the two electronic components.
Furthermore, we show that new chiral valley-polarized second-sound collective modes can propagate along the edges of novel materials with non-trivial Berry curvatures.

References

[1] A. Woessner *et al.* Nature Materials **14**, 421 (2015)
[2] A. Principi *et al.* Phys. Rev. Lett. **117**, 196803 (2016)
[3] A. Principi *et al.* Phys. Rev. Lett. **118**, 036802 (2017)

Figures

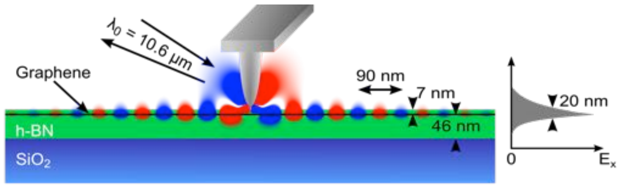

Figure 1: SNOM excitation of graphene plasmons and their lateral field confinement

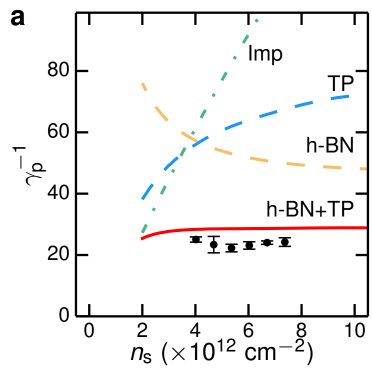

Figure 2: A comparison between experimental and theoretical damping ratios

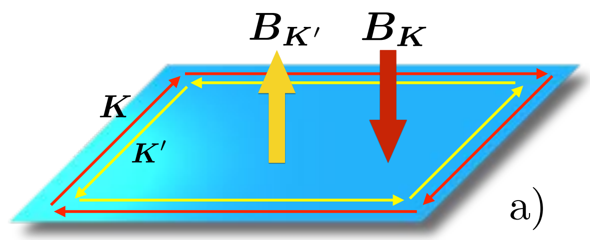

Figure 3: Edge pseudo-magnetoplasmons in the presence of strain fields.