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

Electronic Supporting Information

for

Spectrally Resolved Two-photon Absorption Properties and Switching of Multi-modal Luminescence of $NaYF_4$:Yb,Er/CdSe Hybrid Nanostructures

*Magda A. Antoniak, Dominika Wawrzyńczyk, Jan K. Zaręba, Marek Samoć and Marcin Nyk**

Advanced Materials Engineering and Modelling Group, Faculty of Chemistry, Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland

*corresponding author: marcin.nyk@pwr.edu.pl

IR spectra

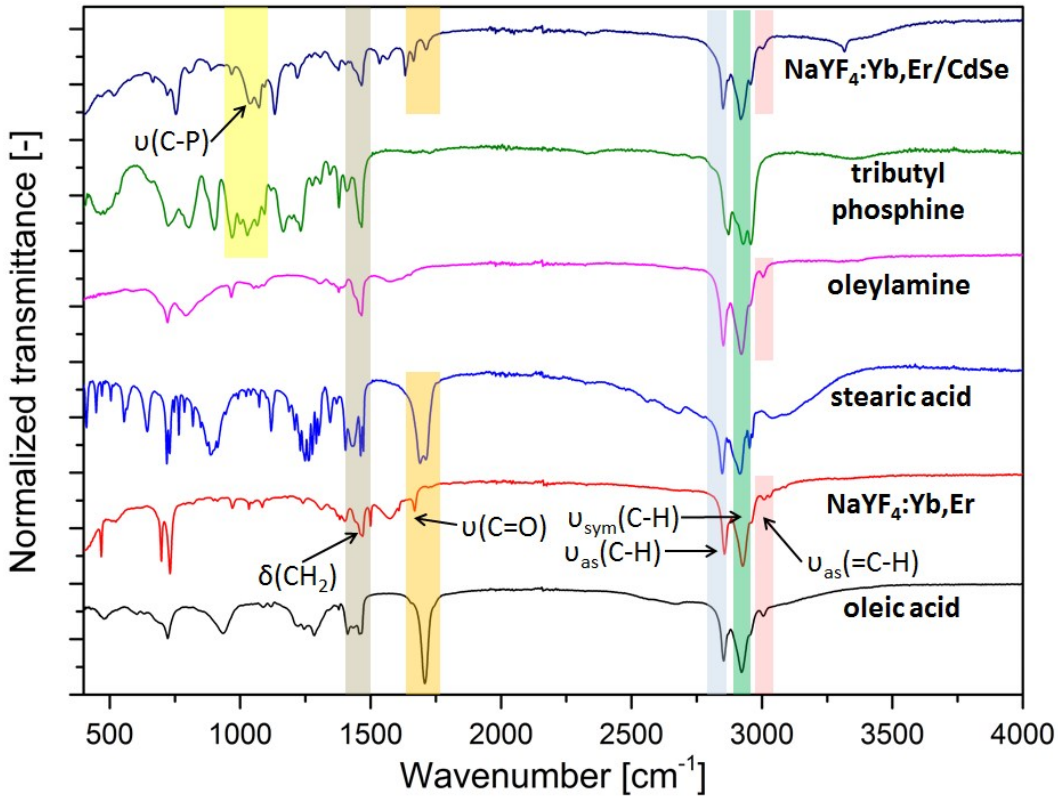

Fig. S1. IR spectra of $NaYF_4$:Yb,Er/CdSe HNSs and $NaYF_4$:Yb,Er NPs compared with IR spectra of ligands used during synthesis (oleic acid, stearic acid, oleylamine, tributyl phosphine).

One-photon spectroscopy and power-dependent measurements

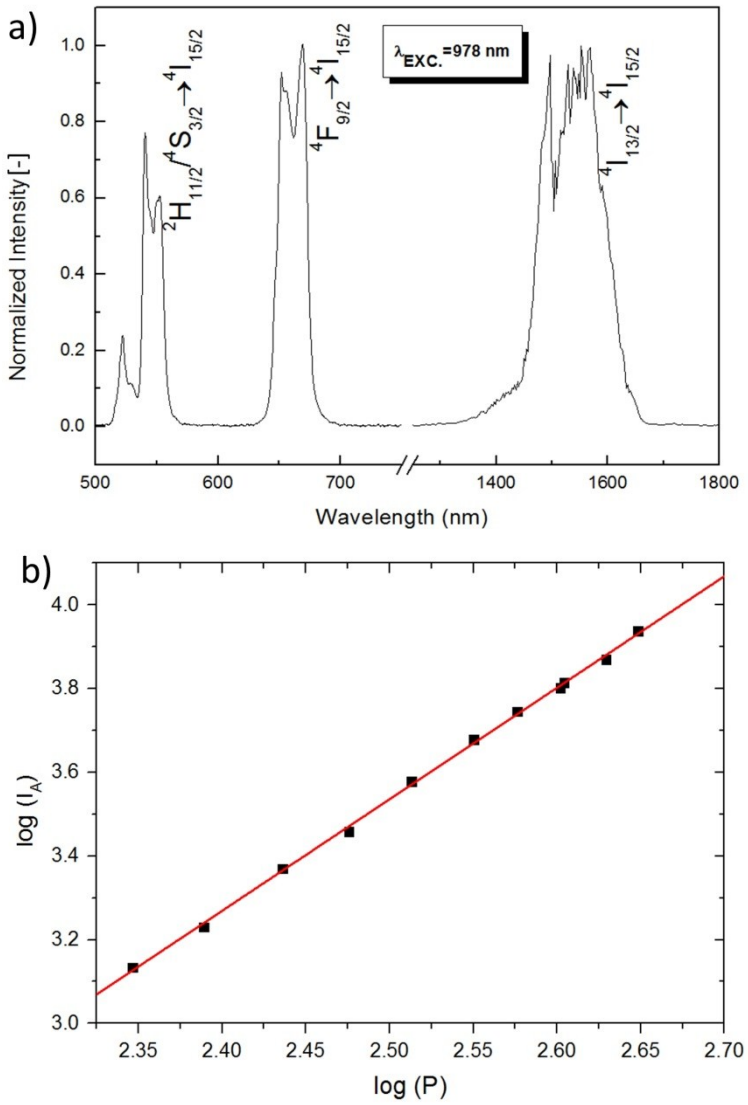

Fig. S2. (a) Room temperature non-calibrated PL spectrum of core $NaYF_4$:20%Yb^{3+},2%Er^{3+} NPs upon 980 nm CW laser diode; (b) log-log plot of integral area of $^4F_{9/2}\rightarrow{}^4I_{15/2}$ electronic transition in the function of 980 nm CW laser intensity – the slope of linear fit is equal 2.6+/-0.08, with $(1-R^2) = 10^{-3}$.

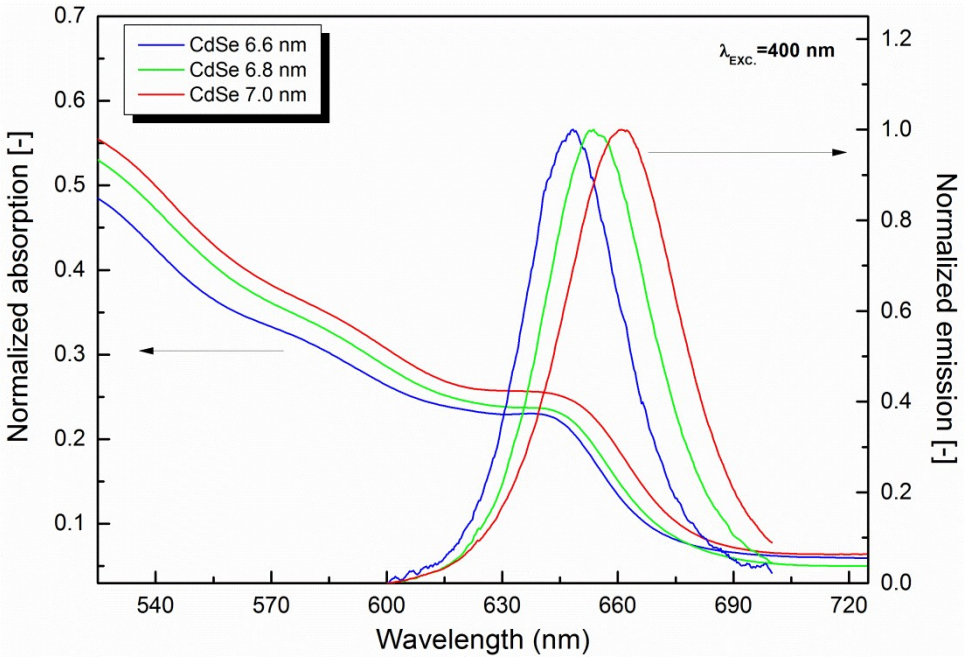

Fig. S3. Absorption and photoluminescence spectra of $NaYF_4$:Yb,Er/CdSe HNSs withdrawn from the reaction vessel after different time intervals and dispersed in chloroform.

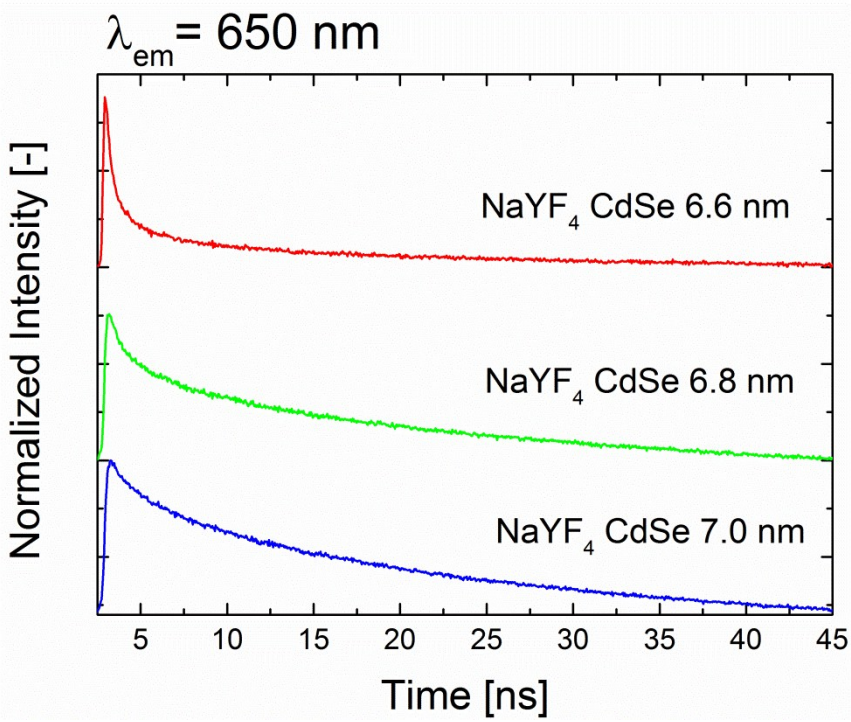

Fig. S4. Room temperature fluorescence intensity decays of $NaYF_4$:Yb,Er/CdSe HNSs upon excitation with 375 nm, monitored at 650 nm.

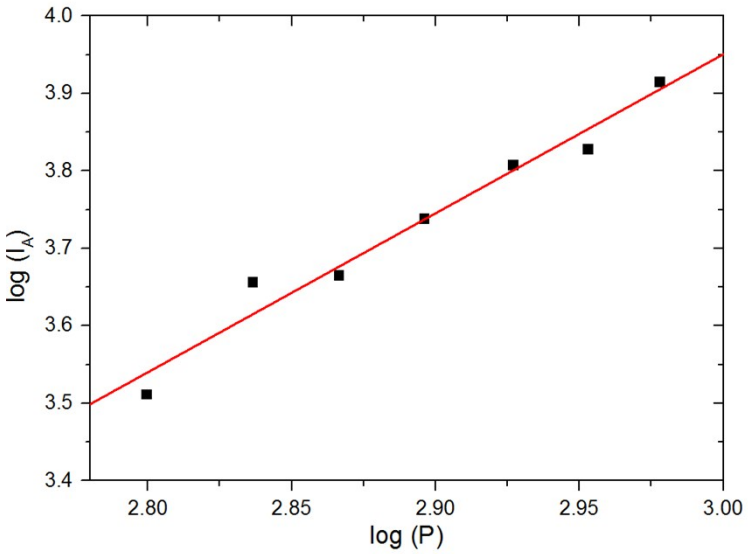

Fig. S5. Log-log plot of integral area of $^4F_{9/2} \rightarrow {}^4I_{15/2}$ electronic transition in the function of 980 nm CW laser intensity, measured for $NaYF_4$:Yb,Er/CdSe HNSs – the slope of linear fit is equal 2.0+/-0.3, with $(1\text{-}R^2) = 2.3 \times 10^{-2}$.

FRET and luminescence decay measurements

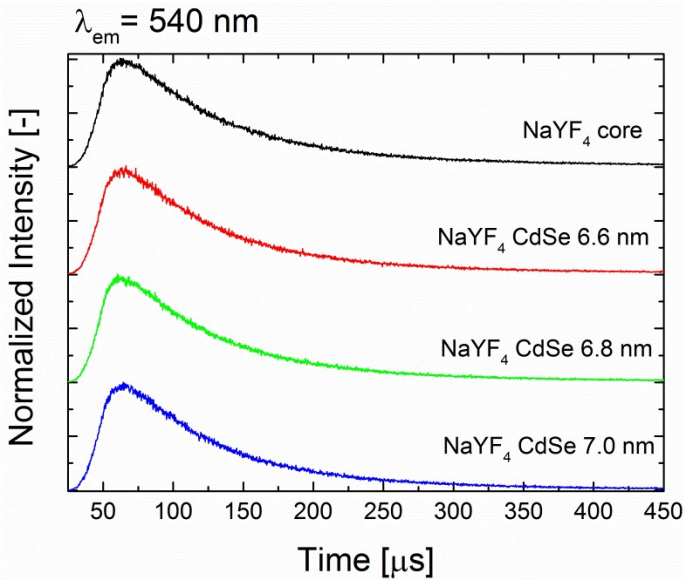

Fig. S6. Room temperature fluorescence intensity decays of $^{2}H_{11/2}/^{4}S_{3/2} \rightarrow {}^{4}I_{15/2}$ electronic transition for core $NaYF_4$:20%Yb^{3+},2%Er^{3+} NPs and hybrid $NaYF_4$:Yb,Er/CdSe HNSs upon excitation with 980 nm laser diode.

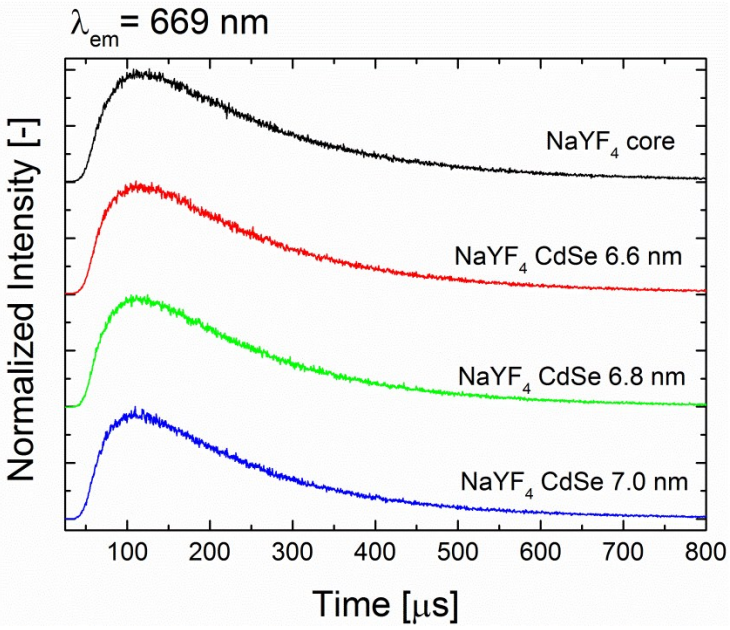

Fig. S7. Room temperature fluorescence intensity decays of $^{4}F_{9/2} \rightarrow {}^{4}I_{15/2}$ electronic transition for core $NaYF_4$:20%Yb^{3+},2%Er^{3+} NPs and $NaYF_4$:Yb,Er/CdSe HNSs upon excitation with 980 nm laser diode.

X-ray diffraction (XRD) measurements

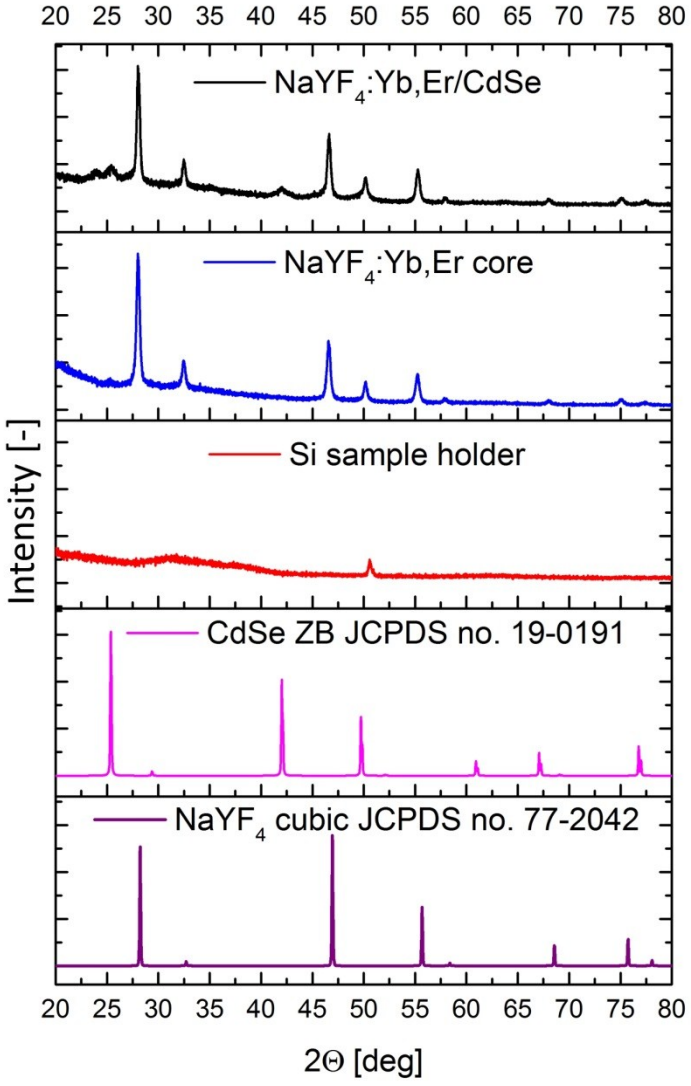

Fig. S8. Experimental X-ray diffraction patterns of $NaYF_4$:Yb,Er/CdSe HNSs, core $NaYF_4$:20%Yb^{3+},2%Er^{3+} NPs, Si sample holder, and the JCPDS standards no. 19-0191 and 77-2042.