Supporting Information

Lighting up WS_2 Nanoparticles on Ag Film via Plasmonic Enhancement and Exciton-Resonant Excitation

Yeshun Guo,[†] Yuheng Mao,[†] Jiancheng Xu,[†] Tianxiang Yu,[‡] Mingcheng Panmai,[§] Lidan Zhou,[‡] Shulei Li,[‖] Fu Deng,[†,] Sheng Lan,[†,*]*

[†] Guangdong Provincial Key Laboratory of Nanophotonic Functional Materials and Devices, School of Optoelectronic Science and Engineering, South China Normal University, Guangzhou 510006, China

[‡] State Key Laboratory of Optoelectronic Materials and Technologies and School of Electronics and Information Technology, Sun Yat-Sen University, Guangzhou 510275, China

[§] School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore 637371, Singapore

[‖] School of Optoelectronic Engineering, Guangdong Polytechnic Normal University, Guangzhou 510665, China

[*] Correspondence: dengfu@m.scnu.edu.cn; slan@scnu.edu.cn

S1. Scattering spectra of more WS_2 nanoparticles

Figure S1 illustrates the scattering spectra of additional WS_2 nanoparticles deposited on the Ag film, revealing two significant observations. First, the A-exciton resonance consistently occurs at approximately 630 nm across all samples examined. Second, nanoparticles exhibiting a regular hexagonal morphology (Figures S1a,c,e) display a distinct scattering peak near 700 nm, as confirmed by comparative SEM analysis. The experimental results presented herein provide a more comprehensive characterization of the mirror-coupled WS_2 nanoparticles, as discussed in Figure 1 of the main text.

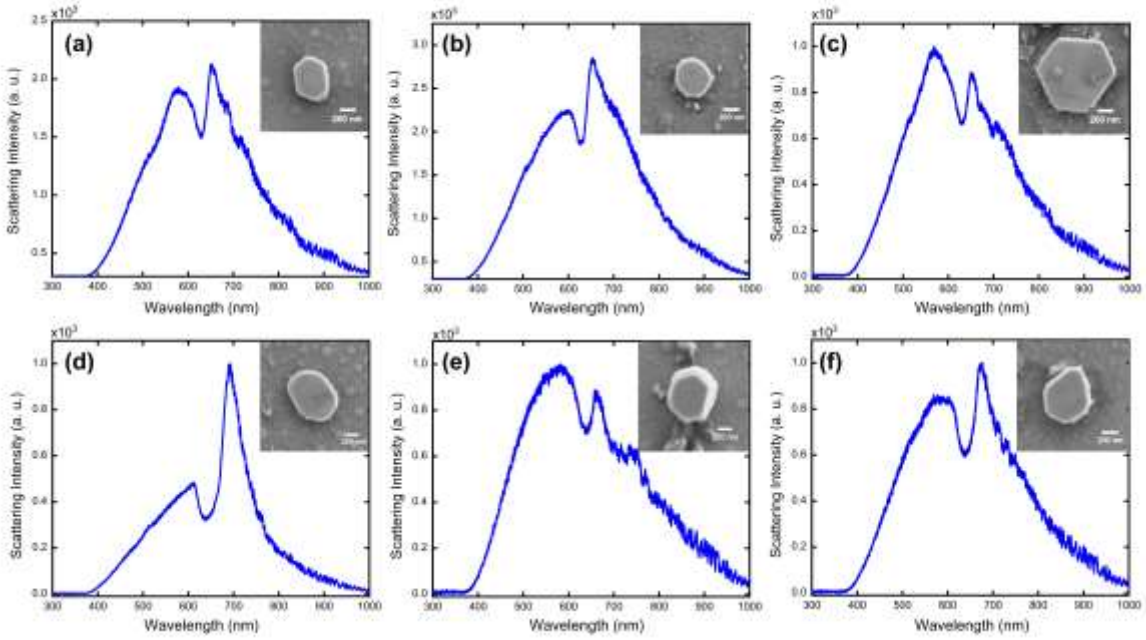

Figure S1. Scattering spectra of WS_2 nanoparticles deposited on an Ag film (a-f). The corresponding SEM images of the nanoparticles are shown in the insets.

S2. SEM characterization of the thickness of WS_2 nanoparticles

Figure S2 illustrates the SEM characterization of the WS_2 powder before its dispersion in deionized water, demonstrating that the thickness of the WS_2 nanoparticles utilized in this study ranges from 130 to 140 nm. This measurement specifies the thickness dimension applied in the experiment, as detailed in the main text.

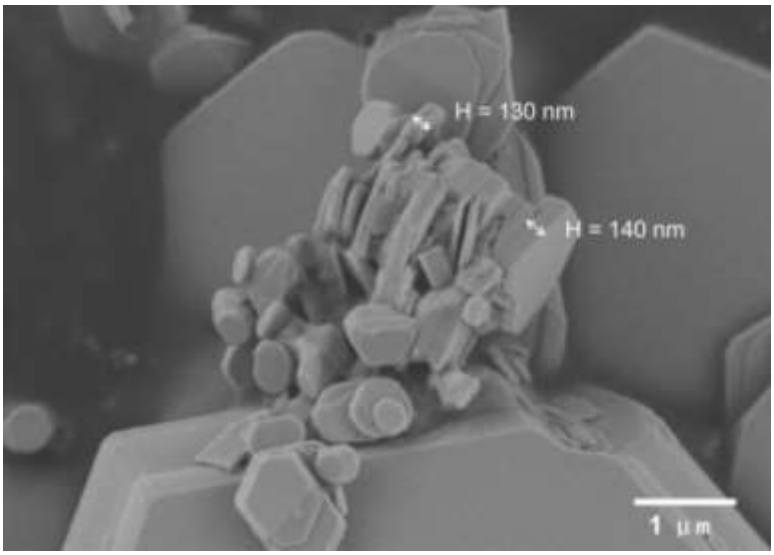

Figure S2. Side-view SEM image of the WS_2 nanoparticles.

S3. Electric field distributions of WS_2 nanoparticles

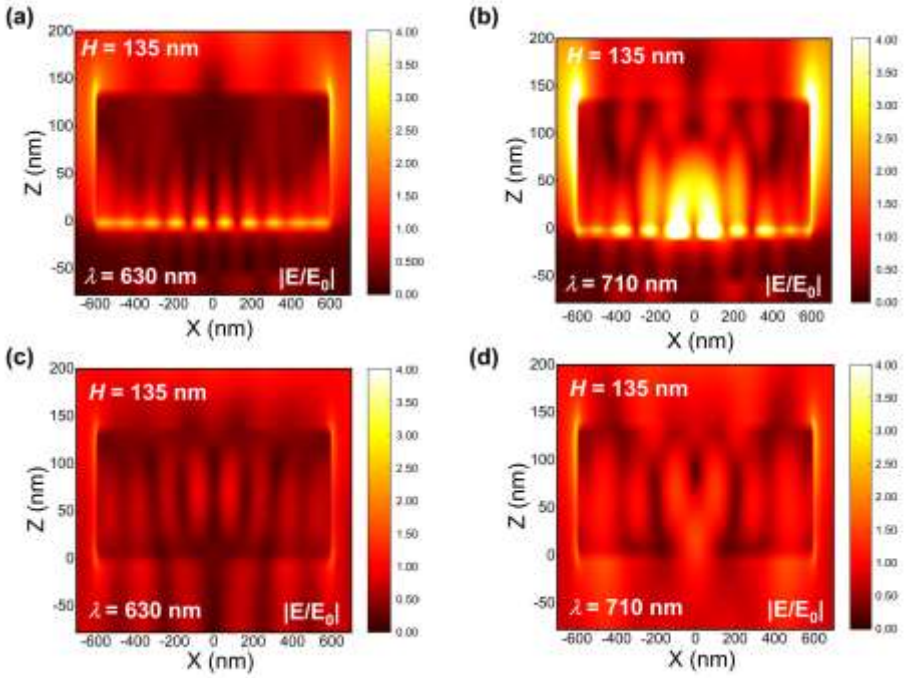

Figure S3. Simulated XZ-plane electric field distributions of WS_2 nanoparticles on different substrates. (a, b) WS_2 nanoparticles on Ag/SiO_2 substrate with a height of 135 nm at excitation wavelengths of 630 nm (a) and 710 nm (b). (c, d) WS_2 nanoparticles on ITO/SiO_2 substrates with a height of 135 nm at excitation wavelengths of 630 nm (c) and 710 nm (d).

S4. CCD images with different filters

To ensure data consistency, all CCD measurements were conducted using identical acquisition parameters, specifically an exposure time of 200 ms and a gain of 20.9×. To protect the spectrometer, long-pass filters with cutoff wavelengths of 550 nm and 650 nm were incorporated into the optical path. Figures S4a-c present CCD images acquired at the same sample location using different filters. Consistent with expectations, the image obtained with the 650 nm cutoff filter exhibits a substantially reduced intensity relative to those captured with the 550 nm filter or without any filtering, thereby corroborating the analysis presented in Figure 4 of the main text.

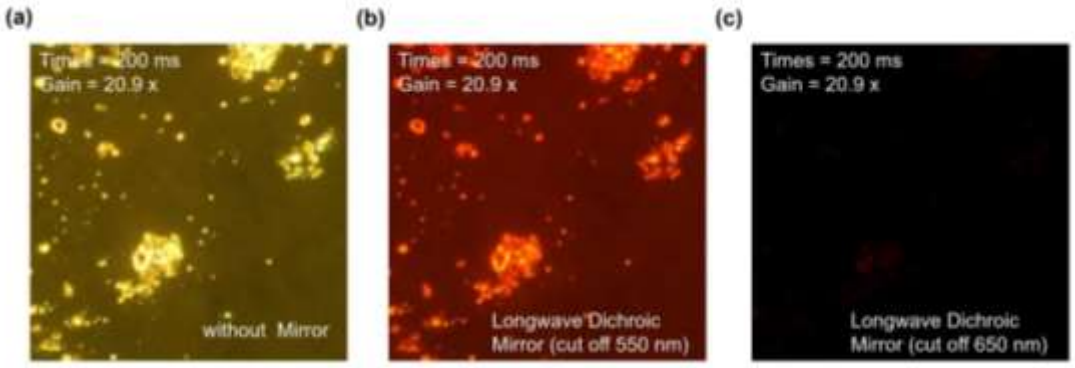

Figure S4. CCD images of WS_2 samples acquired under identical exposure time and gain settings using different optical dichroic mirrors (a-c).

S5. Excited wavelength-dependent PL intensity

Figure S5 illustrates the maximum PL intensity as a function of excitation wavelength near the A exciton wavelength (~630 nm) in the experiment. Both WS_2 nanoparticles demonstrate peak excitation efficiency at 630 nm within the 615-640 nm range, as depicted in Figures S5a,b. This optimal excitation wavelength corresponds to the A-exciton resonance of WS_2, which is further corroborated by the scattering spectra presented in Figures S5c,d.

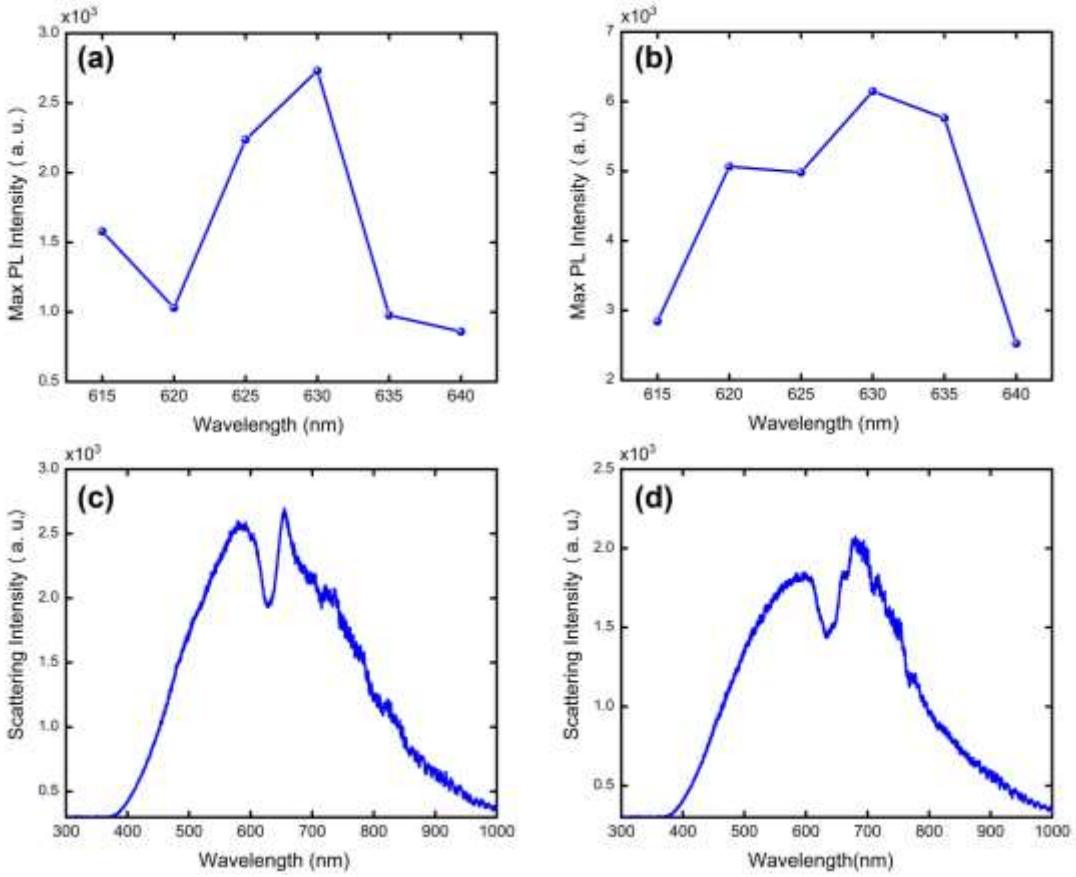

Figure S5. Comparison of wavelength-dependent responses of WS_2 nanoparticles under different pump powers. (a, b) PL emission under 615-640 nm excitation at pump powers of 0.5 mW (a) and 1.0 mW (b). (c, d) Corresponding scattering spectra of the WS_2 nanoparticles at 0.5 mW (c) and 1.0 mW (d).

S6. Spectral artifact caused by the dichroic mirror

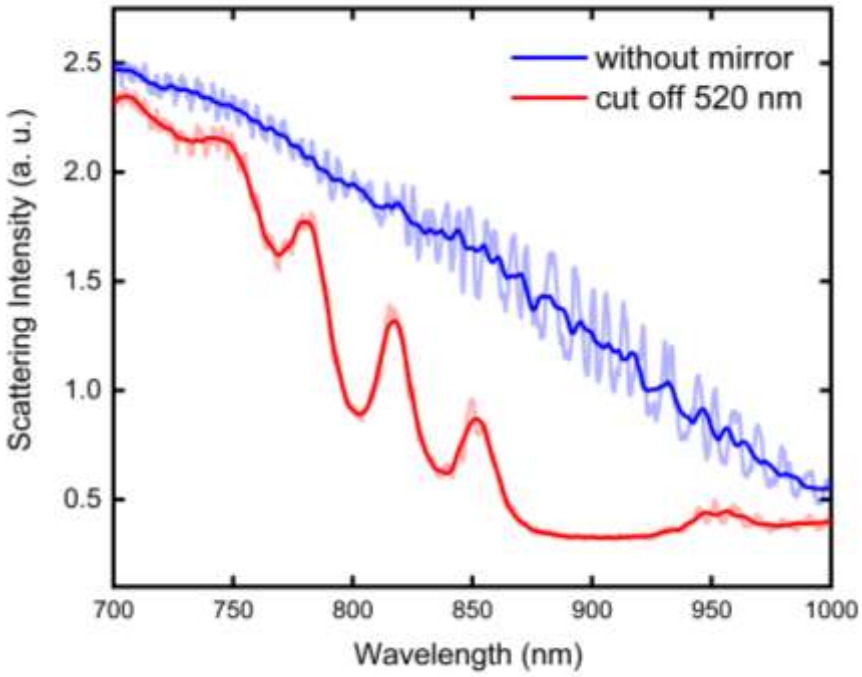

Figure S6. Scattering spectra collected at the same position on the SiO_2 substrate using different dichroic mirrors. The solid lines represent the smoothed spectra. The scattering peaks observed in the red spectrum arise from artifacts introduced by the dichroic mirror with a cutoff wavelength of 520 nm.