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Efficient nonlinear generation of surface plasmons in graphene and topological insulators ALEXEY BELYANIN, XIANGHAN YAO, Texas A&M University, MIKHAIL TOKMAN, Institute of Applied Physics RAS — Two-dimensional materials with massless Dirac electrons such as graphene and topological insulators (TIs) support surface plasmon modes with a number of peculiar properties making them an attractive alternative to metal plasmonics. In this theoretical work we show that a coherent surface plasmon mode guided by graphene or a TI surface can be excited with high efficiency through the second-order nonlinear process of difference frequency generation (DFG). Although graphene is an isotropic medium for low-energy electron excitations, the second-order nonlinear susceptibility becomes non-zero when its spatial dispersion is taken into account. In this case the anisotropy is induced by the in-plane wave vectors of obliquely incident or in-plane propagating electromagnetic waves. The dispersion curves of surface plasmons strongly deviate from the photon dispersion already at terahertz (THz) frequencies, leading to a tight vertical confinement and large in-plane wave vector which can be matched to the sum of the photon wave vectors at mid- or even near-IR frequencies. This enables phase-matched DFG of THz plasmons with counter-propagating mid-infrared pump fields. The DFG process can reach efficiencies of 0.01/W and is broadly tunable by gating or varying an angle of incidence.

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