

Supporting Information

for

Ultrathin ZnSe nanowires: one-pot synthesis via a heat-triggered precursor slow releasing route, controllable Mn doping and application in UV and near-visible-light detection

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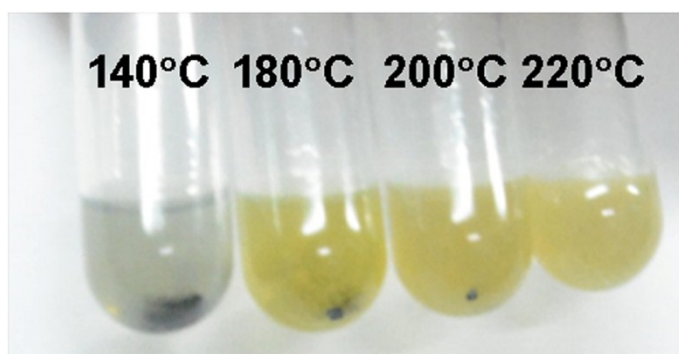


Figure S1. The optical photograph depicting dissolution behavior of Se powder in OLA at different temperatures.

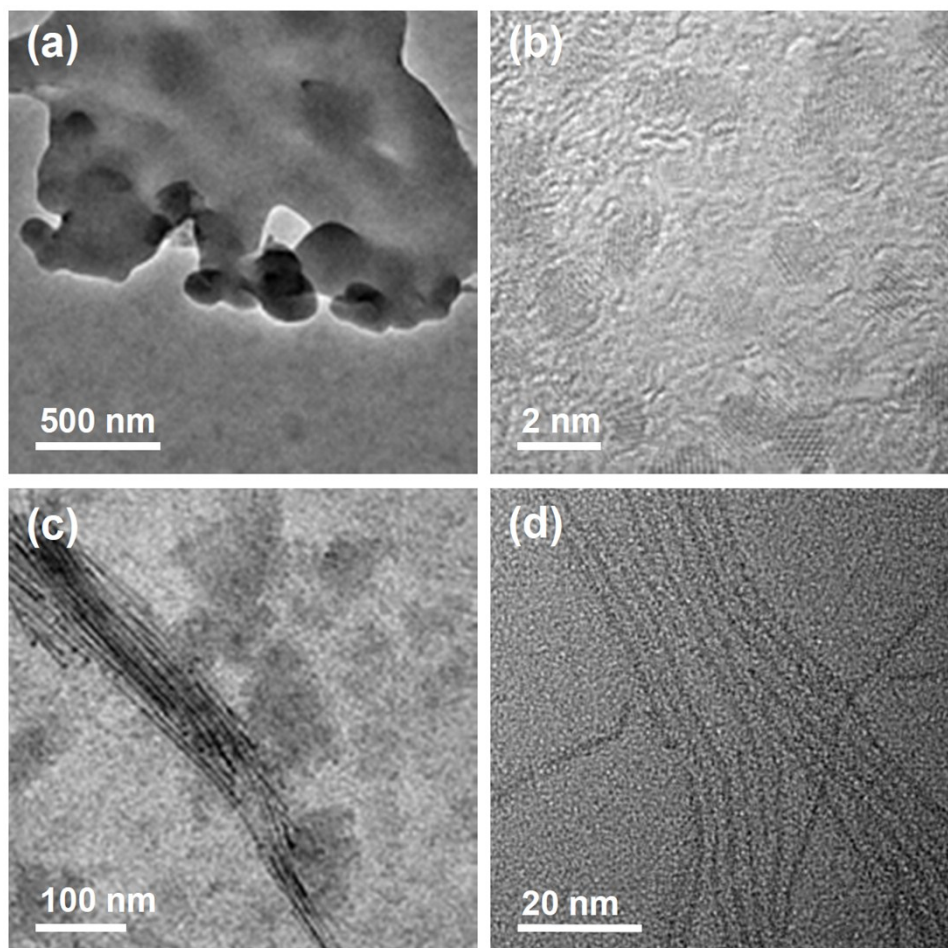


Figure S2. Representative TEM images of the ZnSe samples prepared in a precursor slow releasing one-pot reaction system containing 0.2 mmol $\text{Zn}(\text{NO}_3)_2$, 0.2 mmol Se powder, and 12 mL OLA at different temperatures: (a) 140 °C, (b) 180 °C, (c) 200 °C and (d) 220 °C.

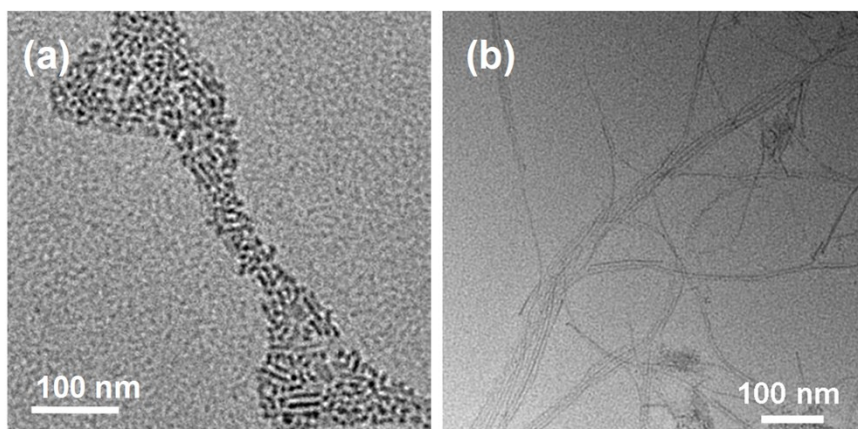


Figure S3. Representative TEM images of the ZnSe samples prepared in a hot-injection reaction system (a) and in a precursor slow releasing one-pot reaction system (b), both containing 0.2 mmol $\text{Zn}(\text{NO}_3)_2$, 0.2 mmol Se powder (or Se-OLA), and 12 mL OLA.

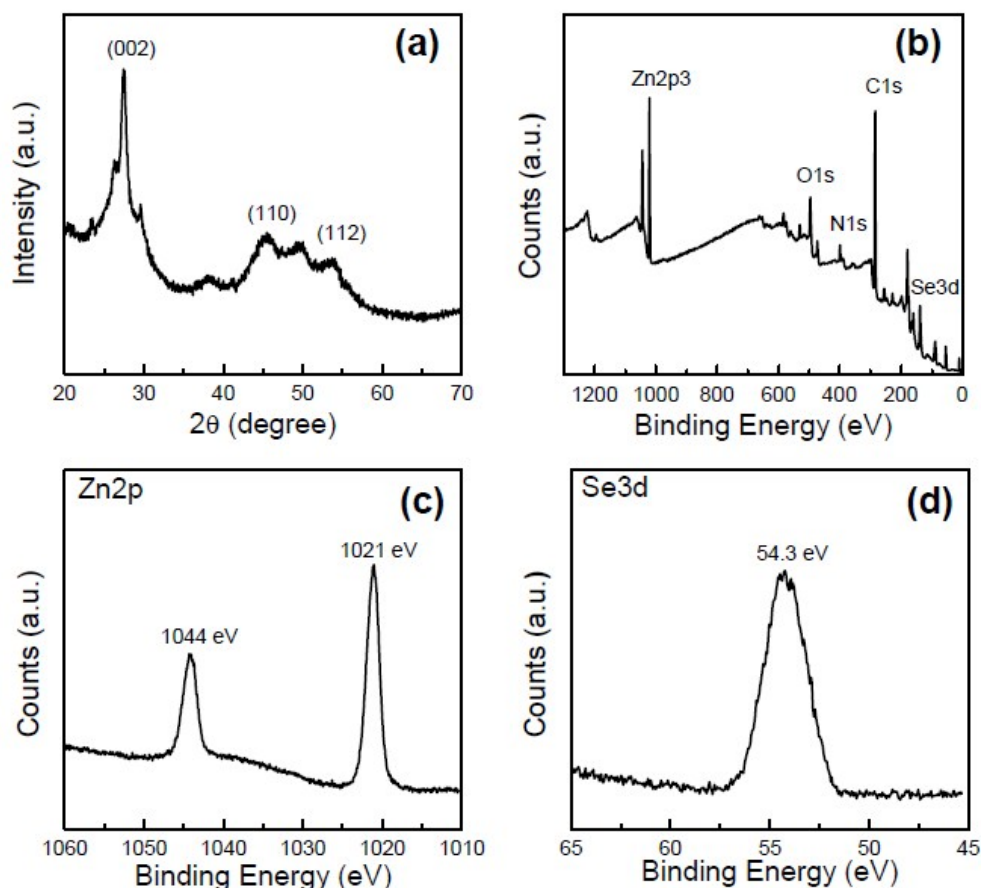


Figure S4. (a) XRD pattern, (b) full-range XPS spectrum, and (c-d) XPS spectrum of Zn_{2p} and Se_{3d} core level of the ZnSe USNWs with a diameter of 2.1 nm (the ones displayed in Figure 2 in main text). The peak at 1021 eV, 1044 eV and 54.3 eV correspond to the binding energies of $\text{Zn}_{2p_{3/2}}$, $\text{Zn}_{2p_{1/2}}$ and Se_{3d} core level, respectively. Quantitative calculation of (c) and (d) gives the atomic ratio of Zn to Se in the NWs is close to 1:1, which is in good agreement with the stoichiometric ratio in ZnSe.^{1,2}

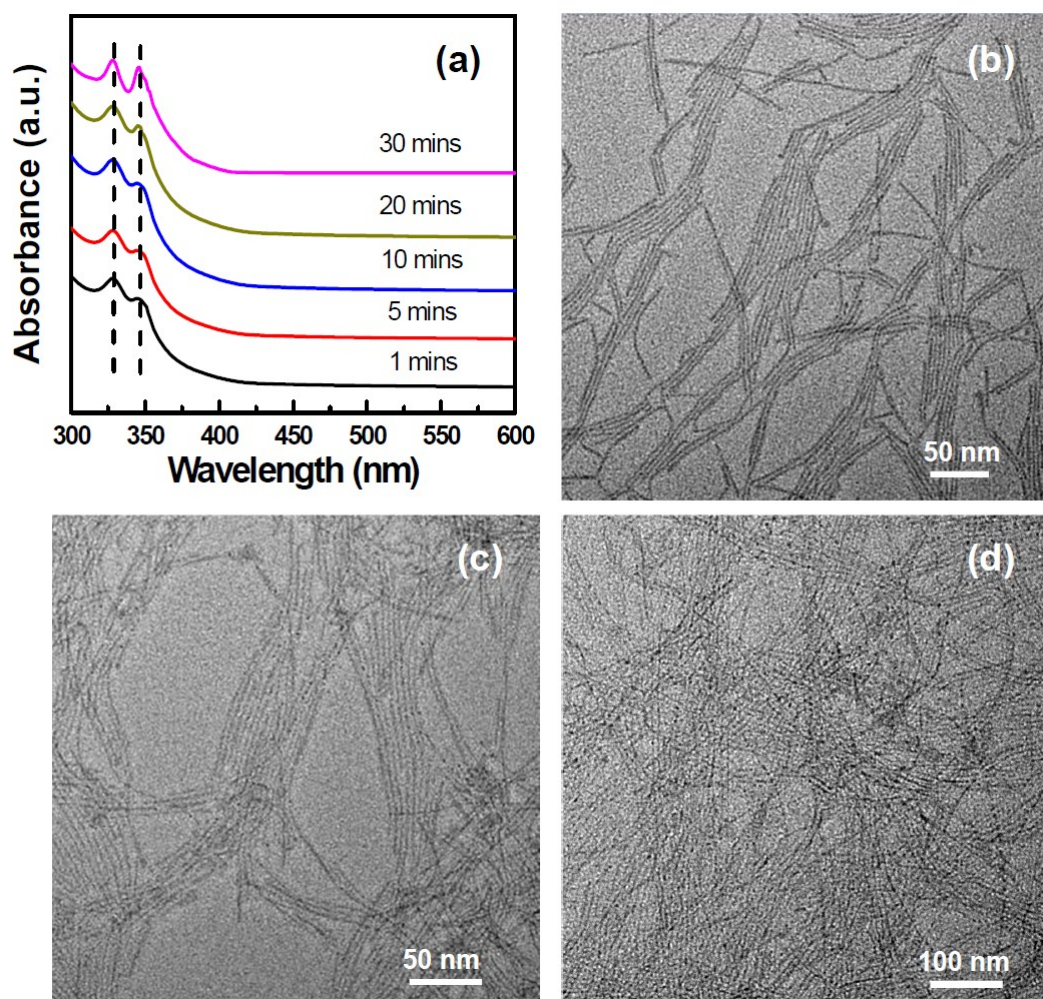


Figure S5. (a) Temporal evolution of UV-vis absorption spectra of the ZnSe USNWs (with a diameter of 2.1 nm) upon increasing temperature to 220 °C. (b-d) TEM images depicting the morphology evolution of the ZnSe USNWs growing at 220 °C for 1 mins (b), 5 mins (c) and 30 mins (d).

Table S1. E_{vb} , E_{cb} and E_g values of the as-prepared ZnSe NWs of different diameters.

| NW Sample | Optical measurement | | Electrochemical measurement | | |
|-----------------|---------------------|----------|-----------------------------|-------------|----------|
| | A_{bs}/nm | E_g/eV | E_{cb}/eV | E_{vb}/eV | E_g/eV |
| ZnSe NWs-2.1 nm | 373 | 3.32 | -5.80 | -2.41 | 3.39 |
| ZnSe NWs-3.1 nm | 385 | 3.22 | -5.75 | -2.51 | 3.24 |
| ZnSe NWs-4.5 nm | 426 | 2.91 | -5.46 | -2.52 | 2.94 |

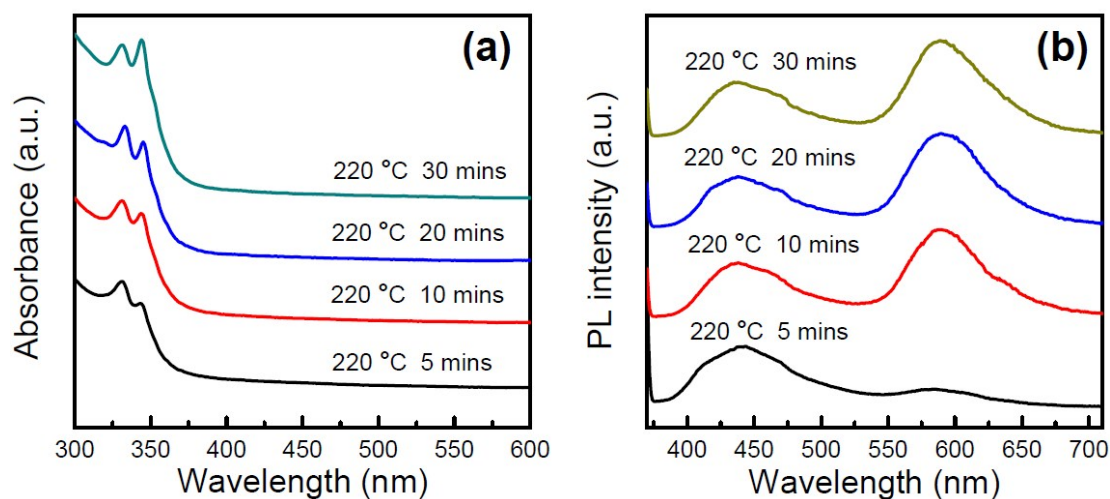


Figure S6. Temporal evolution of UV-vis absorption spectra (a) and PL emission spectra (b) recording the doping of Mn^{2+} into the ZnSe USNWs with a diameter of 2.1 nm at 220 °C for different reaction times.

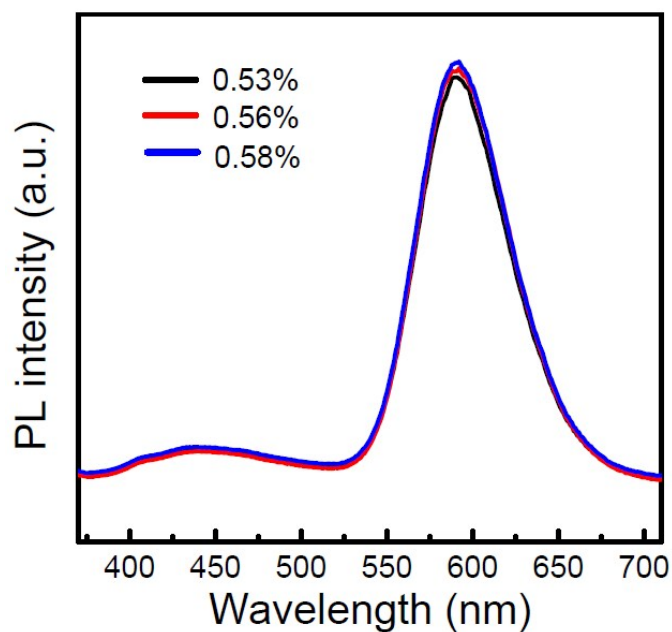


Figure S7. PL emission spectra of Mn^{2+} -doped ZnSe USNWs of 2.1 nm diameter with different Mn^{2+} doping levels (from 0.53% to 0.56%, and then to 0.58%) upon increasing dopant concentration (from 5 mol.% to 8 mol.% and then to 10 mol.%).

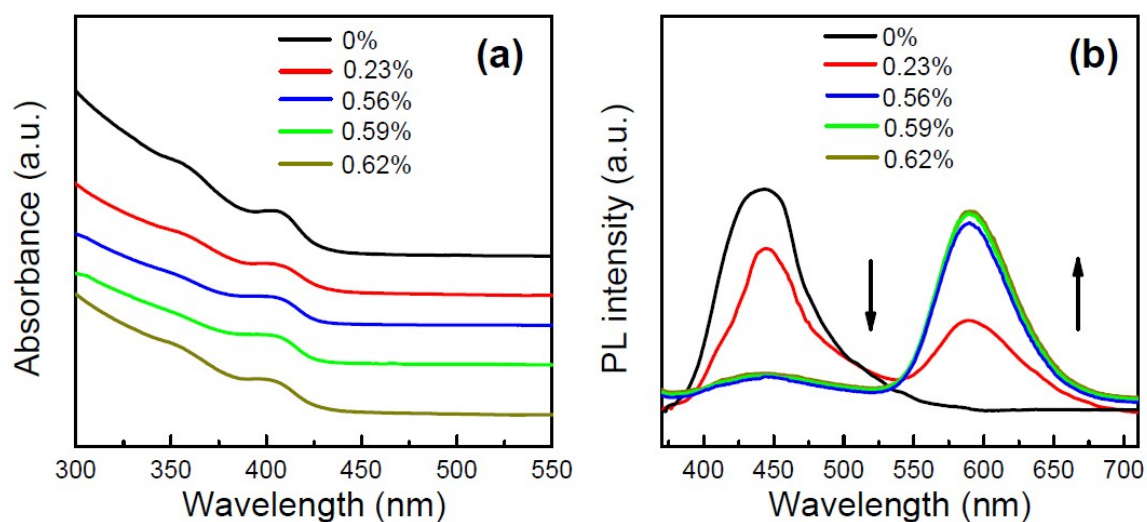


Figure S8. UV-vis absorption spectra (a) and PL emission spectra (b) of Mn^{2+} -doped ZnSe NWs of 4.5 nm diameter with different Mn^{2+} doping levels (from 0% to 0.62%) upon increasing dopant concentration (from 0 mol.% to 5.0 mol.%).

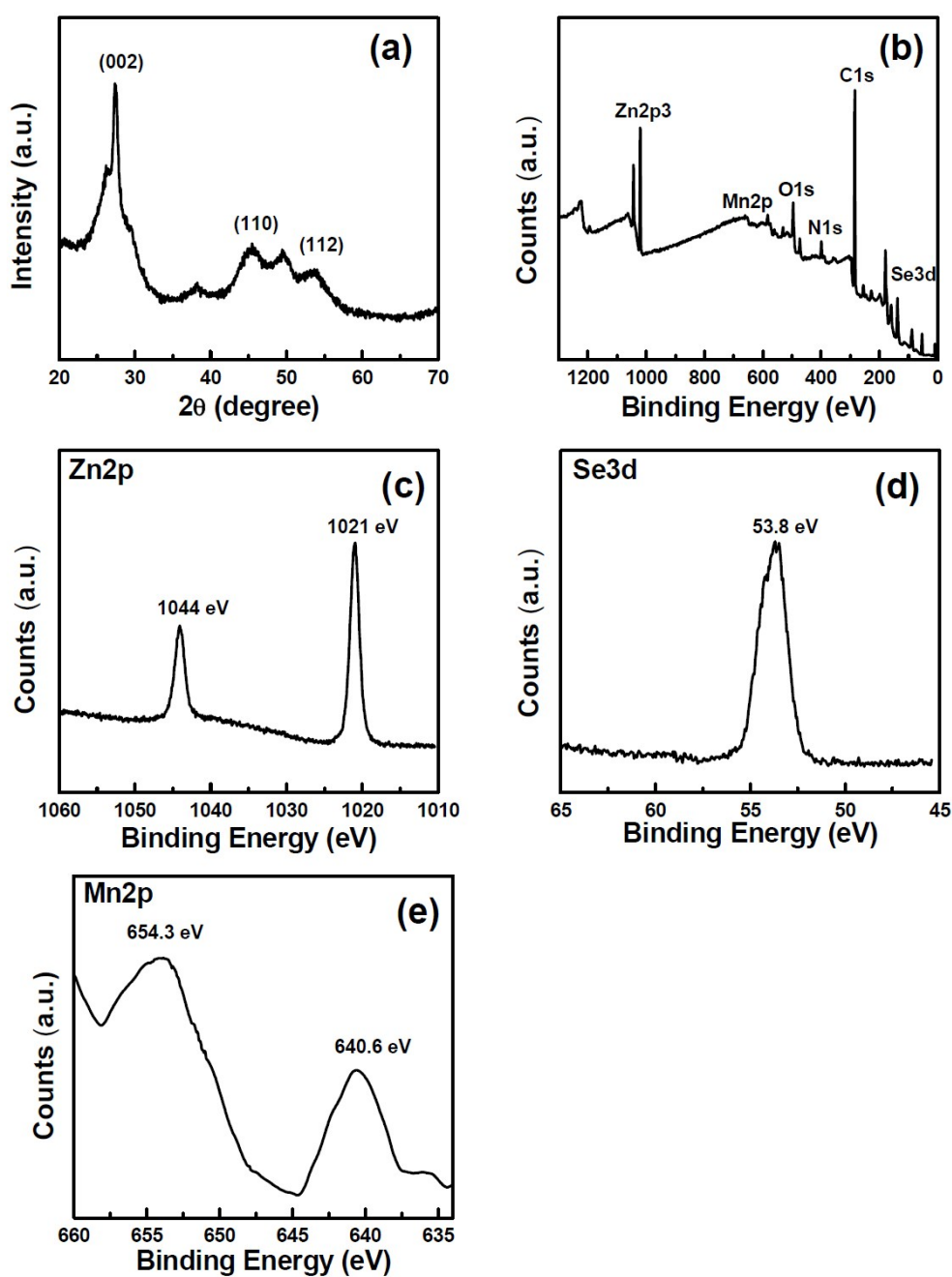


Figure S9. (a) XRD patterns, (b) full-range XPS spectrum, (c) Zn_{2p}, (d) Se_{3d} and (e) Mn_{2p} core level of Mn²⁺-doped ZnSe USNWs with a diameter of 2.1 nm (containing 0.28% Mn²⁺) (the ones displayed in Figure 7 in main text). The peak at 640.6 eV and 654.3 eV correspond to the binding energies of Mn_{2p_{3/2}} and Mn_{2p_{1/2}} core level respectively,³ signifying that Mn ions were successfully doped into the ZnSe USNWs with a diameter of 2.1 nm.

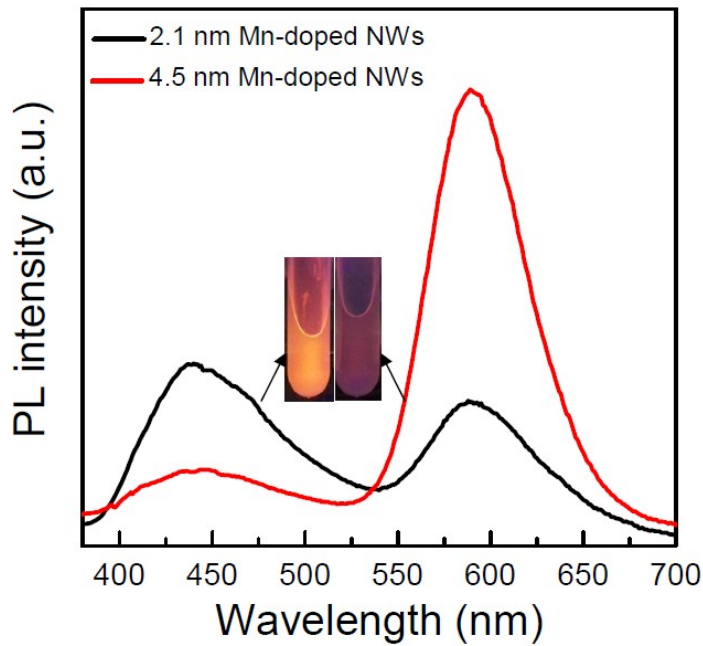


Figure S10. PL emission spectra of Mn^{2+} -doped ZnSe NWs of 2.1 nm diameter (containing 0.28% Mn^{2+}) and of 4.5 nm diameter (containing 0.62% Mn^{2+}) dispersed in chloroform. The insert is the optical photograph of the two ZnSe NW samples dispersed in chloroform under 365 nm UV lamp excitation.

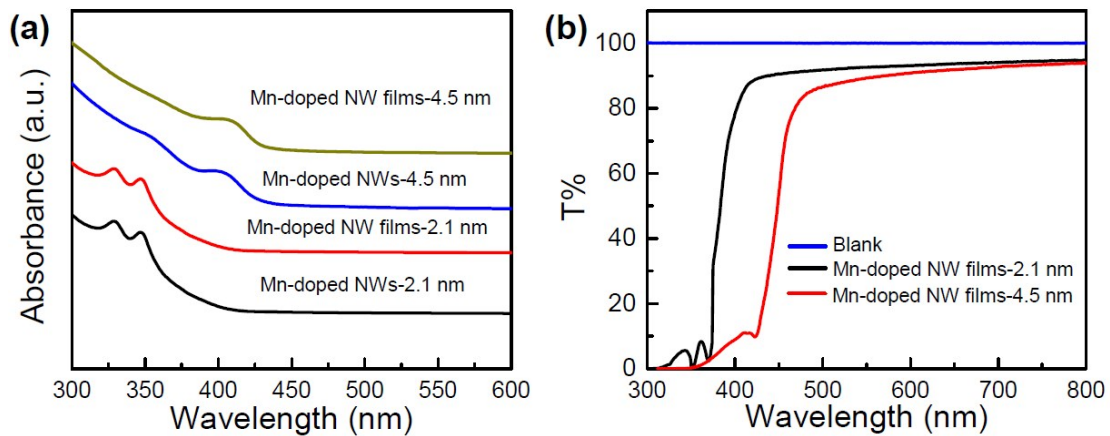


Figure S11. (a) UV-vis absorption spectra of the Mn-doped ZnSe NWs of 2.1 nm diameter (containing 0.28% Mn^{2+}) and of 4.5 nm diameter (containing 0.62% Mn^{2+}), which are both spin-coated on quartz sheets and dispersed in chloroform, respectively, (b) Transmission spectra of the two NW films spin-coated on two quartz sheets.

References

1. B. J. Xi, S. L. Xiong, D. C. Xu, J. F. Li, H. Y. Zhou, J. Pan, J. Y. Li and Y. T. Qian, *Chem. Eur. J.*, 2008, **14**, 9786-9791.
2. S. L. Xiong, B. J. Xi, C. M. Wang, G. C. Xi, X. Y. Liu and Y. T. Qian, *Chem. Eur. J.*, 2007, **13**, 7926-7932
3. C. C. Chen, Y. J. Hsu, Y. F. Lin and S. Y. Lu, *J. Phys. Chem. C*, 2008, **112**, 17964-17968.