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Sequential exciplaston coupling in silver–cyanine bilayer nanoparticles on a monolayer MoS_2 substrate

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Abstract

In this study, exciton–plasmon–exciton coupling in a bilayer system,composed of a silver disk and a J-aggregate cyanine dye disk placed on a monolayer molybdenum disulfide (MoS_2) substrate, was simulated using the finite-difference time-domain (FDTD) method. The optical extinction spectra of the system were examined under various structural parameters. The results revealed that the coupled polaritonic states, arising from the sequential interaction between the plasmonic mode of silver, the excitons of the cyanine disk, and the A and B excitons of the MoS_2 substrate, led to multiple energy branches and significant Rabi splittings. It was found that the silver plasmon mode first couples with the cyanine excitons, and the lower-energy polariton branch subsequently interacts with the A and B excitons of MoS_2. Moreover, by tuning the disk geometry, the polariton energies and coupling strengths could be precisely controlled. This hybrid system provides a promising platform for designing tunable active optical components with potential applications in biosensing, nanolasers, and various quantum technologies.

Keywords: Surface plasmons, Excitons, Sequential coupling, Rabi splitting

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