Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information for

Enhancing Optical Functionality by co-Loading $NaYF_4$:Yb,Er and CdSe QDs in a Single Core-shell Nanocapsule

*Magda A. Antoniak[1], Urszula Bazylińska[2], Dominika Wawrzyńczyk[1], Maciej Ćwierzona[3], Sebastian Maćkowski[3], Dawid Piątkowski[3], Julita Kulbacka[4], Marcin Nyk[1]**

[1]Advanced Materials Engineering and Modelling Group, Faculty of Chemistry, Wrocław University of Science and Technology, Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland

[2]Department of Physical and Quantum Chemistry, Wrocław University of Science and Technology, Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland

[3]Institute of Physics, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University in Toruń, Grudziądzka 5, 87-100 Toruń, Poland

[4]Department of Molecular and Cellular Biology, Faculty of Pharmacy, Wrocław Medical University, Wrocław, 50-556, Poland

*Corresponding author.

E-mail address: marcin.nyk@pwr.edu.pl

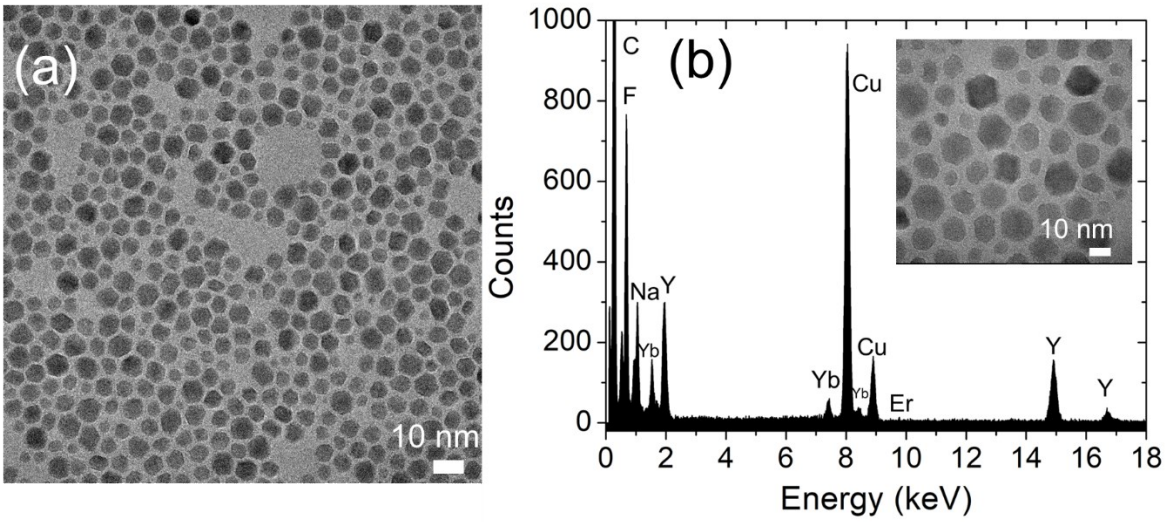

Fig. S1. Representative transmission electron microscope image (a) and energy-dispersive X-ray (EDX) spectra (b) (the inset figure shows TEM image) of the as-prepared $NaYF_4$:Yb,Er NPs before encapsulation.

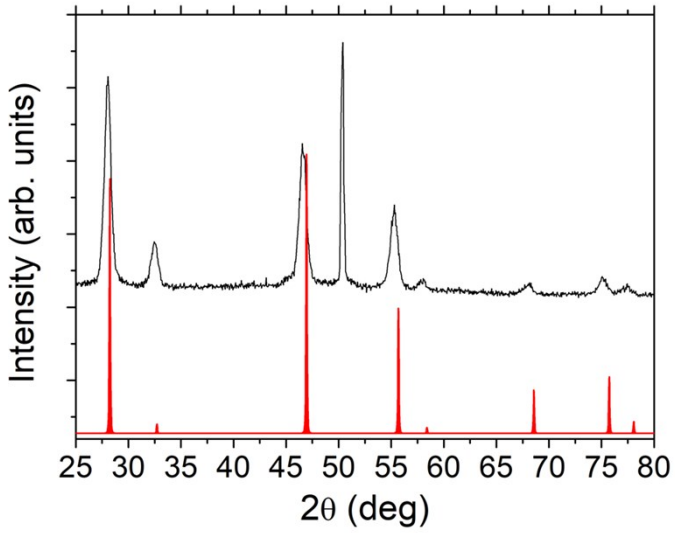

Fig. S2. Experimental X-ray diffraction pattern of α-$NaYF_4$:20%Yb,2%Er NPs before encapsulation (black line) and the JCPDS standard no. 77-2042 for cubic α-$NaYF_4$ (red line). Peak at 50° is from glass sample holder.

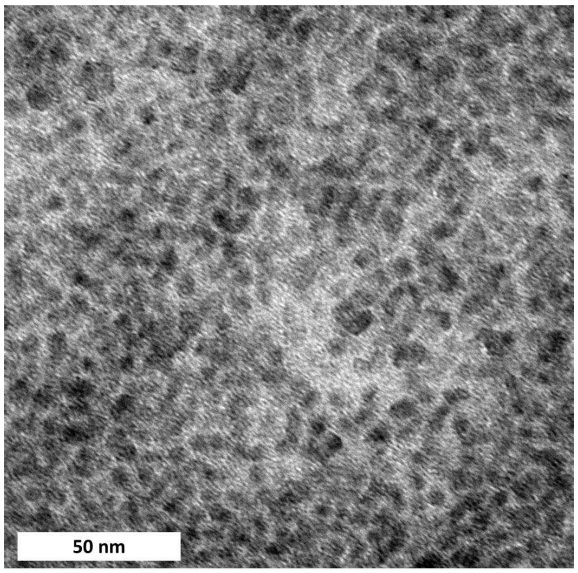

Fig. S3. Representative transmission electron microscope image of the as-prepared CdSe QDs.

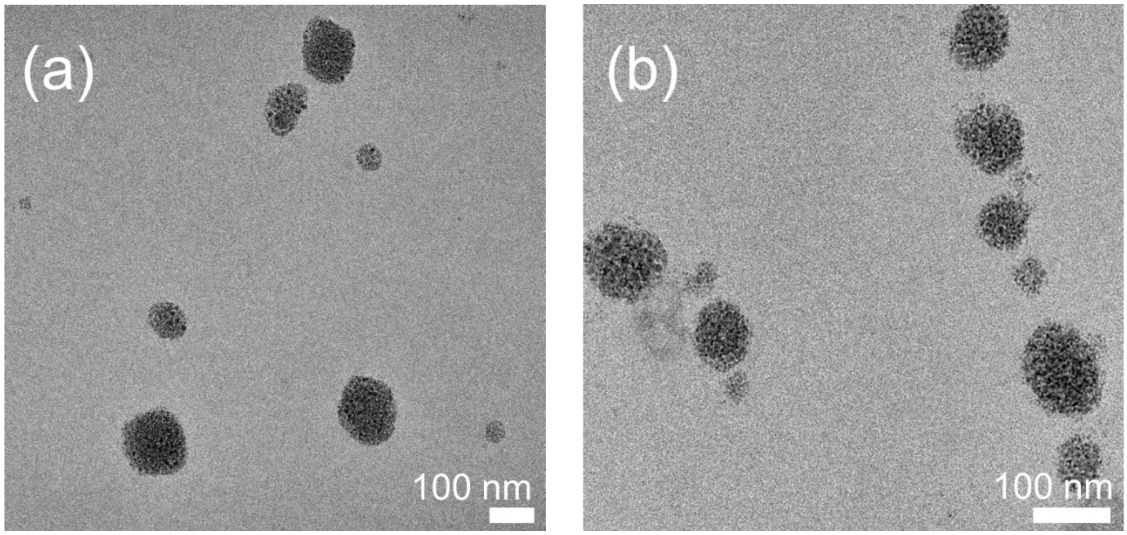

Fig. S4. Representative transmission electron microscope images of the $NaYF_4$:Yb,Er/CdSe NCs.

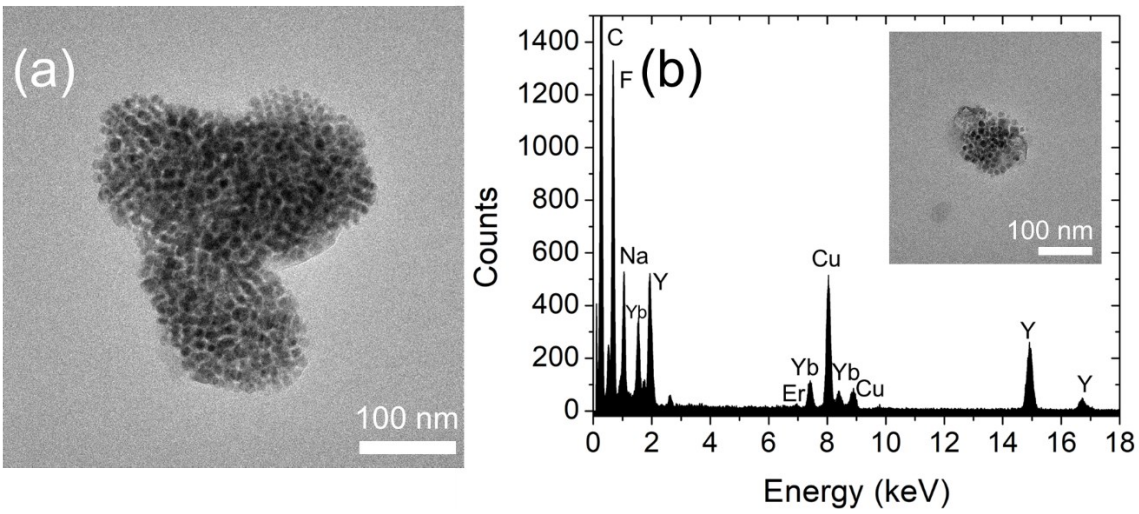

Fig. S5. Representative transmission electron microscope image (a) and energy-dispersive X-ray (EDX) spectra (b) (the inset figure shows TEM image) of the $NaYF_4$:Yb,Er NCs.

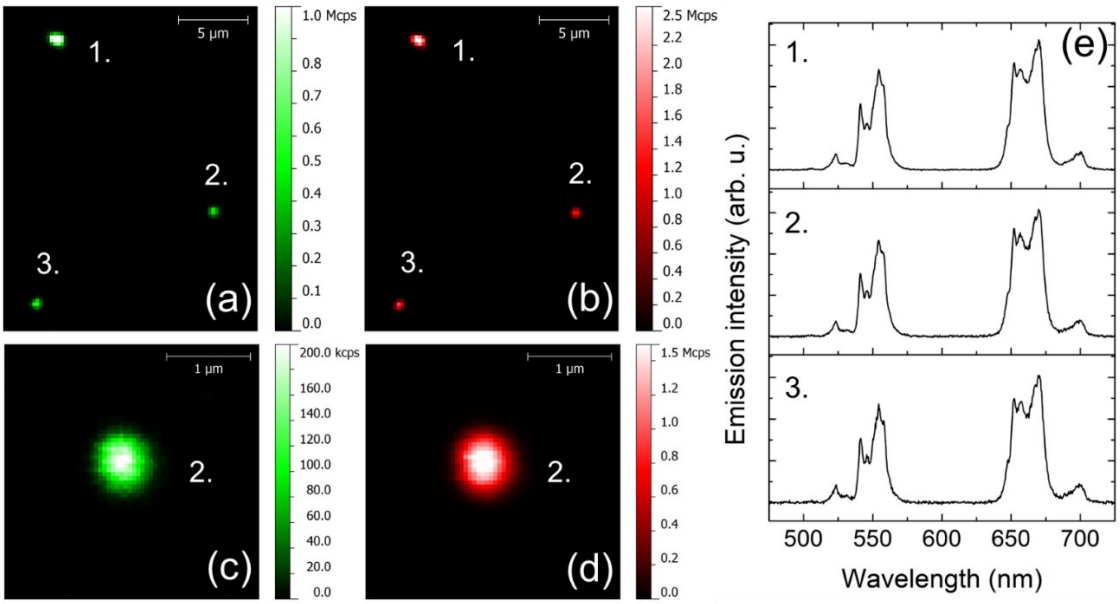

Fig. S6. Photoluminescence intensity maps observed at 540 nm (a, c) and 650 nm (b, d), upconverted emission spectra (e) of individual $NaYF_4$:Yb,Er nanocapsules (dispersed in distilled water) upon excitation with 980 nm CW laser diode. On (c, d) pictures are shown photoluminescence intensity maps nanocapsule labelled as number 2.

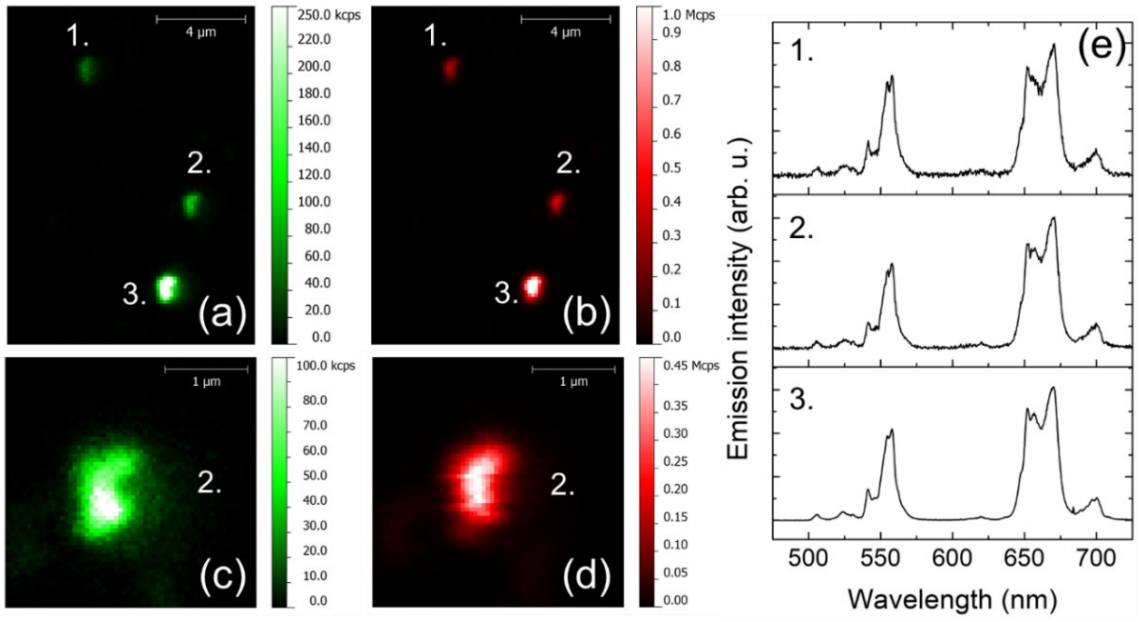

Fig. S7. Photoluminescence intensity maps observed at 540 nm (a, c) and 650 nm (b, d), upconverted emission spectra (e) of individual $NaYF_4$:Yb,Er/CdSe co-loaded nanocapsules (dispersed in distilled water) upon excitation with 980 nm CW laser diode. On (c, d) pictures are shown photoluminescence intensity maps nanocapsule labeled as number 2.

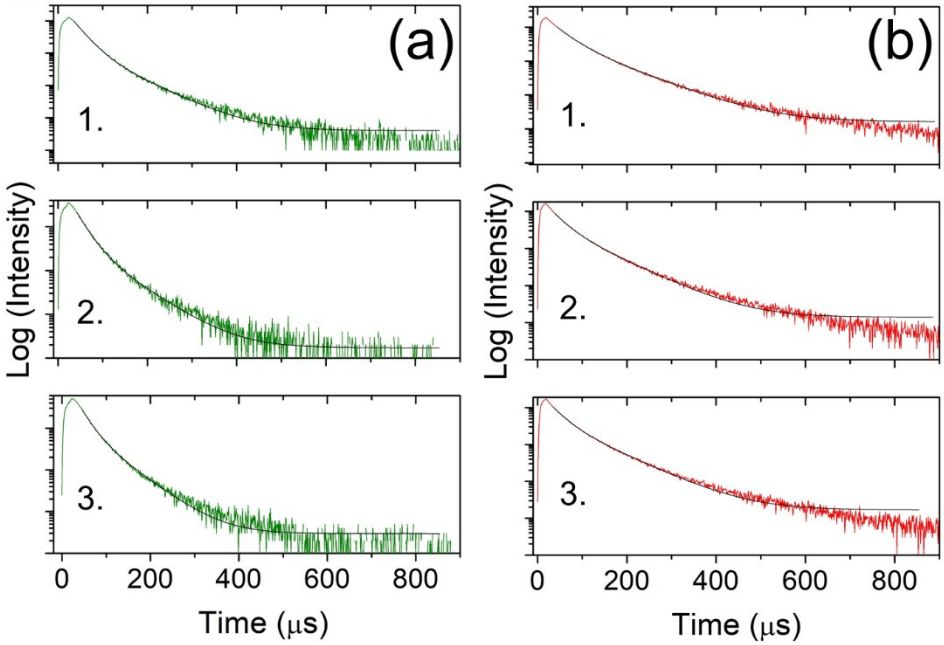

Fig. S8. Room temperature fluorescence intensity decays of $^2H_{11/2}/^4S_{3/2} \rightarrow ^4I_{15/2}$ (a) and $^4F_{9/2} \rightarrow ^4I_{15/2}$ (b) electronic transition for $NaYF_4$:Yb,Er NCs dispersed in distilled water upon excitation with 980 nm laser diode.

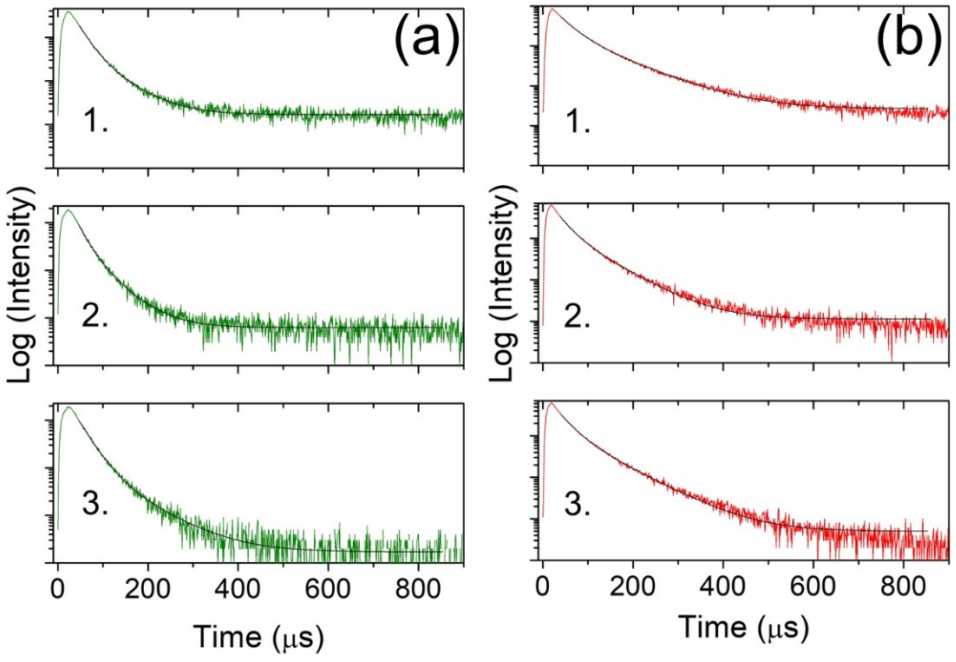

Fig. S9. Room temperature fluorescence intensity decays of $^2H_{11/2}/^4S_{3/2} \rightarrow ^4I_{15/2}$ (a) and $^4F_{9/2} \rightarrow ^4I_{15/2}$ (b) electronic transition for $NaYF_4$:Yb,Er/CdSe NCs dispersed in distilled water upon excitation with 980 nm laser diode.

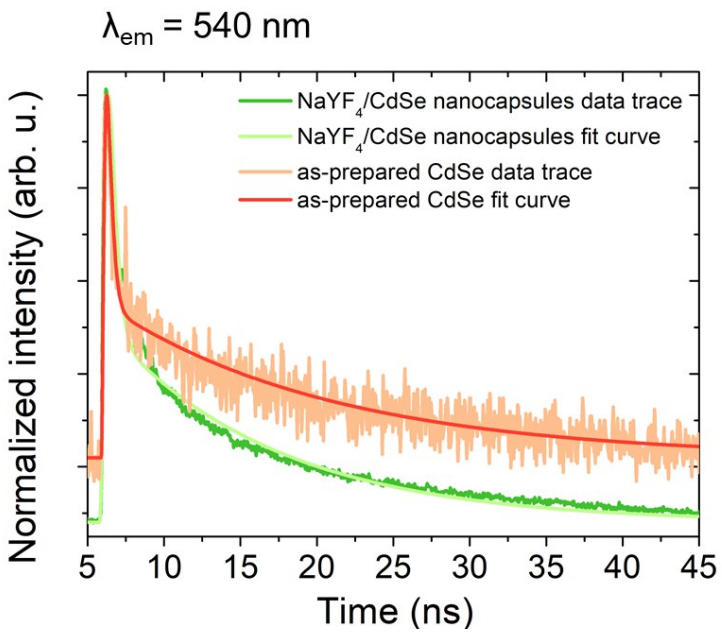

Fig. S10. Room temperature fluorescence intensity decays of the as-prepared CdSe QDs (dispersed in chloroform) and the $NaYF_4$:Yb,Er/CdSe co-loaded NCs (dispersed in distilled water) measured with TCSPC method and 375 nm laser diode excitation.