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Trion formation and exciton photoluminescence enhancement in 2D MoS2 coupled with plasmonic metal nanoparticles

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MoS2 emerged as promising candidate for photovoltaic, light emitting, optoelectronics and sensing applications. However, photoluminescence (PL) of 2D materials is still limited that motivates the researchers to explore the ways to enhance it. Plasmonic enhancement is one of best way to improve the PL in which, nanoparticles resonate with the free electrons present on the surface of 2D material. In this work, we report the PL enhancement of few layer MoS2 decorated with Ag nanoprisms by drop casting. Ag nanoprisms exhibit strong electromagnetic filed near the sharp edges or tips. The strong plasmonic field intensify the electric fields of exciting and emitting photons due to their coupling with surface plasmon resonance in Ag nanoprisms, that increases the photon absorption, radiative emission rate and quantum yield. The μ-PL spectra of MoS2 have two broad bands associated to A (~1.82 nm) and B excitons (~1.9 nm) at room temperature. The A exciton peaks becomes more broaden having a prominent shoulder after decorating MoS2 with Ag nanoprisms. The deconvolution proves that there is an emergence of A− trion component. In the vicinity of Ag nanoprisms, excitation of surface plasmons leads to the generation of hot electrons and transfer rate of hot electron from Ag to MoS2 increases due to their different work function that causes the generation of intralayer trion. This is a notable feature in our study that intralayer trion contribute highly in PL emission. So, the average PL enhancement is about 1.3 times. This work gives the new insight for future generation optoelectronic and nanophotonic devices.

Topics

Session A. Physics of condensed matter and spectroscopy

Primary author: Ms IRFAN, Iqra (Shenzhen University)

Co-authors: Dr GOLOVYNSKYI, Sergii (Shenzhen University); Prof. BOSI, Matteo (Institute of Materials for Electronics and Magnetism, IMEM-CNR, I-43124, Parma, Italy); Prof. SERAVALLI , Luca (Institute of Materials for Electronics and Magnetism, IMEM-CNR, I-43124, Parma, Italy); Dr XUE , Bin (Shenzhen University); Prof. YESHCHENKO , Oleg A. (University of Kyiv); Ms QIU , Ran (Shenzhen University); Dr LI, Baikui (Shenzhen University); Prof. QU, Junle (Shenzhen University)

Presenter: Ms IRFAN, Iqra (Shenzhen University)

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