Enhancement of Photoemission from Hole-Patterned Two-Dimensional Materials by Embedding with Silver Nanostructures

By

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Date: 19 December 2017 (Tuesday)
Time: 10:30
Venue: Room 4582 (Lift 29-30)

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Abstract

Enhancement of photoluminescence (PL) from semiconducting two dimensional (2D), is crucially important for nanophotonic and nanoelectronic applications. However, low refractive index of strongly confined 2D materials, i.e. molybdenum disulphide (MoS2) and boron nitride (BN) results in poor light-matter interactions. Heterostructuring with plasmonic supported metallic nanostructures has been reported as a potential method to boost photo-activity of 2D materials. Here, we developed a PL enhancement strategy by perforating 2D materials with hole-arrays followed by embedding silver nanostructures inside them. Over 30-times enhancement of the photoluminescence from monolayer molybdenum disulphide (MoS2) and two orders of magnitude enhancement from hexagonal boron nitride (h-BN), both synthesized by chemical vapour deposition (CVD), were achieved by embedding engineered plasmonic nano-disc inside perforated flakes. Furthermore, we observed that use of silver dimer array, as opposed to monomer array, lead to stronger enhancements due to their superior collective optical modes in planar surface plasmon resonance (SPR). Those observations were confirmed by simulation results which demonstrated the generation of confined in-plane dipolar resonance at metal-substrate interface. This strategy will certainly pave the way toward providing general protocol for further improvement of photoluminescence of 2D materials.