

Light-Matter Interaction in Graphene/h-BN and Graphene/h-BN/Graphene Heterostructures Mediated by Surface Acoustic Waves

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Surface plasmon polaritons (SPPs) in graphene couple strongly to surface optical (SO) phonons in the substrate leading to hybridized surface phonon-plasmon polaritons (SPPPs). Moreover, unlike conventional SPPs in metals, graphene SPPPs can be tuned in situ through the modulation of the carrier density by electrostatic gating, covering the mid-IR to THz range. Here we demonstrate that surface acoustic wave (SAW) can be used to generate propagating SPPPs in graphene/h-BN and graphene/h-BN/graphene heterostructures on piezoelectric substrates over a broad energy range. h-BN between the graphene and the piezoelectric substrate not only significantly changes the SPPP dispersion but also enhances the lifetime as compared to the previously studied graphene/piezoelectric system [1]. The SPP dispersion of graphene splits into multiple branches due to the coupling with the SO phonons of both h-BN and piezoelectric substrate [2]. In addition, hyperbolic phonon branches appear in the case of multilayer h-BN. Moreover, the addition of a second graphene layer is shown to further disperse and strengthen the SPPPs, providing greater robustness and tunability for future SAW-based plasmonic devices.

References

- [1] Schiefele et al., Phys. Rev. Lett. 111, 237405 (2013).
- [2] Fandan et al. (submitted).

Figures

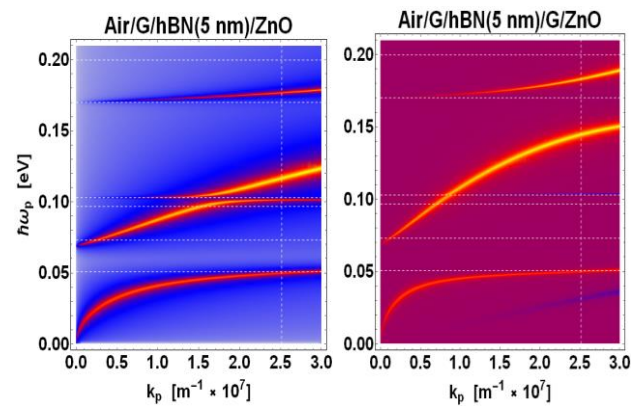


Figure 1: SPPPs dispersion in G/h-BN/ZnO and G/h-BN/G/ZnO for a 5 nm thick h-BN interlayer. Horizontal lines correspond to phonons of h-BN and ZnO, whereas vertical line corresponds to a SAW wavelength of $\lambda_{\text{SAW}} = 250$ nm.

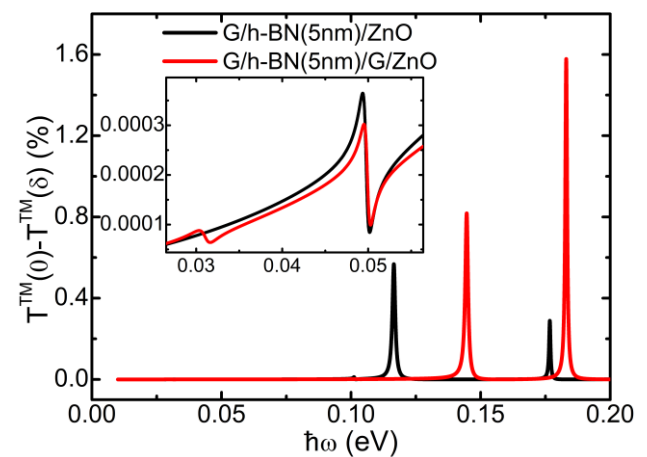


Figure 2: Generation of SPPPs in G/h-BN/ZnO and G/h-BN/G/ZnO for a 5 nm thick h-BN interlayer induced by a SAW of wavelength $\lambda_{\text{SAW}} = 250$ nm and amplitude $\delta = 4$ nm.