Nanomechanical electro-optical modulator based on atomic heterostructures

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Two-dimensional atomic heterostructures combined with metallic nanostructures allow one to realize strong light–matter interactions[1]. Metallic nanostructures possess plasmonic resonances that can be modulated by graphene gating[2]. In particular, spectrally narrow plasmon resonances potentially allow for very high graphene-enabled modulation depth[3]. However, the modulation depths achieved using hybrid graphene-plasmonic systems have so far been low and the modulation wavelength range limited[4]. Here we demonstrate a device in which a graphene/hexagonal boron nitride heterostructure is suspended over a gold nanostripe array. A gate voltage across this device alters the location of the two-dimensional crystals, creating strong optical modulation of its reflection spectra at multiple wavelengths: in ultraviolet Fabry–Perot resonances, in visible and near-infrared diffraction-coupled plasmonic resonances and in the mid-infrared range of hexagonal boron nitride's upper Reststrahlen band. Devices can be extremely subwavelength in thickness and exhibit compact and truly broadband modulation of optical signals using heterostructures of two-dimensional materials.

References

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[2] Grigorenko, A. N. *et al.*, *Nat. Photon.*, 6 (2012) 749–758
[3] Thackray, B. D. *et al.*, *Nano Lett.*, 15 (2015) 3519–3523
[4] Thomas, P. A. *et al.*, *Nat. Commun.*, 7 (2016) 13590

Figures

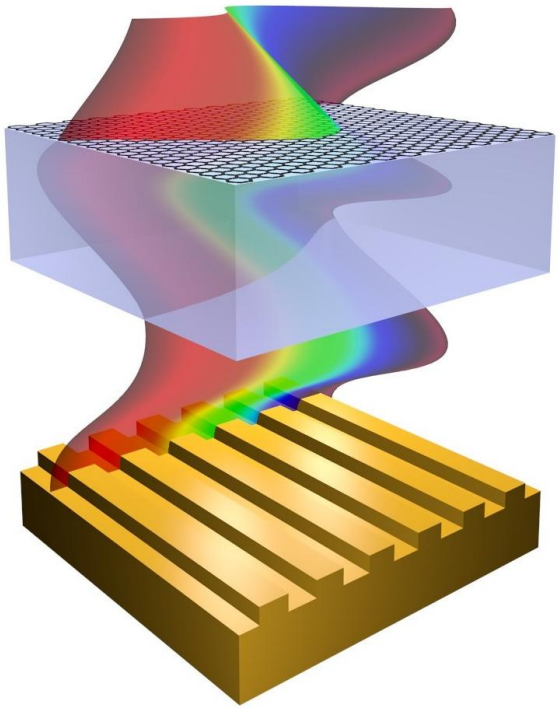

Figure 1: The working principle of the device. The coloured wave represents an unperturbed standing wave for different wavelengths observed under reflection from the nanostructured mirror.