Supplementary Information for

Microsphere-coupled light emission control of van der Waals heterostructures

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Transition metal dichalcogenide, Microsphere, Purcell effect, Light-emitting transistor

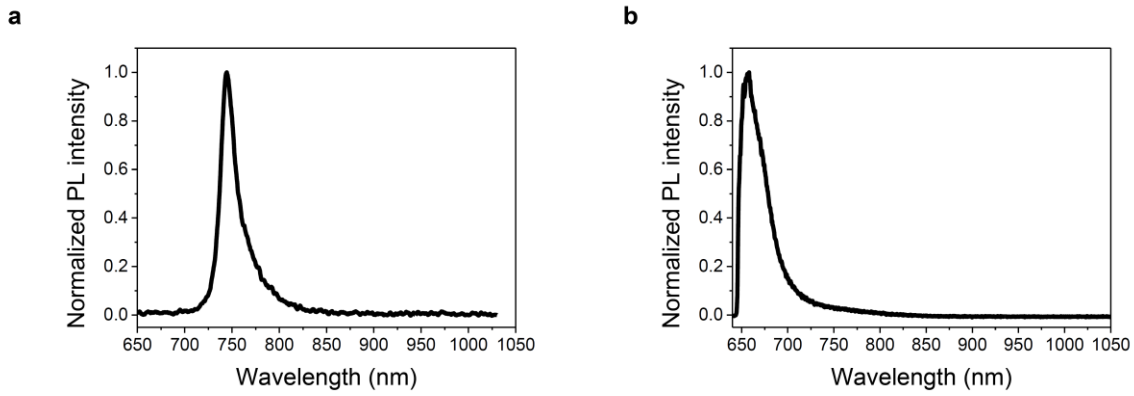

Fig. S1 (a) Photoluminescence spectrum of monolayer WSe_2 showing the absence of the indirect gap emission. **(b)** Photoluminescence spectrum of monolayer MoS_2 showing the absence of the indirect gap emission. Both spectra are measured using the optical pump at 532 nm.

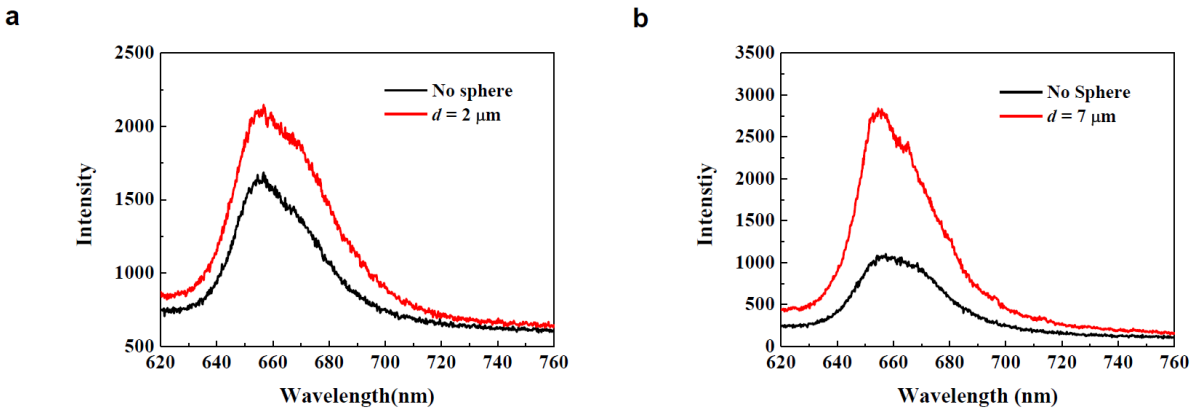

Fig. S2 (a) Photoluminescence enhancement of monolayer MoS_2 coupled to a microsphere with the diameter of 2 μm. **(b)** Photoluminescence enhancement of monolayer MoS_2 coupled to a microsphere with the diameter of 7 μm.

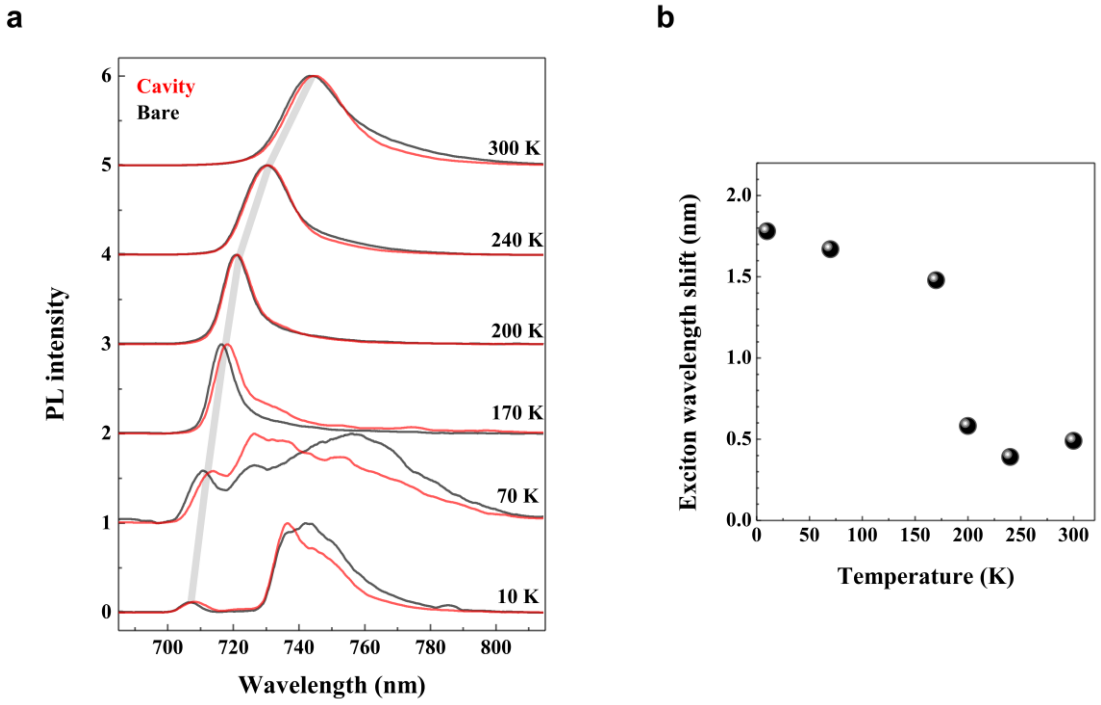

Fig. S3 (a) Temperature dependent PL spectra of the cavity-coupled and bare nearby WSe_2. Exciton emission peak is guided by the grey solid line. **(b)** Wavelength shift of the cavity-coupled exciton peak compared to the bare exciton as a function of temperature.

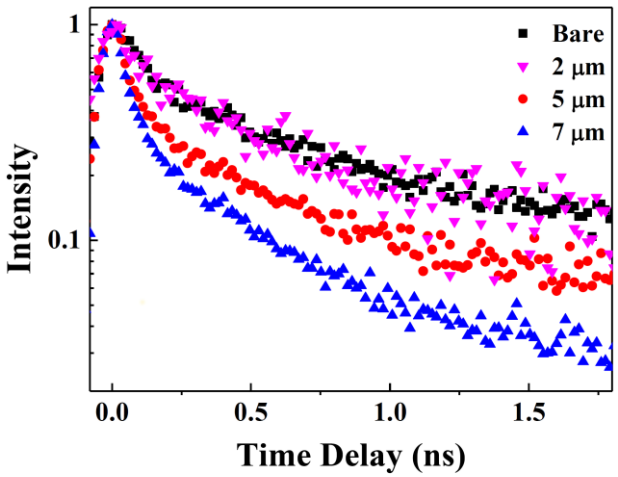

Fig. S4 (a) Time-resolved photoluminescence (TRPL) of monolayer WSe_2 coupled to microspheres with d = 2, 5, and 7 µm. The measurement performed on bare WSe_2 without a microsphere is also shown for reference.

Sample /1 µm SiO_2	A	τ_{Th}(ps)	B	τ_X (ps)
Bare	0.570	125 ± 5	0.422	766 ± 49
2 µm	0.435	124 ± 5	0.422	715 ± 80
5 µm	0.635	60 ± 2	0.325	515 ± 26
7 µm	0.666	46 ± 1	0.326	374 ± 12

Table. T1 Fit parameters of TRPL data shown in **Fig. S3** using the biexponential function $I(t) = A\exp(-t/\tau_{Th}) + B\exp(-t/\tau_X)$. Here, τ_{Th} and τ_X are the thermal dissipation time of hot carriers and the exciton recombination lifetime and A and B are weight factors, respectively.

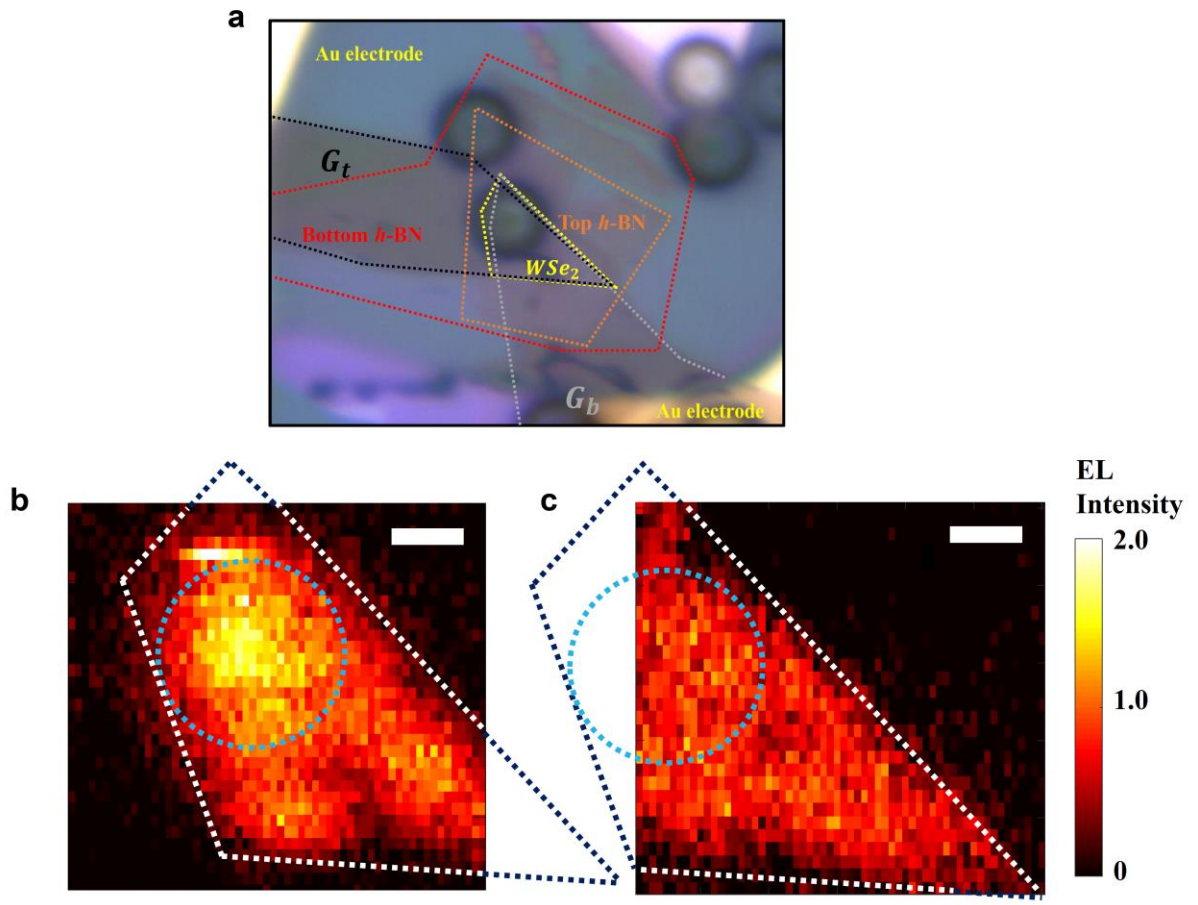

Fig. S5 (a) Optical microscope image of the WSe_2 light-emitting transistor. Monolayer WSe_2 is sandwiched by top and bottom *h*-BN. A voltage is applied through top (G_t) and bottom (G_b) graphene across *h*-BN/WSe_2/*h*-BN structure to induce electron-hole recombination in WSe_2. **(b)** Electroluminescence (EL) scan image of cavity-coupled WSe_2 light-emitting transistor. The white and blue dashed lines refer to the boundaries of WSe_2 and microsphere, respectively. **(c)** EL scan image on the same heterostructure without the microsphere. Scale bar is 3 μm.