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Supporting Information

Plasmon-Trion and Plasmon-Exciton Resonance Energy Transfer from a Single Plasmonic Nanoparticle to Monolayer MoS_2†

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1. Experimental setup for optical scattering and transmission measurements

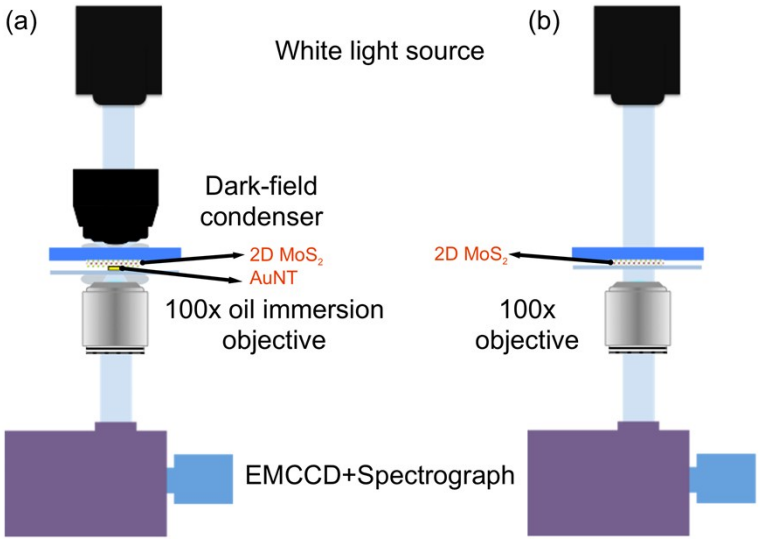

Fig. S1. Schematic of optical setups for (a) dark-field scattering measurement and (b) transmission measurement.

2. Characterization of MoS_2 by atomic force microscopy

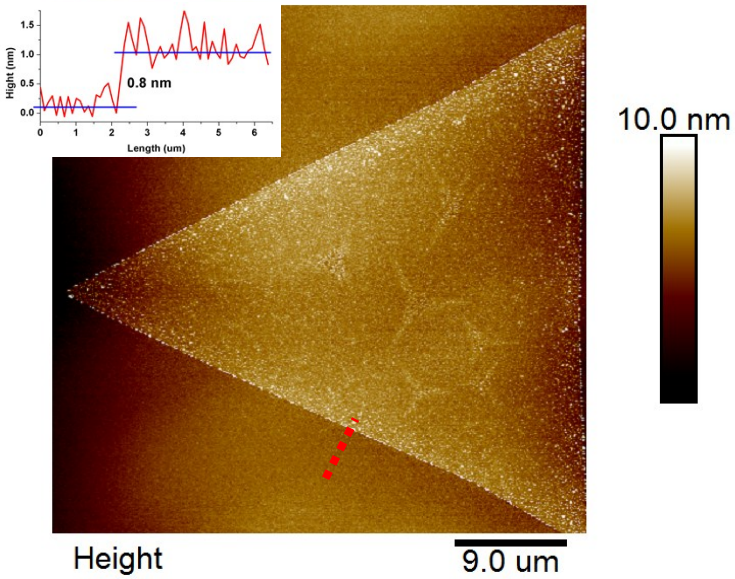

Fig. S2. AFM image of a triangular MoS_2 crystal. Inset is step-height measurement from substrate to monolayer (0.8 nm), as indicated by the red dash line.

Atomic force microscopy (AFM) was applied to measure thickness and morphology of the 2D materials. Fig. S2 shows the AFM image of a typical monolayer crystal with a small bilayer region at its center. The step-height measurement indicates that the CVD-grown MoS_2 film is atomic layer with a thickness of 0.8 nm.

3. Contribution of excitons and trions to the resonance dips in transmission spectra of monolayer MoS_2 and scattering spectra of the AuNT-MoS_2 hybrid

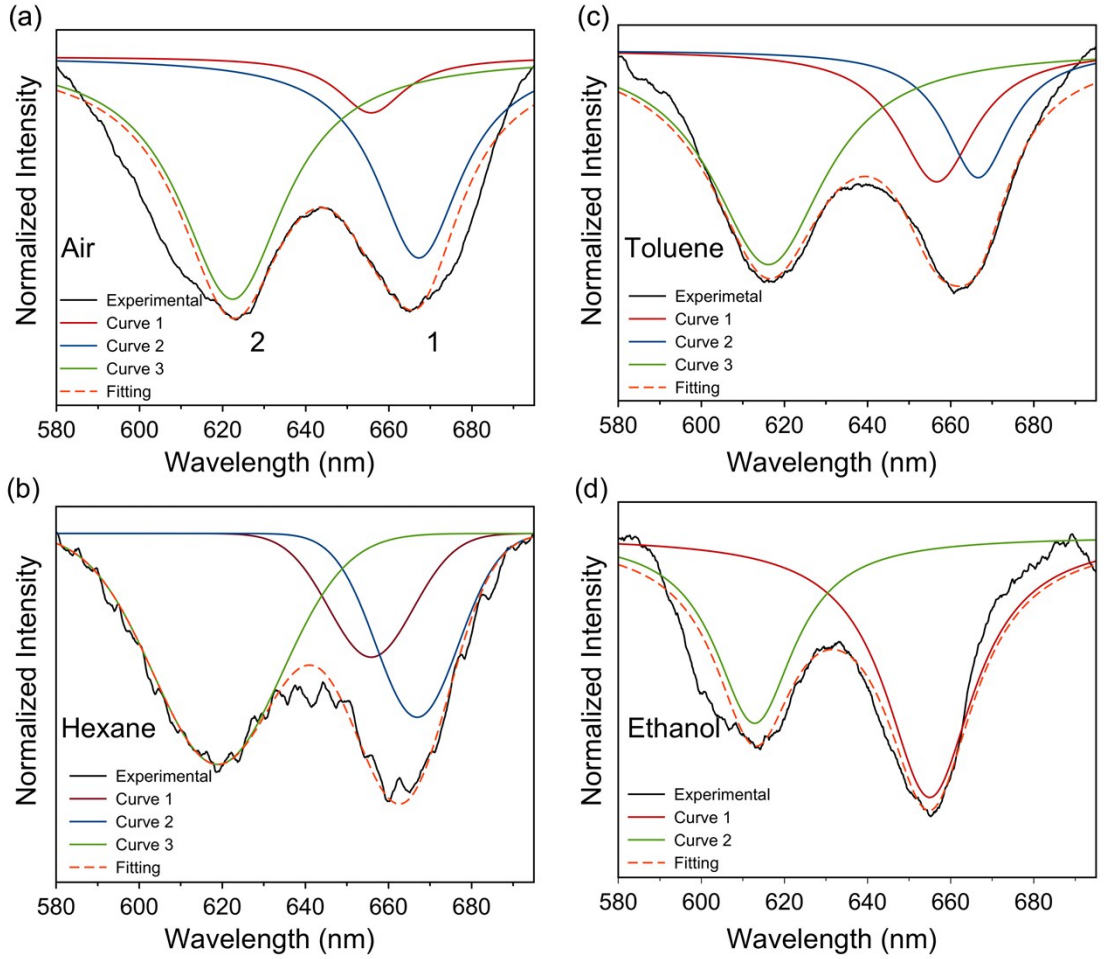

Fig. S3. The fitting curves of the transmission spectra of monolayer MoS_2 in air (a), hexane (b), toluene (c) and ethanol (d). The peaks of the red and blue curve are fixed at 655 nm and 670 nm, respectively.

We fitted the transmission dips in Fig. 2c with Lorentzians. One or two Lorentzians were used to fit the transmission dip 1, and another one was matched with the transmission dip 2. Because the absorption peaks of bare A excitons and bare A^- trions are at ~655 nm and ~670 nm at room temperature, respectively,[1] we fixed two Lorentzian peaks (the red and blue curve) in Figs. S3a, b and c at these two wavelengths for

fitting the dip 1. Figs. S3a, b and c also show that the depth of A exciton dip (red) increases while that of the A^- trion dip (blue) decrease with the dielectric constant of surroudning media. Table S1 summazies the contribution of excitons and trions to the dip 1. Moreover, as can be seen in Fig. 2c, when monolayer MoS_2 was surrounded by ethanol or water, the dip 1 was at ~655 nm. In this situation, we assumed that there were only excitons in monolayer MoS_2, and the fitted transmission spectrum of monolayer MoS_2 surrounded by ethanol is shown in Fig. S3d as an example. We also found that the contribution of exitons to the transmission dip 1 has a linear relationship with the wavelength of the dip 1, as shown in Fig. S4. Therefore, we assumed the scattering dip 1' in Fig. 6e also follows the same relationship and estimated the contribution of plasmon-exciton and plasmon-trion RET to dip 1' with different surrounding media, as listed in Table S1.

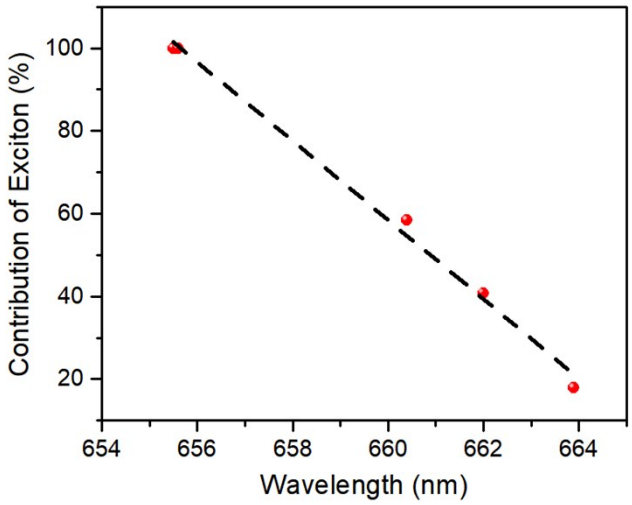

Fig. S4. The linear relationship between the contribution of excitons to dip 1 and the dip 1 wavelength.

Table S1 The estimated contribution of excitons and trions to dip 1 in Fig. 2c and plasmon-exciton and plasmon-trion RET to dip 1' in Fig. 6c.

Surrounding medium	Contribution of exciton (%)	Contribution of trion (%)	Contribution of plasmon-exciton RET (%)	Contribution of plasmon-trion RET (%)
Air	17.9	82.1	20.2	79.8
Hexane	40.8	59.2	58.4	41.6
Toluene	54.8	45.2	77.5	22.5

Ethanol	~100.0	~0	87.0	13.0
Water	~100.0	~0	96.6	3.4

3. TEM images, absorption spectra, and SEM images of AuNTs

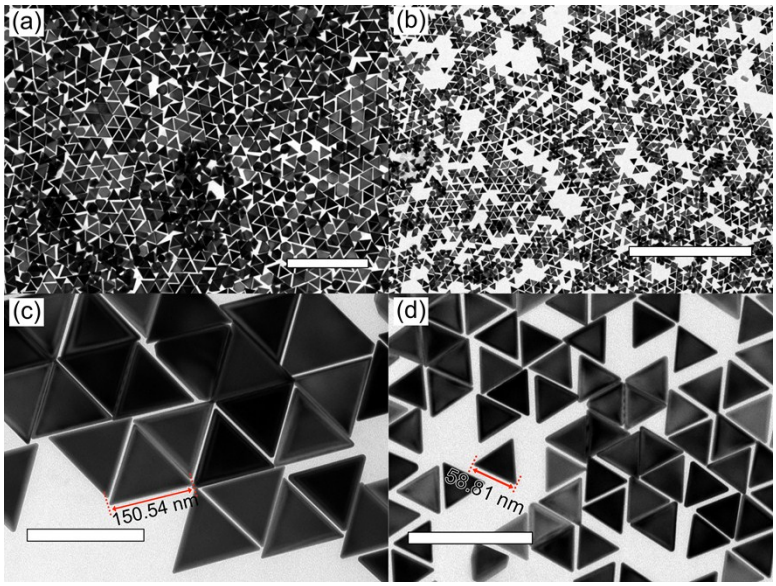

Fig. S5. TEM images of (a) 150 nm and (b) 60 nm Au nanotriangles (AuNTs). Scale bar is 1 μm. High magnification TEM images of (a) 150 nm and (b) 60 AuNTs, which show the size of AuNTs. Scale bar is 250 nm.

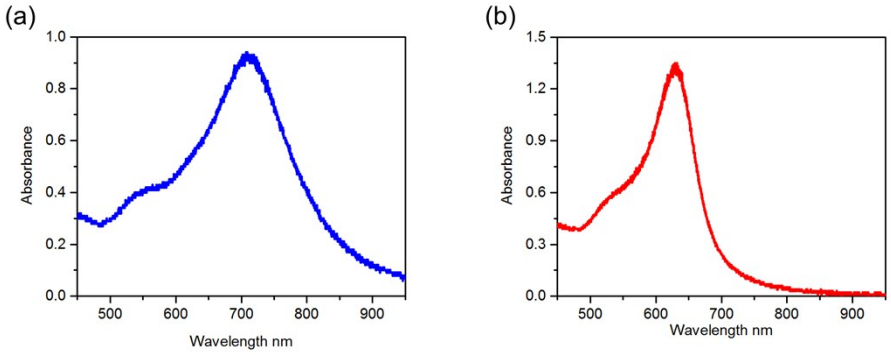

Fig. S6. Absorption spectra of (a) 150 nm and (b) 60 nm AuNTs in solution.

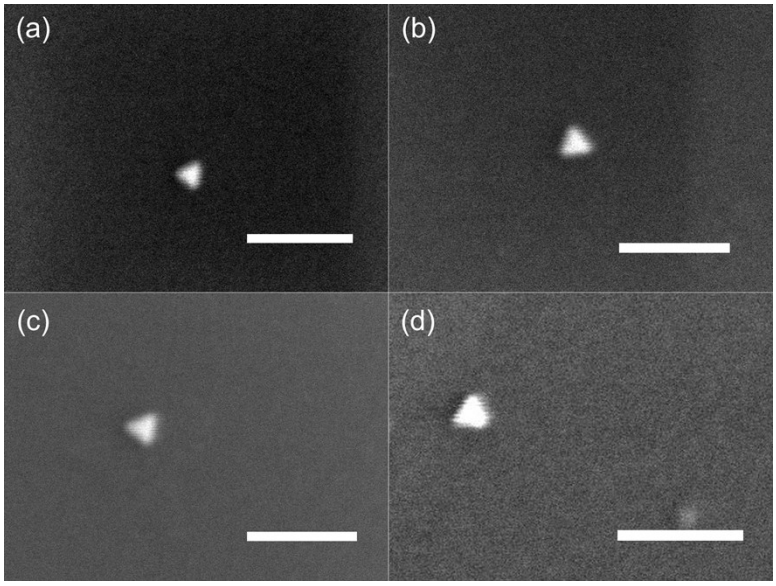

Fig. S7. (a), (b), (c) and (d) SEM images of single AuNTs on monolayer MoS_2.

4. Simulated scattering spectra of a single 150 nm and 60 nm AuNT with different surrounding media.

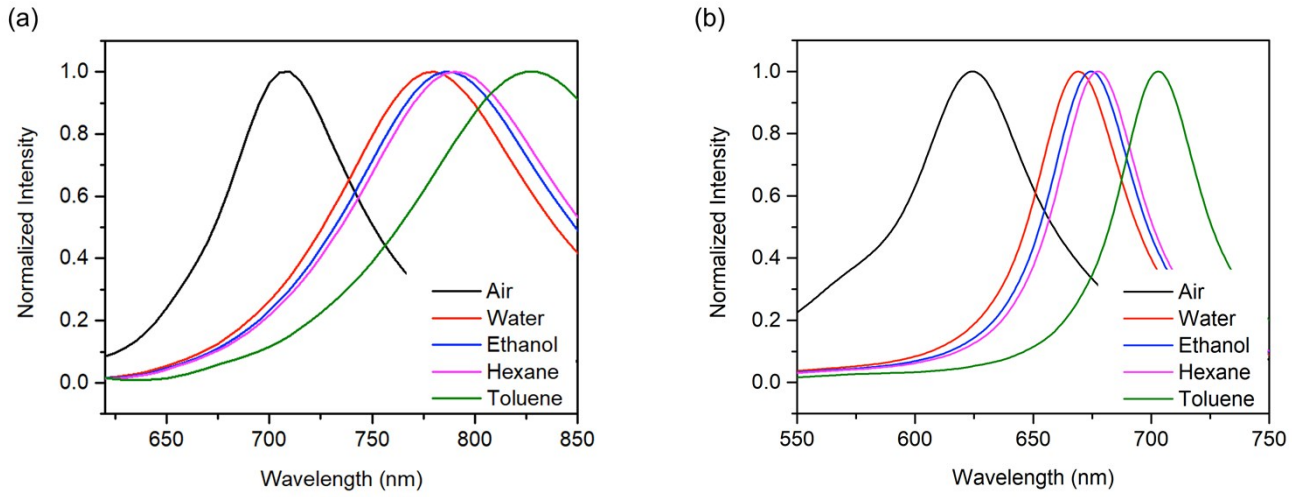

Fig. S8. Simulated scattering spectra of a single 150 nm (a) and 60 nm (b) AuNT.

The FDTD simulation (detailed information is in Experimental part) was used to simulate the scattering spectra of a single 150 nm (a) and 60 nm (b) AuNT, as shown in Fig. S6. The reflective indexes of air (1), water (1.333), ethanol (1.361), hexane (1.375) and toluene (1.497) were used to define those of the

surrounding media. It is worth noticing that the experimental scattering peaks of a single 150 nm AuNT are at slightly shorter wavelengths than the simulated ones. This may be caused by the shape deviation of the systhesized AuNTs to the prefect triangle used in the simulation and the defects in systhesized nanocrystals.

5. Experimental setup for 2D MoS_2 growth

Fig. S9. Schematic of experimental setup for 2D MoS_2 growth from MoO_3 and S precursors.

1. R. Soklaski, Y. Liang and L. Yang, *Appl. Phys. Lett.*, 2014, **104**, 193110.