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Plasmon-enhanced light-matter interaction in MoS2 monolayer by Gold Nanostructures

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Monolayer transition metal dichalcogenides (TMDs) with a direct bandgap hold enormous potential for designing novel electronic and optoelectronic devices. (1) However, their atomic-thin thickness leads to inefficient light-matter interactions and hinders more versatile applications. (2) One promising solution to overcome this problem is hybridizing the 2D-TMDs with plasmonic structures to increase the optical absorption of the monolayer materials. (3) Here, we report on the fabrication of MoS2-coated gold nanostructures and their characterization by photoluminescence (PL) and lifetime measurements. For excitation with an energy above the bandgap, we observed a PL enhancement of 400-fold and that the decay profiles were well-fitted by a triple-exponential decay curve, demonstrating the existence of different relaxation processes. In contrast, if the incident photon energy is below the direct bandgap, the enhancement was just 120-fold and the characteristic lifetimes are shorter than in the previous case, showing absorption of light by the plasmonic metal nanostructure, its conversion into hot electron-hole pairs, and subsequent injection into MoS2happens at faster timescales. This study shines a light on the plasmonic-excitonic interaction in these hybrid metal/semiconductor devices and paves the way toward implementing plasmon-enhanced transition metal dichalcogenide photodetectors, sensors, and emitters.

Palavras-chave: Two-dimensional materials. Plasmonics. Light-matter interaction.

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