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Substrate-Phonon-Mediated Plasmon Hybridization in Coplanar Graphene Nanoribbons[1] QING DAI, XIAOXIA YANG, XIANG-TIAN KONG, BING BAI, ZHENJUN LI, HAI HU, XIAOHUI QIU, National Center for Nanoscience and Technology — Mode hybridization between adjacent graphene nanoribbons determines the integration density of graphene-based plasmonic devices. Here we demonstrate this plasmon hybridization by characterizing the coupling strength of plasmons in graphene nanoribbon arrays in terms of graphene Fermi level and inter-ribbon spacing. Both experimental and computational results showed that the plasmon coupling is strongly mediated by the substrate phonons. For polar substrate, the plasmon coupling strength was limited by the plasmon-phonon interaction. In contrast, nonpolar substrate affects neither the energy distribution of original plasmon modes in graphene nanostructures nor their plasmon interactions, which increase exponentially as the inter-ribbon spacing decreases. To further explore the potential of graphene broadband plasmonics on nonpolar substrate, we propose a scheme that uses a metal-dielectric heterostructure to prevent the overlap of plasmons between neighboring graphene nanoribbons. The device structures retain the plasmon resonance frequency of the graphene ribbons and maximally isolate the plasmonic components from the surrounding electromagnetic environment, allowing modular design in integrated plasmonic circuits.

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