Supplementary Information

UV-A scintillation and persistent luminescence from Ce- and Ce/Ho-doped YPO_4 nanoparticles

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	Precursors concentration (mol/L)		
	Y	Ce	Ho
MW-1	2,033E-01	1,02E-03	-
MW-2	2,020E-01	1,02E-03	1,02E-03
MW-3	2,012E-01	1,02E-03	2,04E-03
MW-4	1,992E-01	1,02E-03	4,09E-03

Table S1. Nominal concentrations of $Y(NO_3)_3 \cdot 6H_2O$, $Ce(NO_3)_3 \cdot 6H_2O$ and $Ho(NO_3)_3 \cdot 5H_2O$ precursors introduced the microwave reactor for the microwave-assisted hydrothermal synthesis.

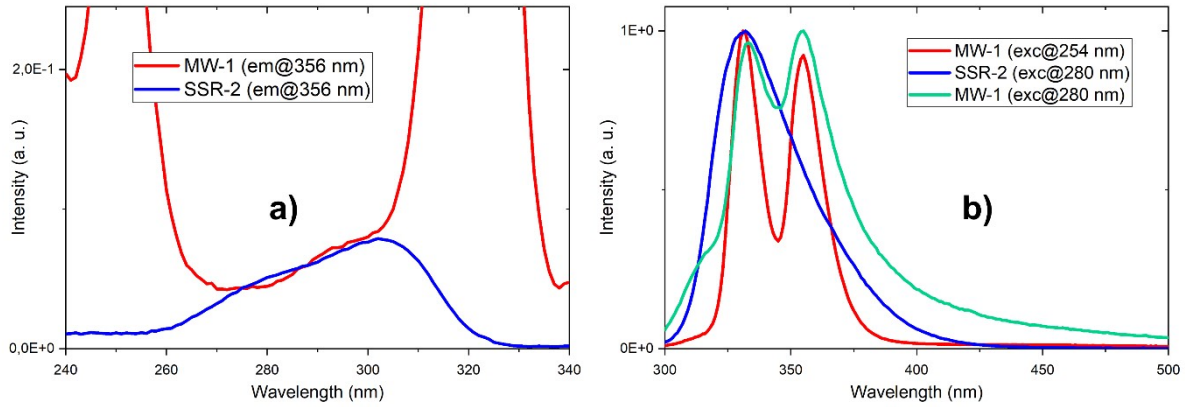

Figure S1.

(a) Zoom in PL excitation spectra of Fig. 5c
(b) Normalized PL emission spectra of MW-1 excited at two different excitation wavelengths (@254 nm exciting YPO4:Ce and @ 280 nm exciting the impurity $Y(PO_3)_3$:Ce) and of SSR-2 excited @ 280 nm.

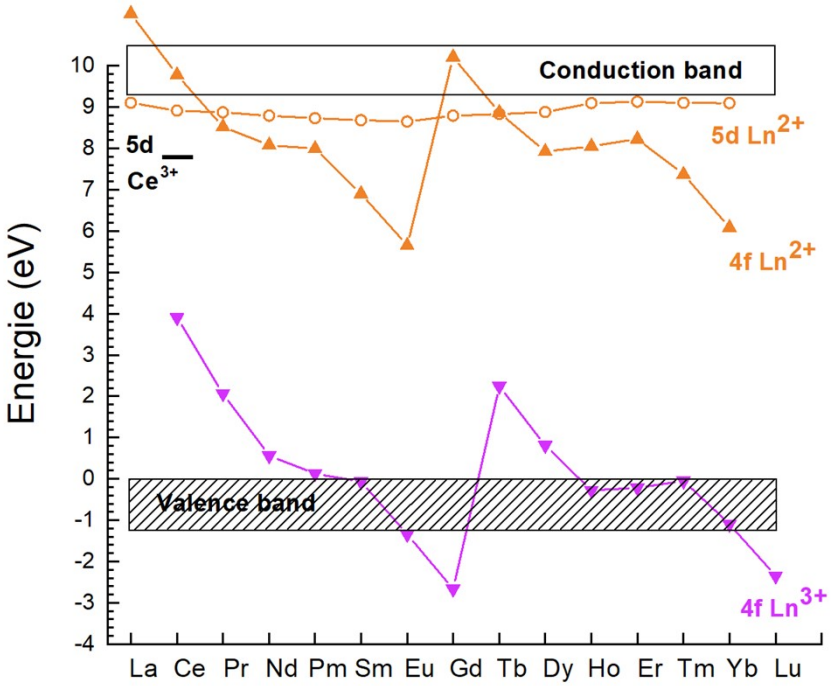

Figure S2.

Energy level scheme of lanthanide (Ln) ions doped in YPO_4 (reproduced with permission from[1]). The magenta curve with downward-pointing triangles connects the lowest energy levels of the $4f^n$ configuration for trivalent lanthanide ions (Ln^{3+}), plotted relative to the valence band maximum. The orange curve with upward-pointing triangles represents the lowest energy levels of the $4f^{n+1}$ configuration for divalent lanthanide ions (Ln^{2+}), while the open orange circles indicate the lowest levels of the $4f^{n-1}5d$ configuration for Ln^{2+}. The conduction and valence bands of YPO_4 are indicated by the boxed and shaded regions, respectively. The position of the first excited 5d level of Ce^{3+} is also shown.

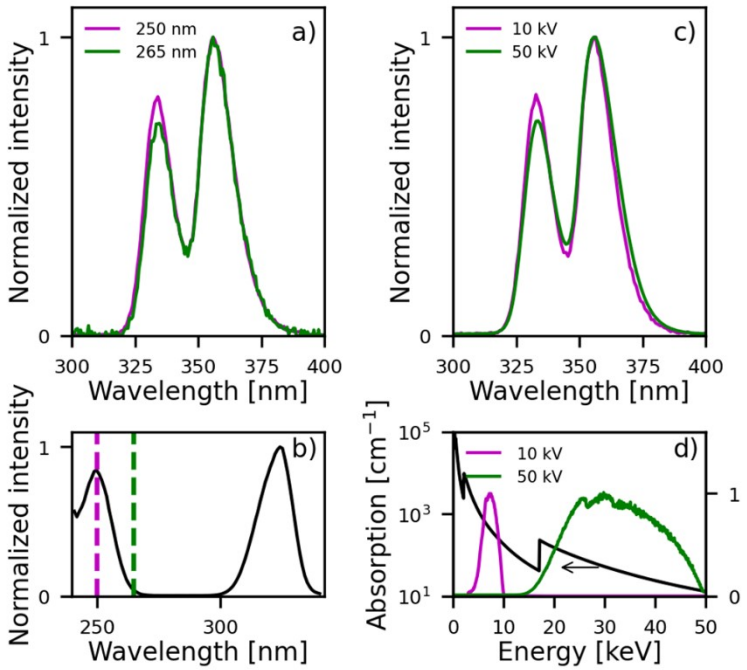

Figure S3.

(a) Normalized photoluminescence emission spectra of SSR-1 under excitation at 250 nm (magenta) and 265 nm (green).

(b) Normalized photoluminescence excitation spectrum of SSR-1. Vertical dashed lines indicate the excitation wavelengths used in panel (a), showing that absorption at 265 nm is significantly lower than at 250 nm. Because 265 nm light is less strongly absorbed, it penetrates deeper into the sample, and the resulting emission spectrum is more influenced by the self-absorption effect.

(c) Radioluminescence spectra of SSR-1 under X-ray excitation at 10 kV (magenta) and 50 kV (green) tube voltages.

(d) X-ray absorption coefficient of YPO_4 (black line, left axis) and X-ray tube emission spectra at 10 kV (magenta) and 50 kV (green) (right axis). A 10 mm aluminum (Al) filter was used at 50 kV to suppress low-energy X-rays. As the 50 kV X-rays are less absorbed than the 10 kV ones, they penetrate deeper into the sample, leading to stronger self-absorption effects in the emission spectrum.

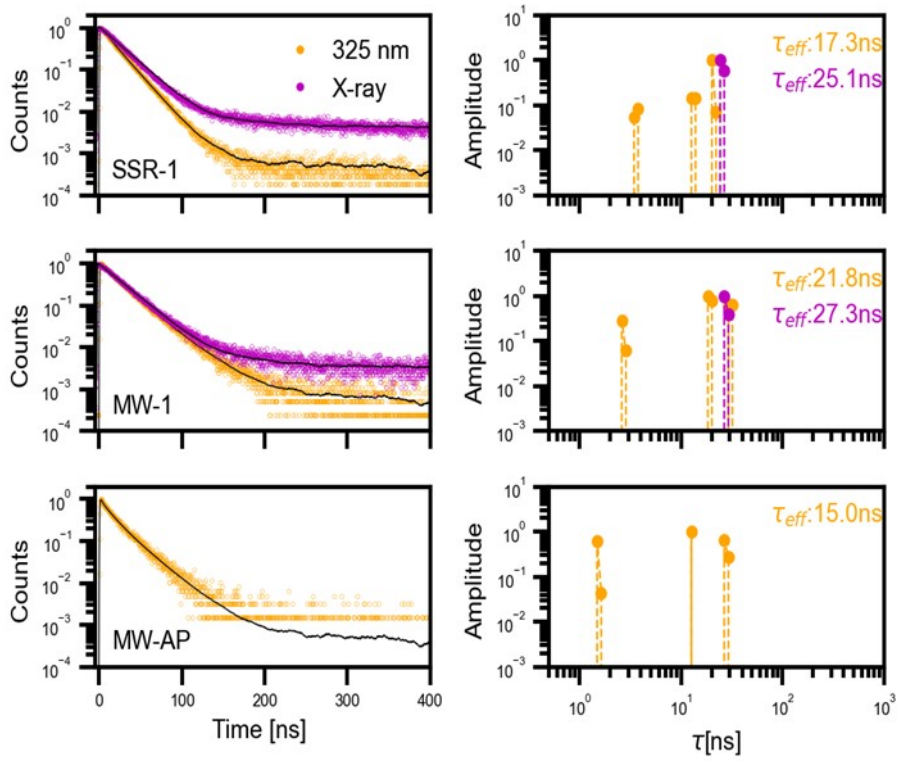

Figure S4. Left panels: Luminescence decay curves of SSR-1 (top), MW-1 (middle), and MW-AP (bottom) samples under pulsed optical excitation at 325 nm (orange) and X-ray excitation (magenta). The corresponding multi-exponential fitting curves are shown as black solid lines.

Right panels: Extracted decay components from the fits, presented as amplitudes versus lifetimes (τ). The effective lifetimes (τ_{eff}) are calculated using the amplitude-weighted average

$$\tau_{\text{eff}} = \frac{\sum_i A_i \tau_i}{\sum_i A_i}$$

Values of τ_{eff} for each excitation condition are indicated in the plots.

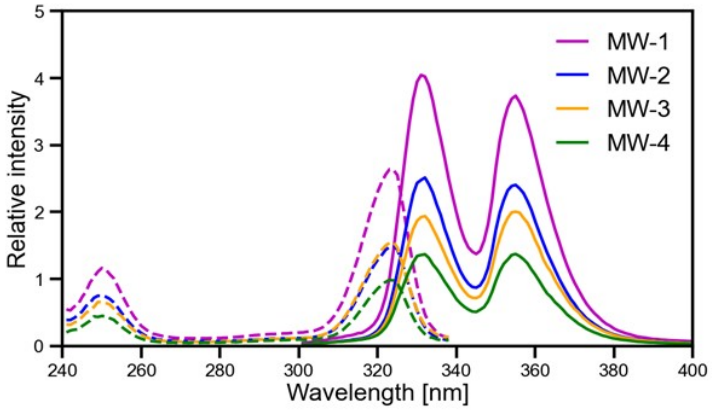

Figure S5. Photoluminescence excitation (dashed line) and emission (solid line) spectra of YPO_4:0.5 mol %Ce, x mol %Ho with nominal x = 0, 0.5, 1, 2.

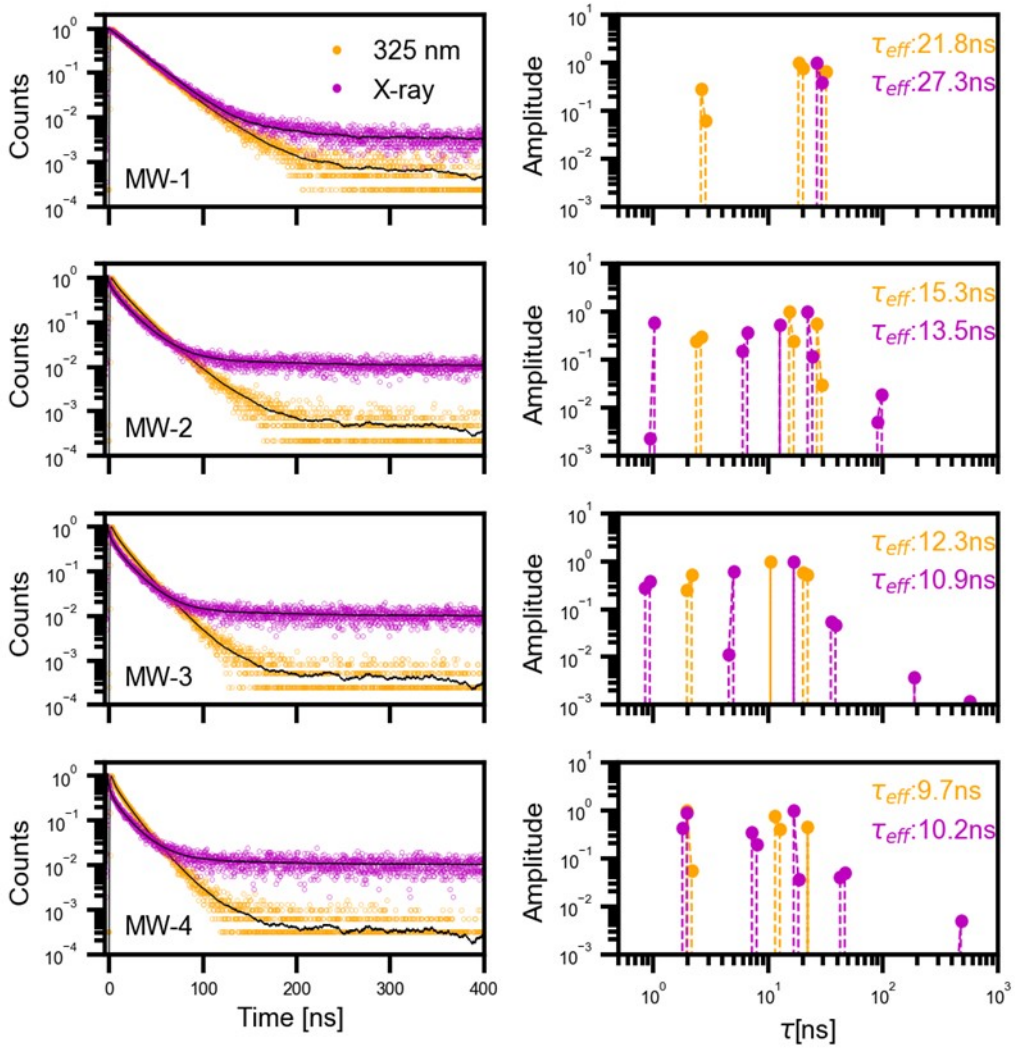

Figure S6. Left panels: Luminescence decay curves of MW-1, MW-2, MW-3 and MW-4 samples under pulsed optical excitation at 325 nm (orange) and X-ray excitation (magenta). The corresponding multi-exponential fitting curves are shown as black solid lines.

Right panels: Extracted decay components from the fits, presented as amplitudes versus lifetimes (τ). The effective lifetimes (τ_{eff}) are calculated using the amplitude-weighted average

Values of τ_{eff} for each excitation condition are indicated in the plots.

1 A. Lecointre, A. Bessière, A. J. J. Bos, P. Dorenbos, B. Viana and S. Jacquart, Designing a Red Persistent Luminescence Phosphor: The Example of YPO_4 :Pr^{3+} ,Ln^{3+} (Ln = Nd, Er, Ho, Dy), *J. Phys. Chem. C*, 2011, **115**, 4217–4227.