Extreme plasmonics in atomically thin materials

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The recent observation[1-4] and extensive theoretical understanding[5-7] of plasmons in graphene has triggered the search for similar phenomena in other atomically thin materials, such as noble-metal monolayers[8] and molecular versions of graphene.[9] The number of valence electrons that are engaged in the plasmon excitations of such thin layers is much smaller than in conventional 3D metallic particles, so that the addition or removal of a comparatively small number of electrons produces sizeable changes in their oscillation frequencies. This can be realized using gating technology, thus resulting in fast optical modulation at high microelectronic speeds. However, plasmons in graphene have only been observed at mid-infrared and lower frequencies,[1-4] and therefore, small molecular structures[9] and atomically thin metals[9] constitute attractive alternatives to achieve fast electro-optical modulation in the visible and near-infrared (vis-NIR) parts of the spectrum. We will discuss several approaches towards optical modulation using atomically thin structures, as well as the challenges and opportunities introduced by these types of materials, including their application to a new generation of quantum-optics and electro-optical devices.

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