Supporting Information

Optimized plasmonic enhancement and deformation reduction in MoS_2 monolayers using Au-nanowire-embedded polymers

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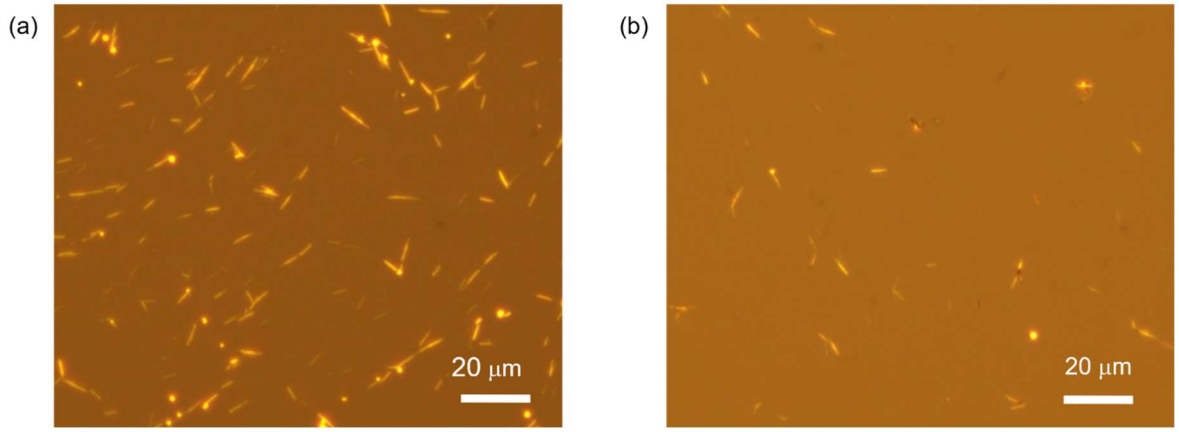


Figure S1. OM images of (a) AuNWs dispersed on PDMS and (b) AuNWs embedded in PDMS. The OM images indicate a lower density of AuNWs in the embedded PDMS film, as only a fraction of the originally dispersed AuNWs is transferred from the SiO_2/Si substrate during the embedding process. The detailed fabrication processes are described below.

AuNWs dispersed on PDMS

1. Prepare a PDMS mixture (SYLGARD 184, DOW corning) by mixing the base elastomer and curing agent in a 10:1 ratio. Pour the mixture into a glass Petri dish.
2. Cure the PDMS mixture at 100°C for 1 hour, then cut the PDMS films into 0.5×0.5 cm^2 pieces.
3. Attach the PDMS film onto a glass substrate.
4. Set the ultrasonic bath to 30°C and place AuNW suspension (A14-10K, Nanopartz) in the bath for 1~2 minutes. Sonicate for 5 minutes.
5. Drop-cast 2 mL of AuNW suspension onto the PDMS film using a micropipette and allow it to dry.
6. Rinse the sample with deionized water preheated to 30°C, then dry it using an N_2 blowing gun.

AuNWs embedded in PDMS

1. Prepare AuNWs dispersed on a SiO_2/Si substrate following the same procedure as for the AuNWs dispersed on PDMS.
2. Place the AuNW/SiO_2/Si sample in a glass Petri dish and pour the PDMS (10:1) mixture over it.
3. Cure the PDMS/AuNW/SiO_2/Si sample at 100°C for 1 hour, then carefully peel off the AuNW-embedded PDMS films.

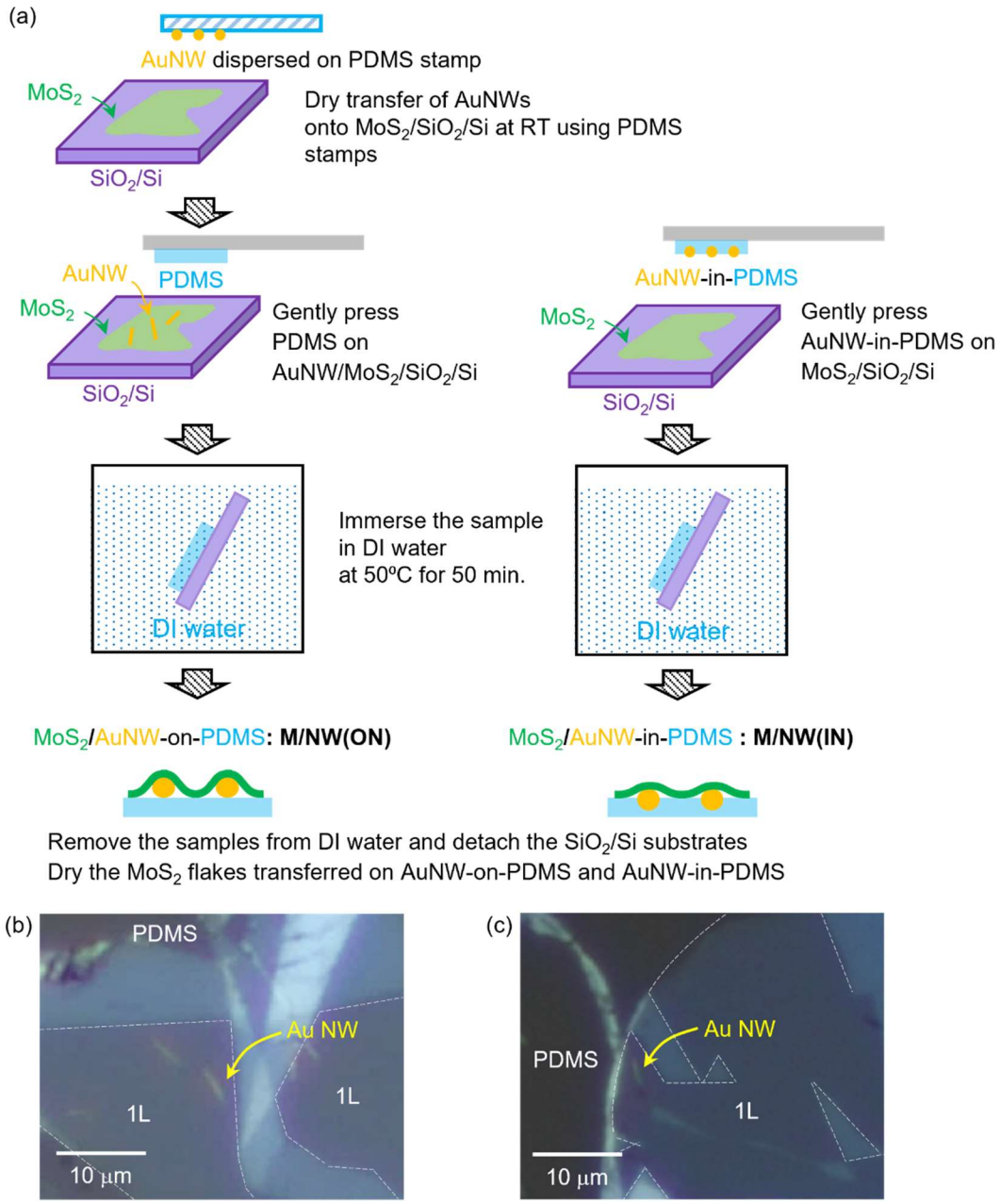


Figure S2. (a) Schematic illustration of the fabrication processes for MoS_2-AuNW integrated structures: MoS_2/AuNW-on-PDMS (M/NW(ON)) and MoS_2/AuNW-embedded-PDMS (M/NW(IN)). OM images of (b) M/NW(ON) and (c) M/NW(IN), with labeled 1L MoS_2 regions, multilayer (ML) MoS_2 regions, PDMS surfaces, and AuNWs. 1L regions of MoS_2 flakes are significantly larger than AuNWs with an average length of 5 μm. In the OM images, bright AuNWs are distinctly visible and optical contrast of MoS_2 flakes varies depending on their thickness.

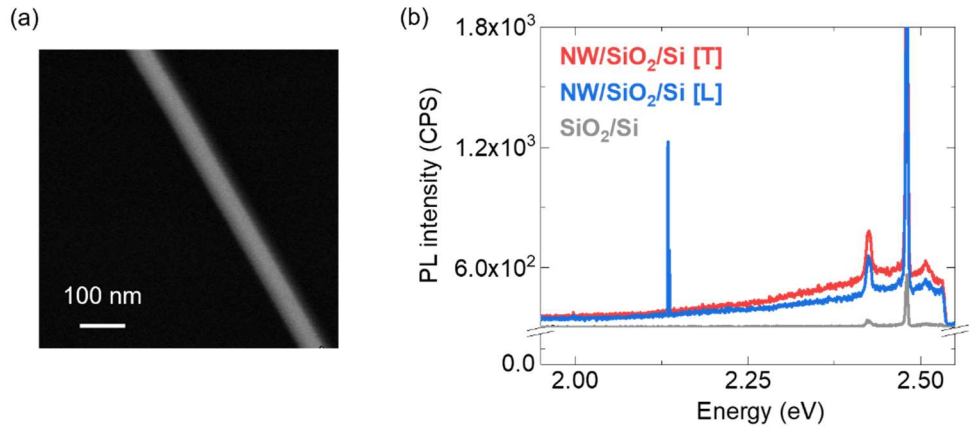


Figure S3. (a) Scanning electron microscope image of a single AuNW dispersed on a SiO_2/Si substrate, showing a uniform diameter of ~50 nm. (b) Polarization-dependent PL spectra of AuNWs on SiO_2/Si under transverse (T, red) and longitudinal (L, blue) illumination, compared to a bare SiO_2/Si reference (gray). The strong polarization dependence and broad peaks near 2.4 eV (corresponding to 520 nm) confirm the LSP excitation in AuNWs.[R1] Scanning electron microscope characterization of AuNWs on PDMS films was not feasible due to severe polymer deformation induced by high-energy electron beam exposure.

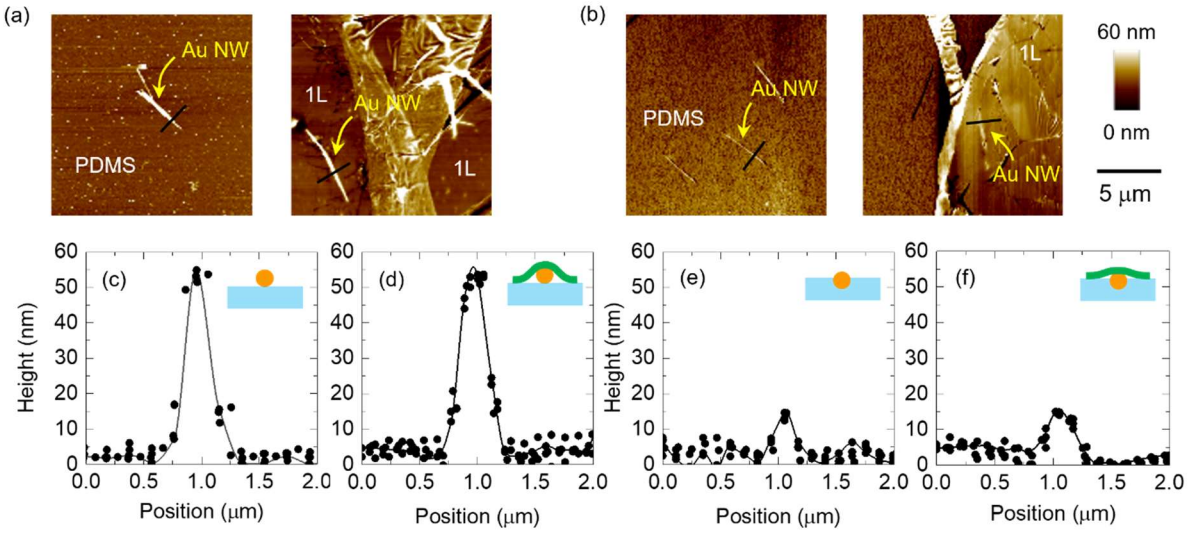
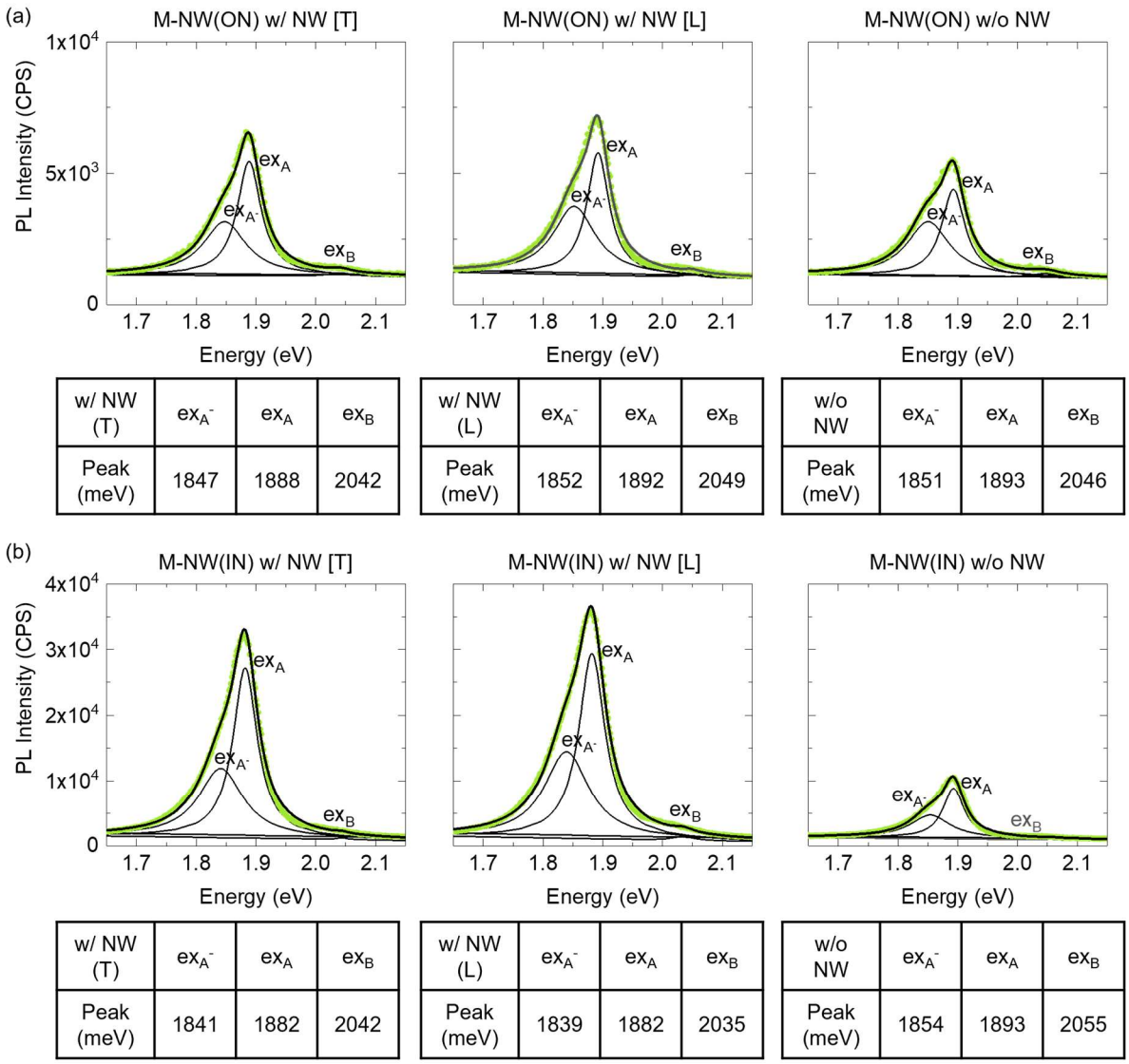


Figure S4. AFM images of (a) M/NW(ON) and (b) M/NW(IN). Height profiles obtained from surface regions (c) without MoS_2 and (d) with MoS_2 for M/NW(ON), and (e) without MoS_2 and (f) with MoS_2 for M/NW(IN). In (c-f), symbols represent raw data acquired from multiple line scans across AuNWs and the lines indicate the corresponding average values. Exemplary scan lines are shown in the AFM images in (a) and (b). The nearly identical height profiles observed for regions without and with MoS_2 suggest that the MoS_2 flakes were successfully transferred onto the non-flat AuNW-containing PDMS films without significant gaps. The observed broadening of the height profiles, compared to the actual AuNW diameter (50 nm), is attributed to tip-sample convolution effects inherent in AFM measurements.



w/ NW (T)	ex_{A^-}	ex_A	ex_B
Peak (meV)	1847	1888	2042

w/ NW (L)	ex_{A^-}	ex_A	ex_B
Peak (meV)	1852	1892	2049

w/o NW	ex_{A^-}	ex_A	ex_B
Peak (meV)	1851	1893	2046

w/ NW (T)	ex_{A^-}	ex_A	ex_B
Peak (meV)	1841	1882	2042

w/ NW (L)	ex_{A^-}	ex_A	ex_B
Peak (meV)	1839	1882	2035

w/o NW	ex_{A^-}	ex_A	ex_B
Peak (meV)	1854	1893	2055

Figure S5. Polarization-dependent PL spectra of (a) M/NW(ON) and (b) M/NW(IN). 'T' and 'L' denote transverse and longitudinal illumination, respectively. ex_A and ex_B represent A and B excitons, respectively, and ex_{A^-} denotes a trion. Green symbols represent raw data, and the black lines indicate the fitted curves. All samples exhibit a low ex_B/ex_A intensity ratio less than 5%, suggesting a low defect density and high quality of the MoS_2 flakes.[R2]

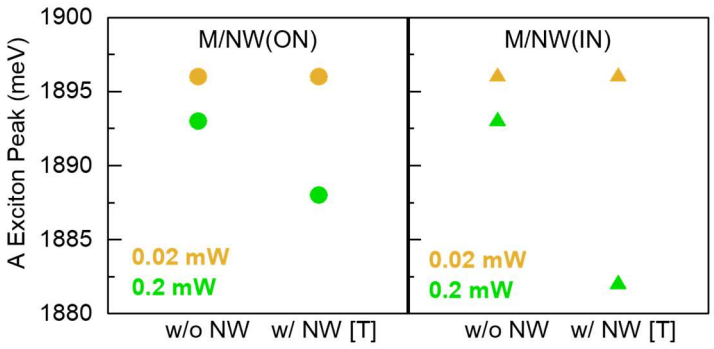


Figure S6. A exciton peak positions of MoS_2 regions with and without AuNWs for (a) M/NW(ON) and (b) M/NW(IN), measured at laser powers of 0.02 mW and 0.2 mW. 'T' denotes transverse illumination. Under low-power excitation (0.02 mW), negligible peak shifts are observed between AuNW-containing and AuNW-free regions, indicating that thermal effects are negligible at low power. In contrast, at 0.2 mW, a distinct redshift of the A exciton peak is observed in AuNW-containing regions.

References

[R1] A. Mooradian, Phys. Rev. Lett. 22 (1969) 185.

[R2] K. M. McCreary, A. T. Hanbicki, S. V. Sivaram, B. T. Jonker, APL Mater. 6 (2018) 111106.