Electronic Supplementary Material (ESI) for RSC Advances.


# Supporting Information

## Hydrothermal synthesis of water-soluble Mn- and Cu-doped CdSe quantum dots with multi-shell structures and their photoluminescence properties

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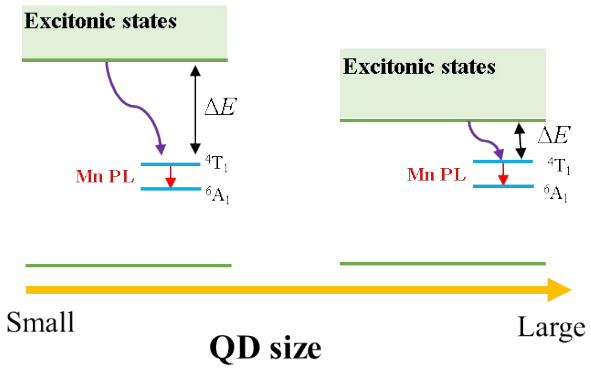


Fig. S1 Sketch of the variation of the energy gap between the $^4T_1$ state of the $Mn^{2+}$ dopants and the excitonic states: $\Delta E$ with the change in the QD size of the CdSe-core. [1]

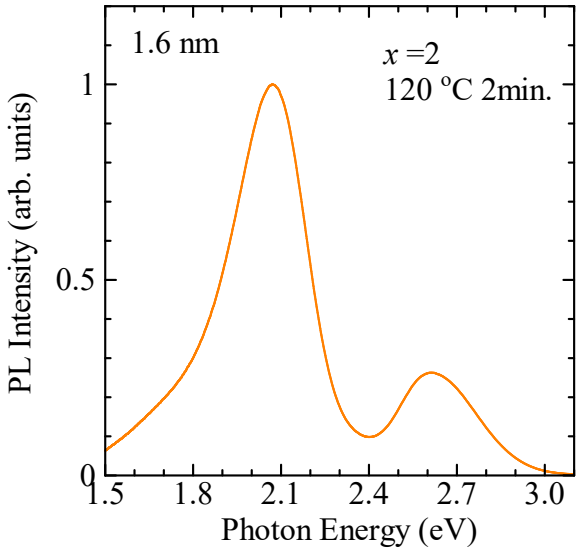


Fig. S2 PL spectra of CdSe/ZnS:Mn/ZnS QDs prepared under the same conditions as in ref. [2].

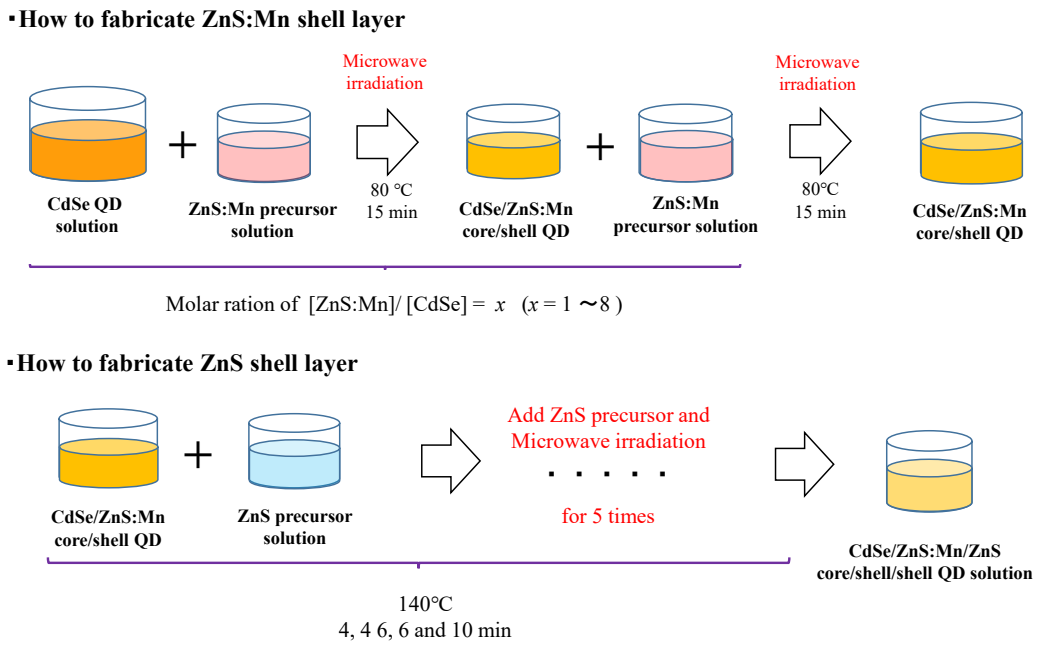


Fig. S3 Synthesis scheme of the CdSe/ZnS:Mn/ZnS QDs.

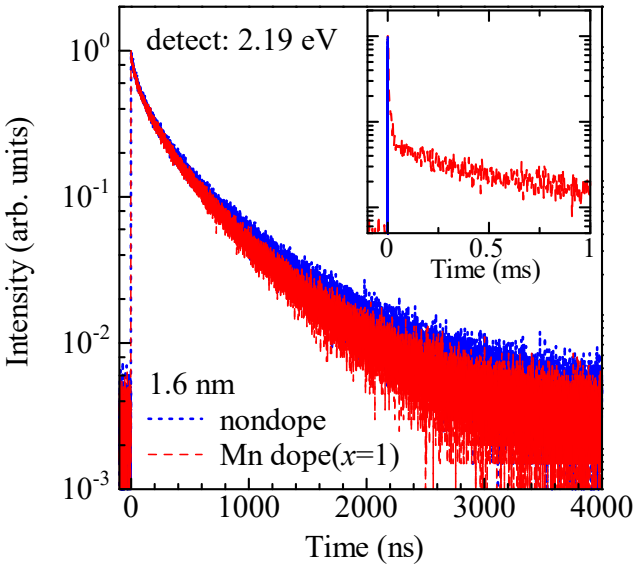


Fig. S4 PL decay profiles of CdSe/ZnS:Mn/ZnS QDs ($x$ =1) and non-doped CdSe/ZnS QDs detected at 2.19 eV. The inset shows the decay profiles with the time scale in milliseconds.

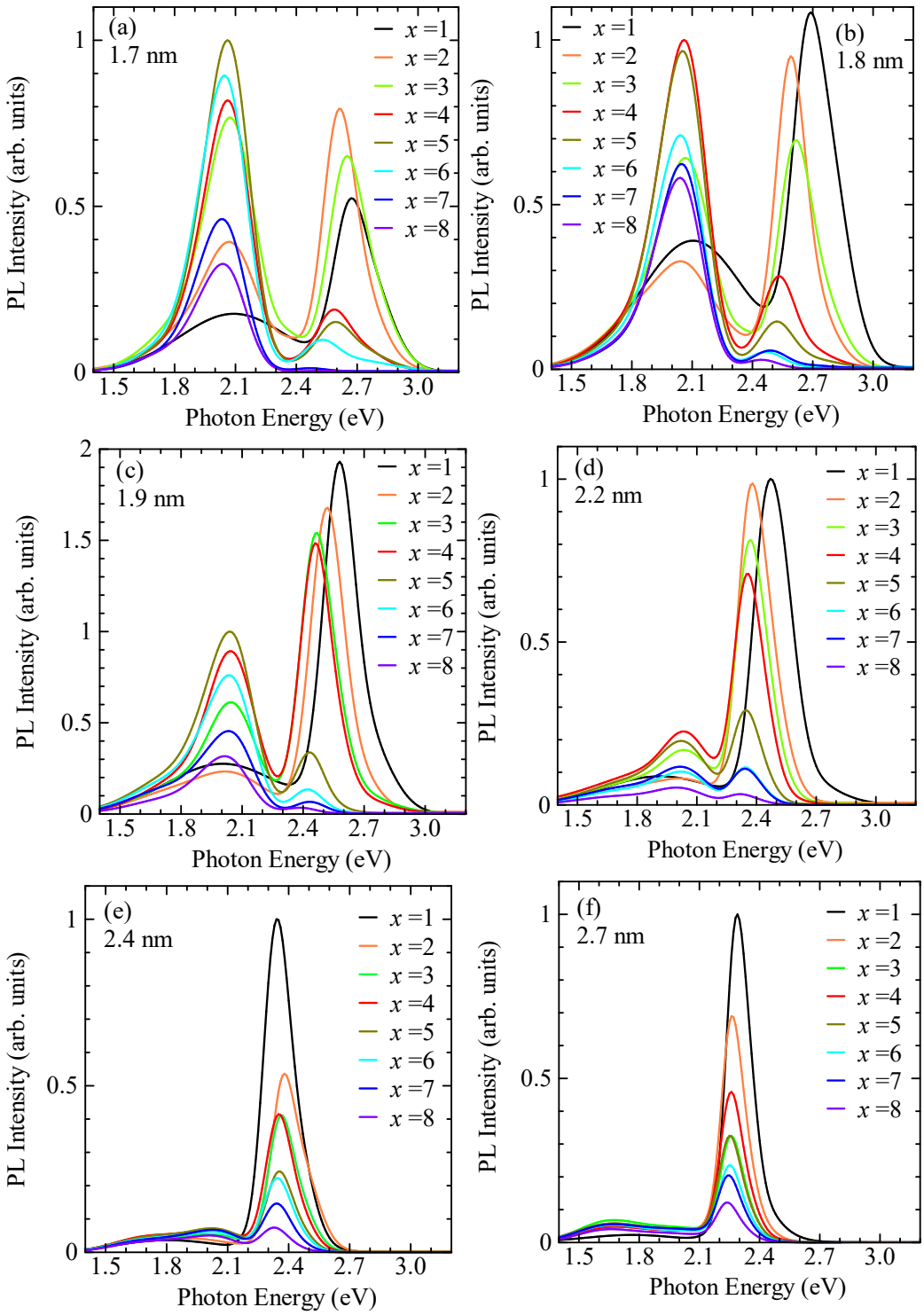


Fig. S5 PL spectra of CdSe/ZnS:Mn/ZnS QDs synthesized with different Mn preparation concentration at each QD size.

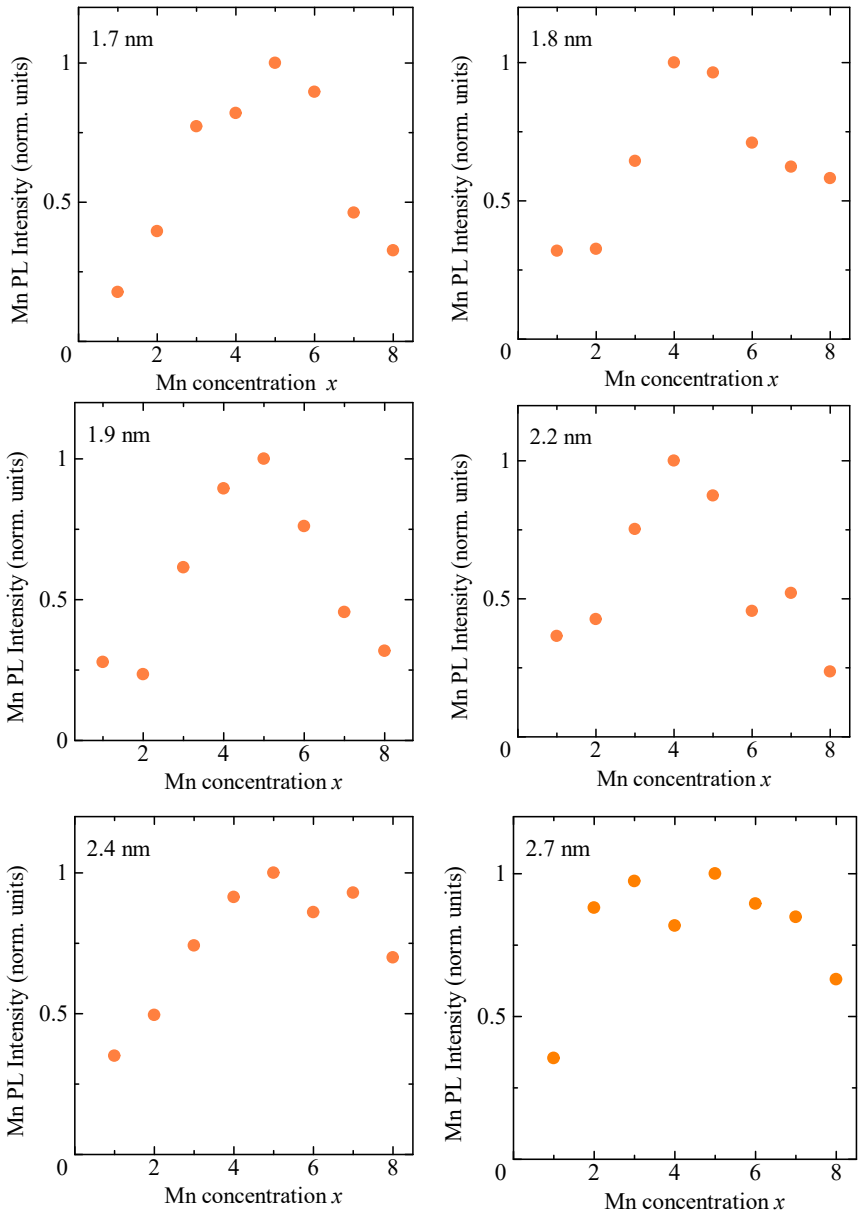


Fig. S6 Mn preparation concentration dependence of the CdSe/ZnS:Mn/ZnS QDs at each QD size.

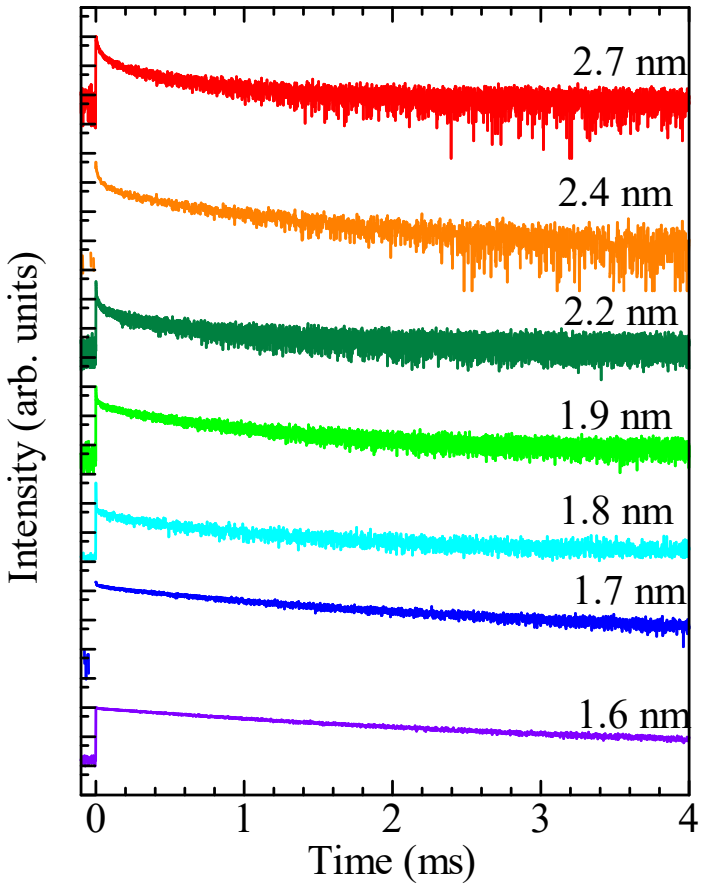


Fig. S7 PL decay profiles of the Mn-PL bands for each QDs.

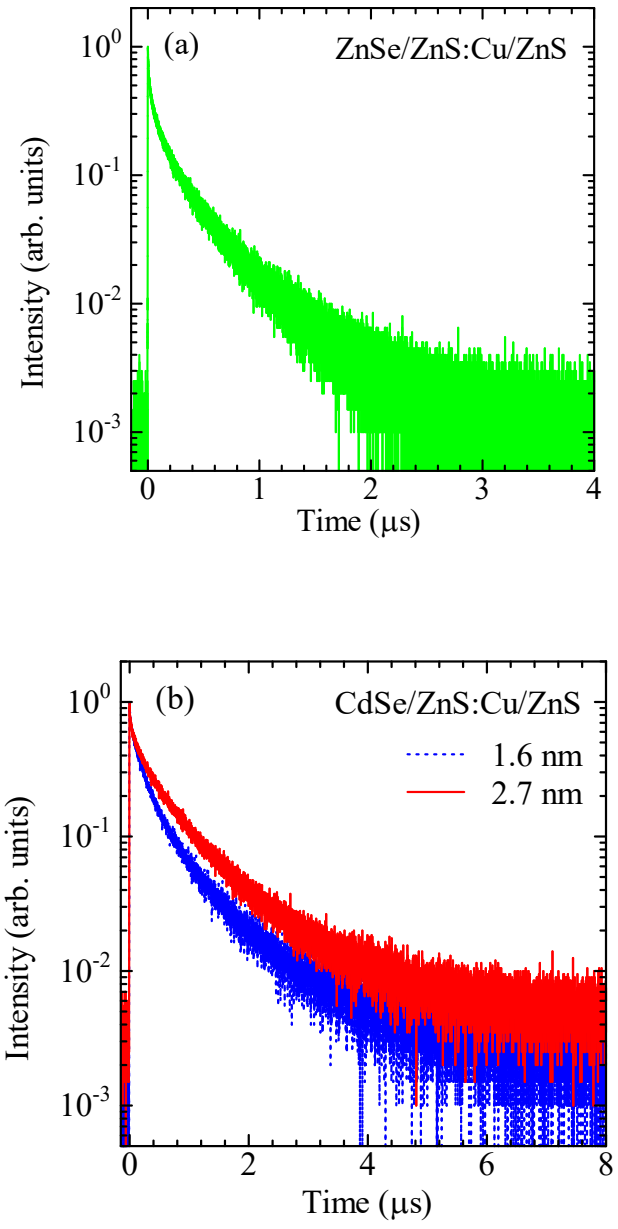


Fig. S8 PL decay profiles of Cu-doped QDs. (a) PL decay profile of the ZnSe/ZnS:Cu/ZnS QDs detected at 2.6 eV. (b) PL decay profiles of the CdSe/ZnS:Cu/ZnS QDs using the CdSe-core QDs with d = 1.6 (blue line) and 2.7 nm (red line) detected at 1.9 eV and 1.5 eV, respectively.

## References

[1] R. Beaulac, P. I. Archer, X. Y. Liu, S. Lee, G. M. Salley, M. Dobrowolska, J. K. Furdyna and D. R. Gamelin, *Nano Lett.*, 2008, **8**, 1197–1201.

[2] H. Nishimura, T. Maekawa, K. Enomoto, N. Shigekawa, T. Takagi, S. Sobue, S. Kawai and D. Kim, *J. Mater. Chem. C*, **9**, 693-701.