Atomically Thin Multilayer Architectures for Plasmonics

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In the first part, I will briefly introduce research group Surfaces, Interfaces & 2D Materials at the Institute of Physics in Zagreb.

In the remaining part, I will focus on recent results which regard epitaxial graphene and hexagonal boron nitride (hBN) engineering by the adsorption and intercalation of atomic species. Our initial interest was on revealing the mechanism of the intercalation process[1] and related effects of chemical doping of graphene or hBN themselves. However, it turns that the adsorption and intercalation with the atomic precision is a tool to form special atomically thin multilayer architectures of novel functionality.

The epitaxial graphene or hBN on Ir(111) is used as a substrate for special architecture of alkali metal bilayers, where alkali atom intercalation and low-temperature adsorption enable formation of a structure in which 2D material is "sandwiched" between the two alkali layers. Such structure ensures efficient electronic decoupling of the outermost layer of alkali atoms, which together with 2D material support a so-called multipole plasmon with a dipole charge density profile. The dipole character enables direct coupling to external electromagnetic field and a pronounced effect of light absorption in the visible region, which is experimentally observable as a giant and narrow absorption band in sample reflectivity spectra[2]. Such an extreme system downsizing also significantly alters the ultrafast plasmonic response. Namely, the atomic scale confinement of the plasmon excitation leads to the generation of high-energy hot carries and a transient response within several tens of femtoseconds that is much faster than a typical hot-electron decay observed in other plasmonic systems[3]. In addition, the localized excitation non-thermally launches coherent surface phonons of the composite, exhibiting the plasmon band modulation in the THz frequency range. These new findings will pave the way for tailoring plasmon-induced processes by the atomic scale fabrication.

References:

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