Giant terahertz nonlinearities of the turbostratic multilayer graphene

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Abstract

Graphene, a single atomic layer of bulk graphite, is one of the most attractive materials for terahertz (THz) optoelectronic devices due to its unique electronic band structure[1]. However, THz absorbance and nonlinearity of monolayer graphene are intrinsically limited by itself, since THz conductivity of graphene strongly depends on temperature and carrier doping state. Here, we report that the randomly stacked multilayer graphene (RSMG) film, consisting of vertically-stacked layers with arbitrary angles between adjacent polycrystalline CVD-grown graphene sheets, enhances THz nonlinear modulation strength ~9 times, compared to the as-grown multilayer graphene film as shown Fig. 1. The experimental results are in excellent agreement with our theoretical simulations confirming that the ultrafast THz modulation in RSMG films is associated with the THz photon-induced free carrier heating and the carrier-phonon coupling in each graphene sheet. Moreover, we observed that the hot plasma-contributed THz nonlinear effects of graphene are 10^3 times stronger than NIR nonlinearities based on Pauli blocking for the first time. Our experimental finding can pave the way toward the highly-sensitive graphene-based THz optoelectronics.

References

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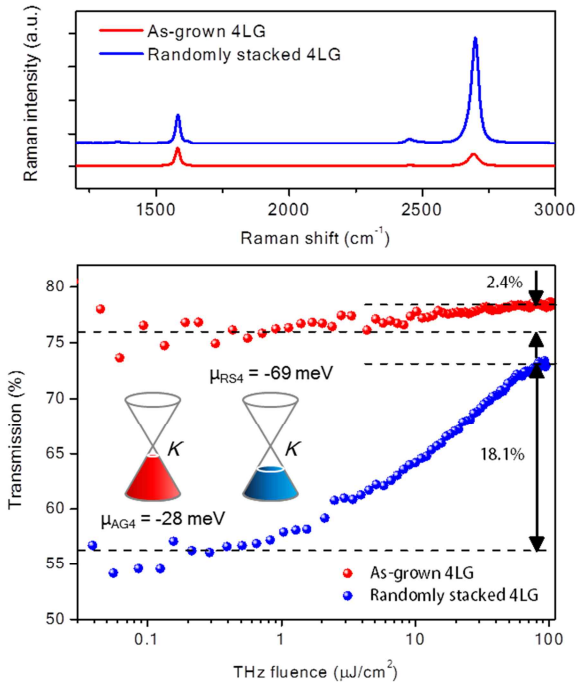

Figure 1. Raman spectra and THz nonlinear transmission curves of as-grown and turbostratic 4-layers graphene sheets