Light-Emitting Plexciton: Exploiting Plasmon-Exciton Interaction in the Intermediate Coupling Regime

The interaction between plasmons in metal nanostructures and excitons in layered materials attracts recent interests due to its fascinating properties inherited from the two constituents, e.g., the high tunability on its spectral or spatial properties from the plasmonic component, and the large optical
nonlinearity or light emitting properties from the excitonic counterpart. Here, we demonstrate the light-emitting plexcitons from the coupling between the neutral excitons in monolayer WSe2 and highly-confined nanocavity plasmons in nanocube-over-mirror system. We observe, simultaneously, an anti-crossing dispersion curve of the hybrid system in the dark-field scattering spectrum and a 1700 times enhancement in the photoluminescence. We attribute the large photoluminescence enhancement to the increased local density of states by both the plasmonic and excitonic constituents in the intermediate coupling regime. What’s more, increasing the confinement of the hybrid systems is achieved by shrinking down the size of hot spot within the gap between the nanocube and the metal film. Numerical calculations reproduce the experimental observations and provide the effective number of excitons taking part in the interaction. This highly compact system provides a room temperature testing platform for quantum cavity electromagnetics at the deep subwavelength scale.

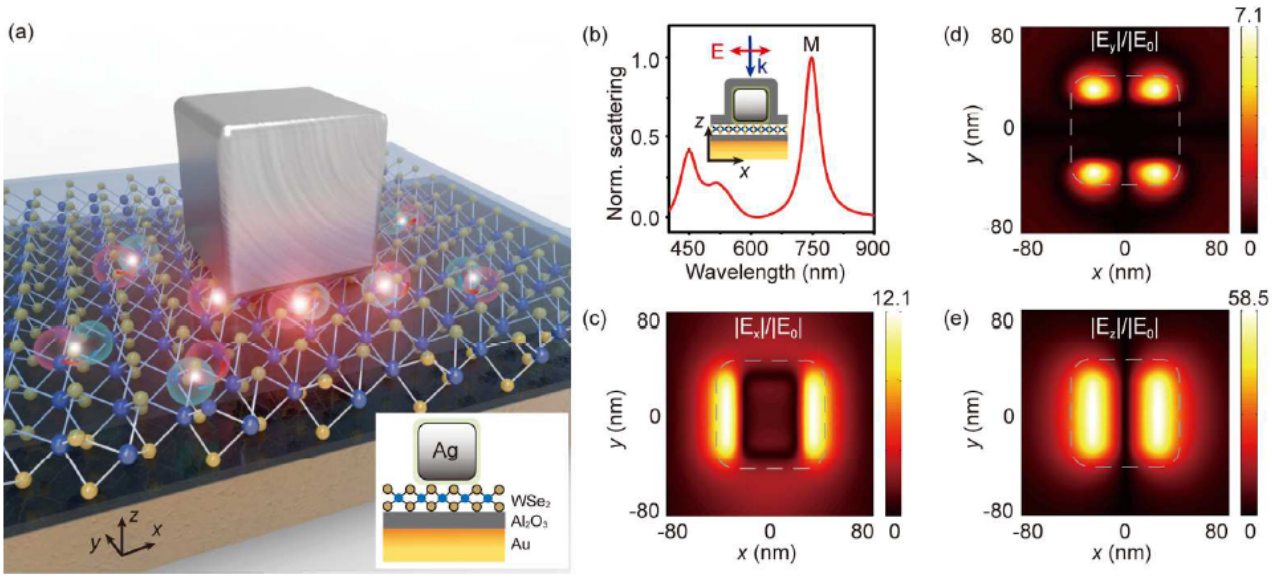

Figure 1

Our hybrid NCOM sample consists of a monolayer WSe2 inserted into the gap between a silver nanocube and a gold film (Figure 1a). Interestingly, the emission of this mode is shown to be highly directional along the film normal, making it addressable by free space radiation.30 Under the illumination of a normal incident x-polarized plane wave (as shown in Figure 1b inset), Figures 1c-e show the scattered electric field of x, y, z- component of the M mode normalized to the incident electric field E0.

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