Screened Strong Coupling of Excitons in Multilayer WS2 with Collective Plasmonic Resonances

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Résumé

We demonstrate the strong coupling of direct transition excitons in tungsten disulfide (WS2) with collective plasmonic resonances at room temperature. We use open plasmonic cavities formed by periodic arrays of metallic nanoparticles. We show clear anti-crossings with monolayer, bilayer and thicker multilayer WS2 on top of the nanoparticle array. The Rabi energy of such hybrid system varies from 50 to 110 meV from monolayer to sixteen layers, while it does not scale with the square root of the number of layers as expected for collective strong coupling. We prove that out-of-plane coupling components can be disregarded since the normal field is screened due to the high refractive index contrast of the dielectric layers. Even though the in-plane dipole moments of the excitons decrease beyond monolayers, the strong in-plane field distributed in the flake can still enhance the coupling strength with multilayers. However, the screened out-of-plane field leads to the saturation of the Rabi energy. The achieved coherent coupling of TMD multilayers with open cavities could be exploited for manipulating the dynamics and transport of excitons in 2D semiconductors and developing ultrafast valley/spintronic devices.

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