

High-contrast multi-surface imaging of latent fingerprints using color-tunable YOF:Tb³⁺, Eu³⁺ ultrafine nanophosphors with high quantum yield

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Supporting Information

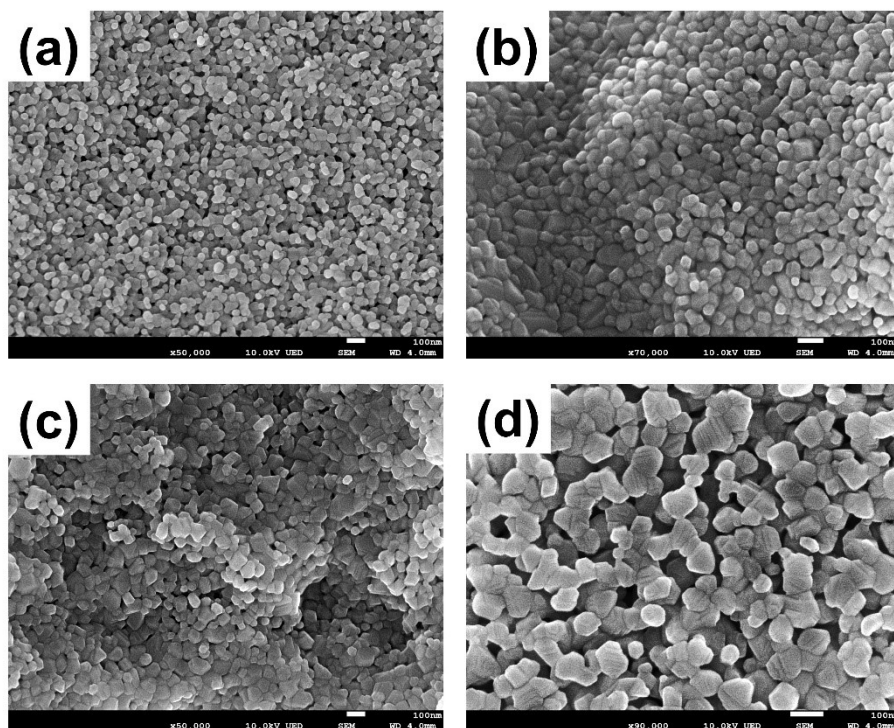


Figure S1 FE-SEM images of: (a) YOF: 0.01 Tb³⁺, (b) YOF: 0.01 Eu³⁺, (c) YOF: 0.01 Tb³⁺, 0.005 Eu³⁺, (d) YOF: 0.005 Tb³⁺, 0.01 Eu³⁺ nanophosphors.

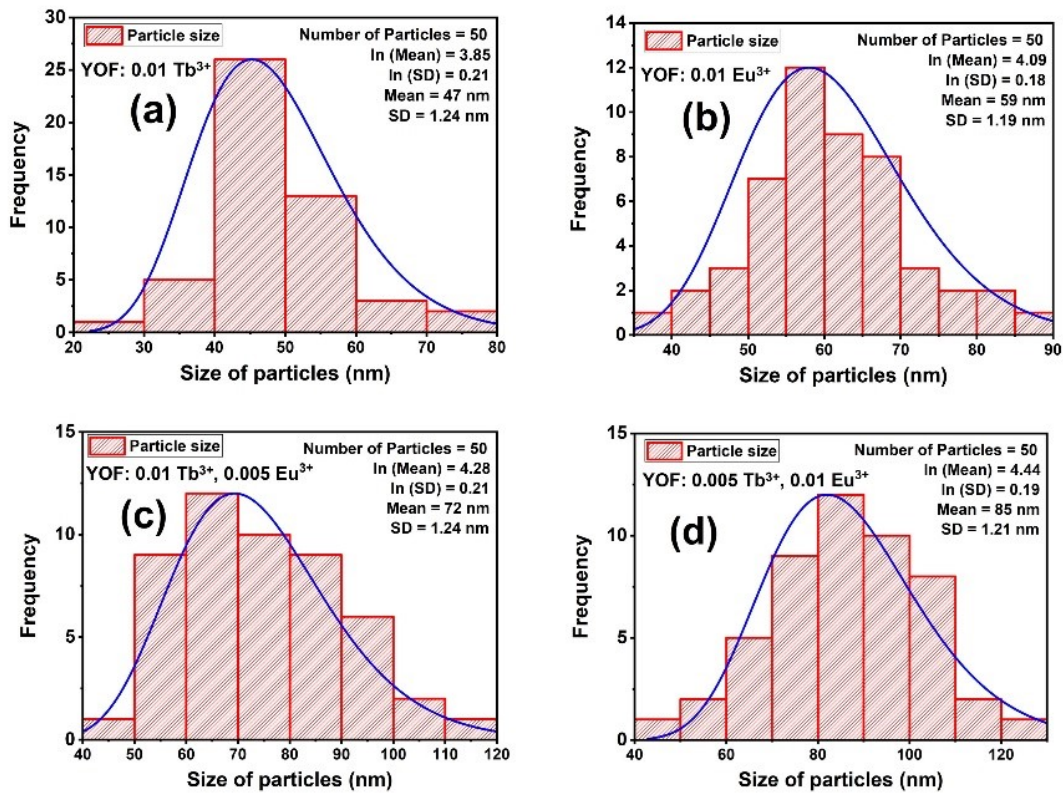


Figure S2 Histograms showing the particle-size distribution of: (a) YOF: 0.01 Tb³⁺, (b) YOF: 0.01 Eu³⁺, (c) YOF: 0.01 Tb³⁺, 0.005 Eu³⁺, (d) YOF: 0.005 Tb³⁺, 0.01 Eu³⁺ nanophosphors.

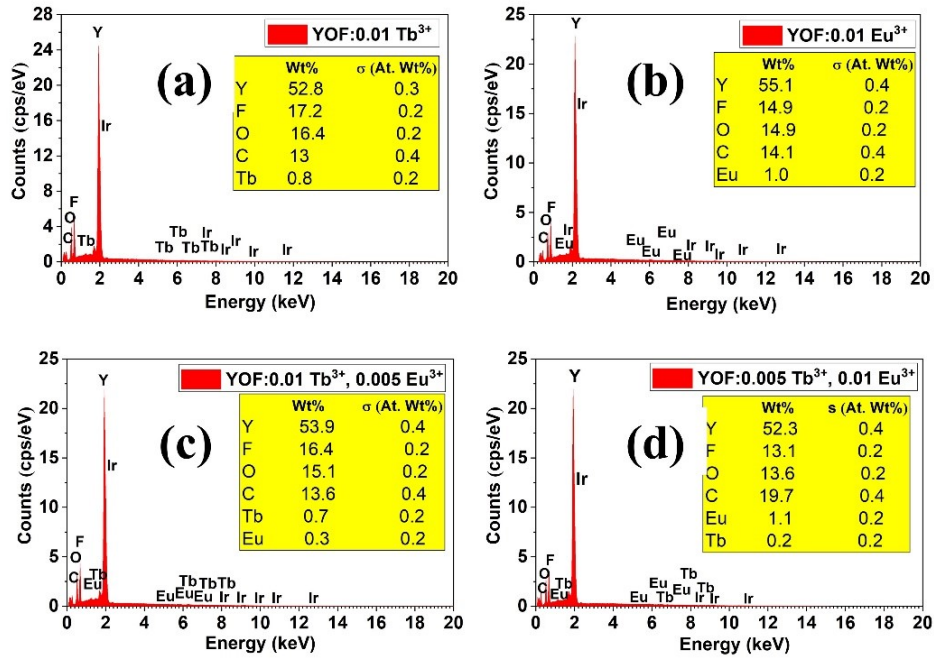


Figure S3 EDS of: (a) YOF: 0.01 Tb³⁺, (b) YOF: 0.01 Eu³⁺, (c) YOF: 0.01 Tb³⁺, 0.005 Eu³⁺, (d) YOF: 0.005 Tb³⁺, 0.01 Eu³⁺ nanophosphors.

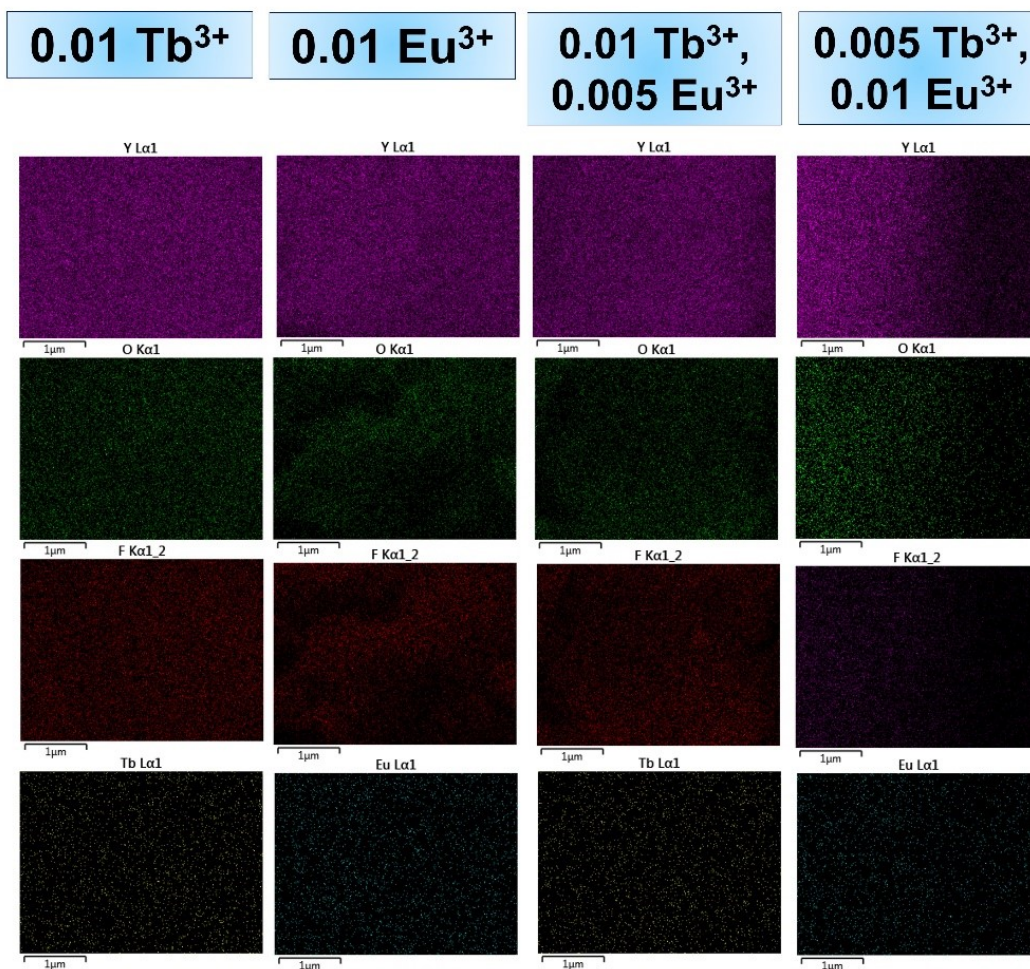


Figure S4 Elemental mapping of: (a) YOF: 0.01 Tb³⁺, (b) YOF: 0.01 Eu³⁺, (c) YOF: 0.01 Tb³⁺, 0.005 Eu³⁺, (d) YOF: 0.005 Tb³⁺, 0.01 Eu³⁺ nanophosphors.

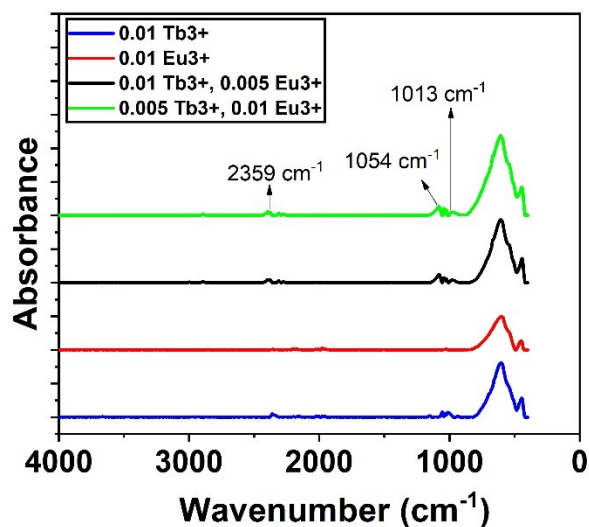


Figure S5 FTIR spectra for: (a) YOF: 0.01 Tb³⁺, (b) YOF: 0.01 Eu³⁺, (c) YOF: 0.01 Tb³⁺, 0.005 Eu³⁺, (d) YOF: 0.005 Tb³⁺, 0.01 Eu³⁺ nanophosphors.

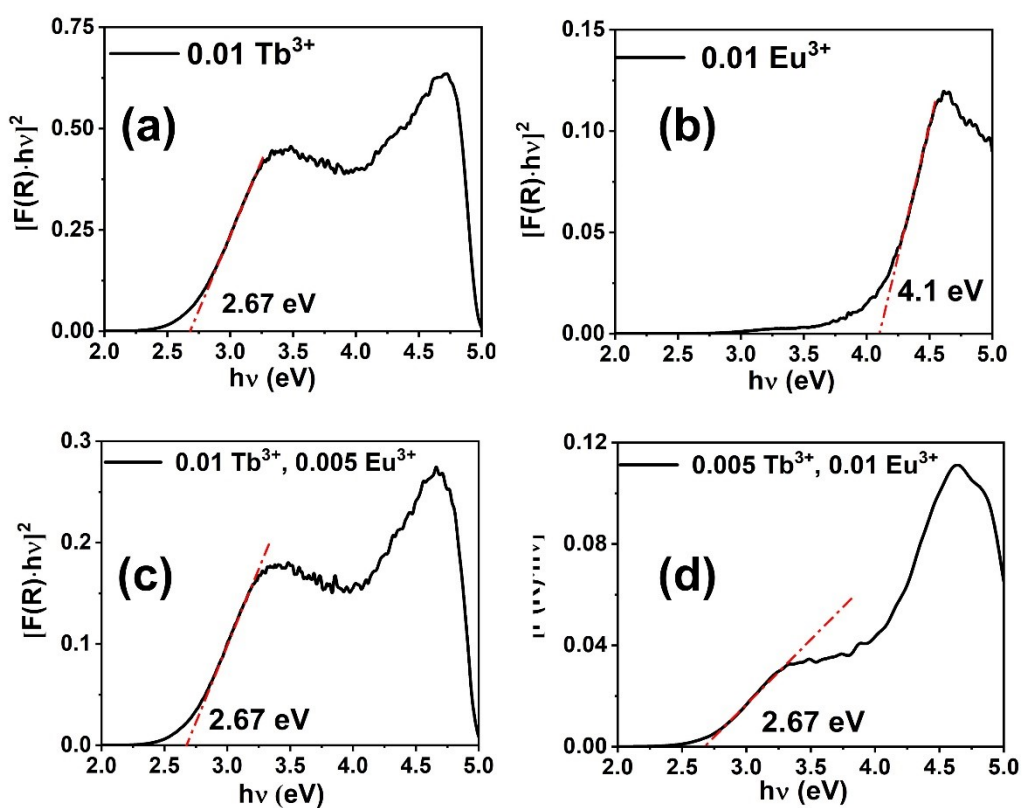


Figure S6 Optical band gap obtained from the DRS for: (a) YOF: 0.01 Tb³⁺, (b) YOF: 0.01 Eu³⁺, (c) YOF: 0.01 Tb³⁺, 0.005 Eu³⁺, (d) YOF: 0.005 Tb³⁺, 0.01 Eu³⁺ nanophosphors.

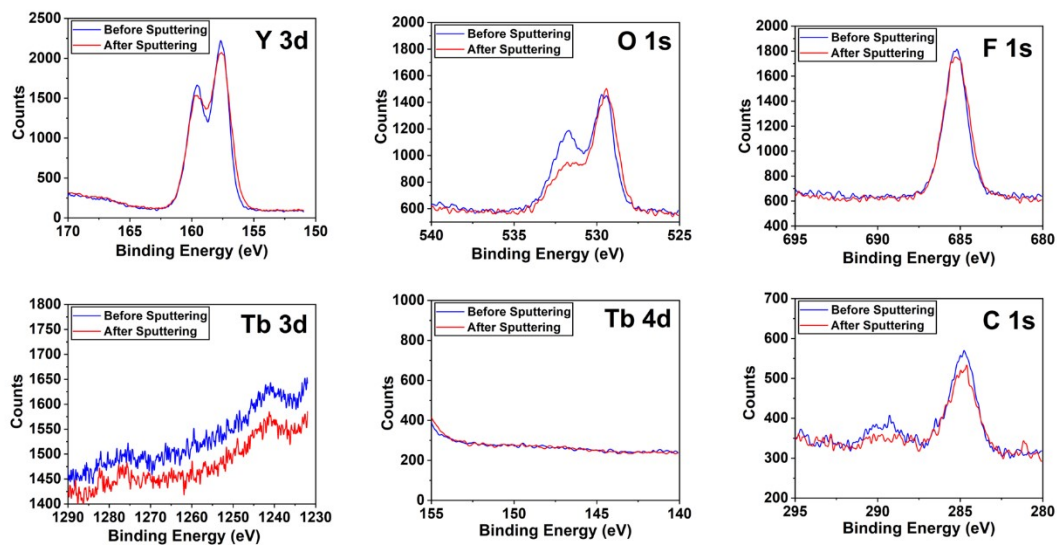


Figure S7 High-resolution XPS spectra of different core levels of YOF: 0.01 Tb³⁺ nanophosphors before and after sputtering.

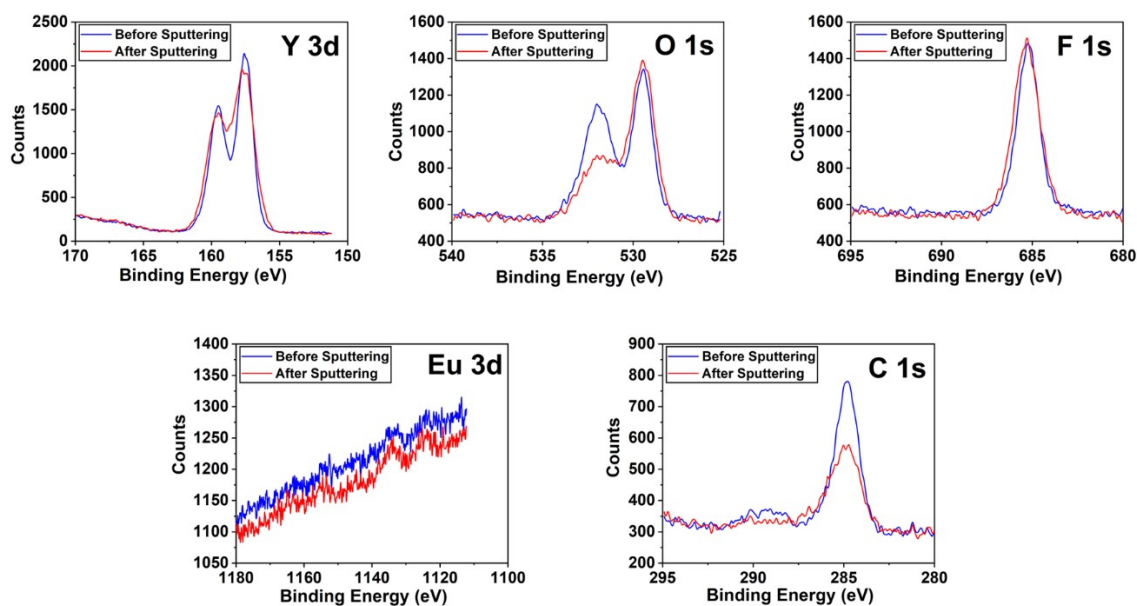


Figure S8 High-resolution XPS spectra of different core levels of YOF: 0.01 Eu³⁺ nanophosphors before and after sputtering.

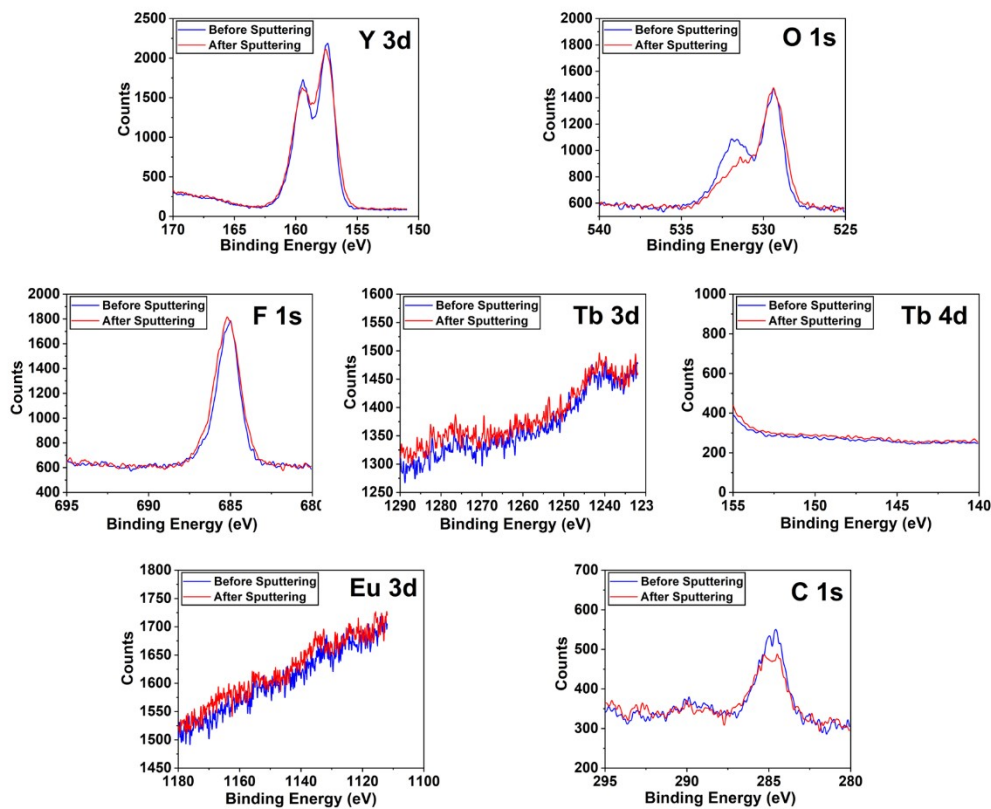


Figure S9 High-resolution XPS spectra of different core levels of YOF: 0.01 Tb³⁺, 0.005 Eu³⁺ nanophosphors before and after sputtering.

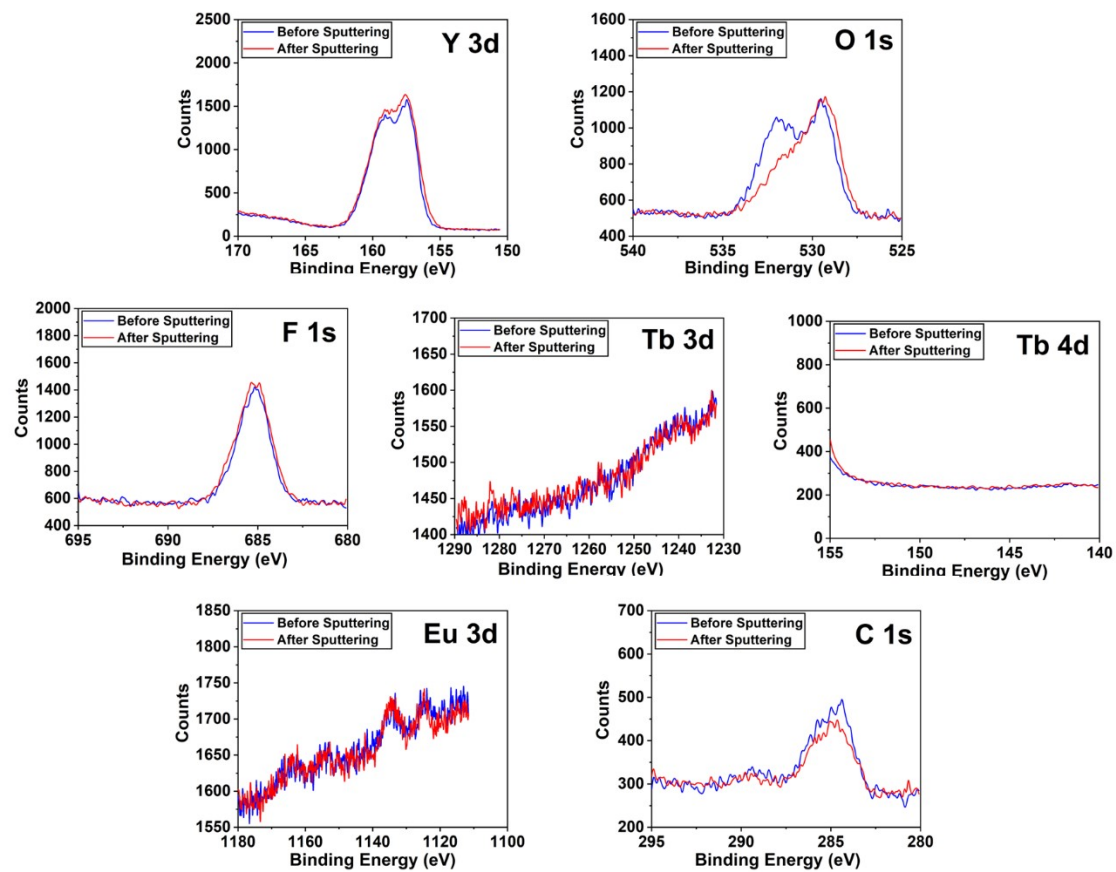


Figure S10 High-resolution XPS spectra of different core levels of YOF: 0.005 Tb³⁺, 0.01 Eu³⁺ nanophosphors before and after sputtering.

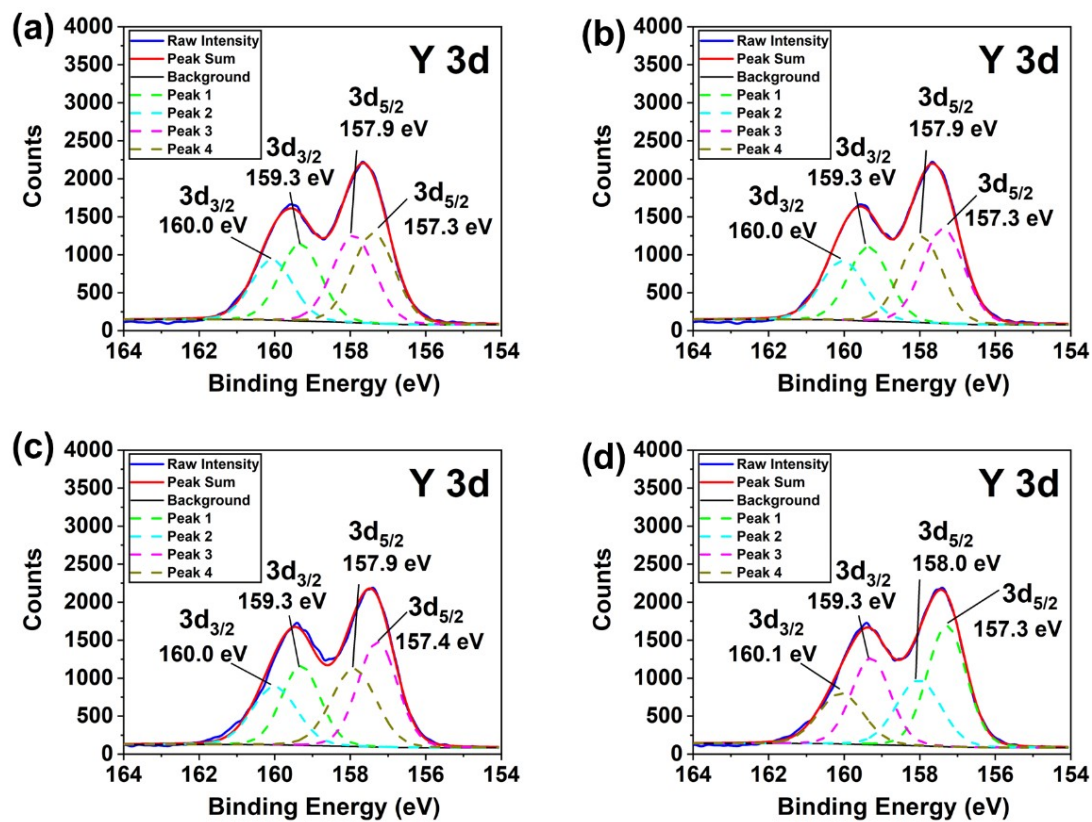


Figure S11 High-resolution XPS curve fitting for the Y 3d signals obtained for: (a) YOF: 0.01 Tb^{3+} , (b) YOF: 0.01 Eu^{3+} , (c) YOF: 0.01 Tb^{3+} , 0.005 Eu^{3+} , and (d) YOF: 0.005 Tb^{3+} , 0.01 Eu^{3+} nanophosphors.

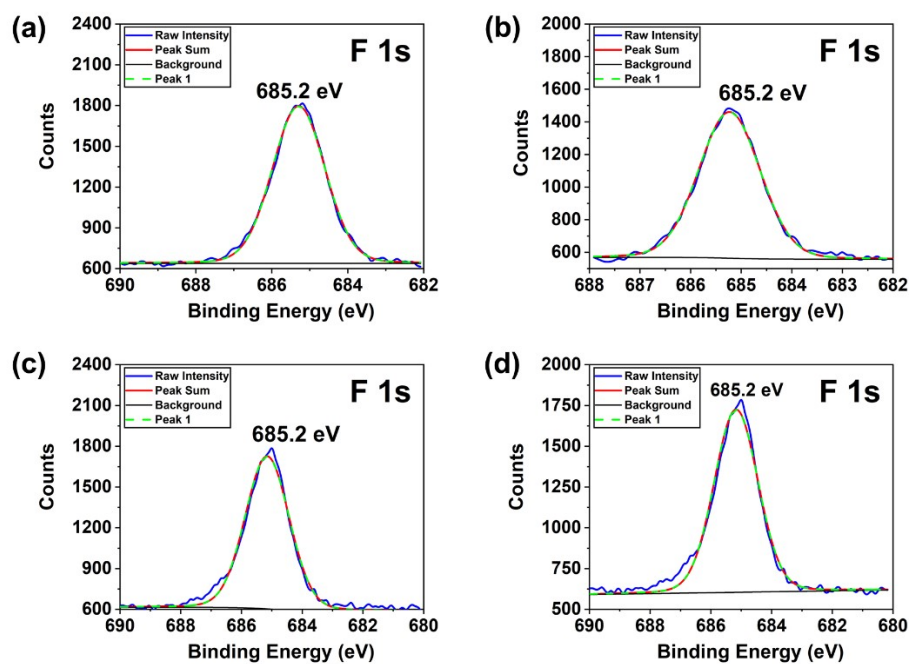


Figure S12 High-resolution XPS curve fitting for the F 1s signals obtained for: (a) YOF: 0.01 Tb³⁺, (b) YOF: 0.01 Eu³⁺, (c) YOF: 0.01 Tb³⁺, 0.005 Eu³⁺, and (d) YOF: 0.005 Tb³⁺, 0.01 Eu³⁺ nanophosphors.

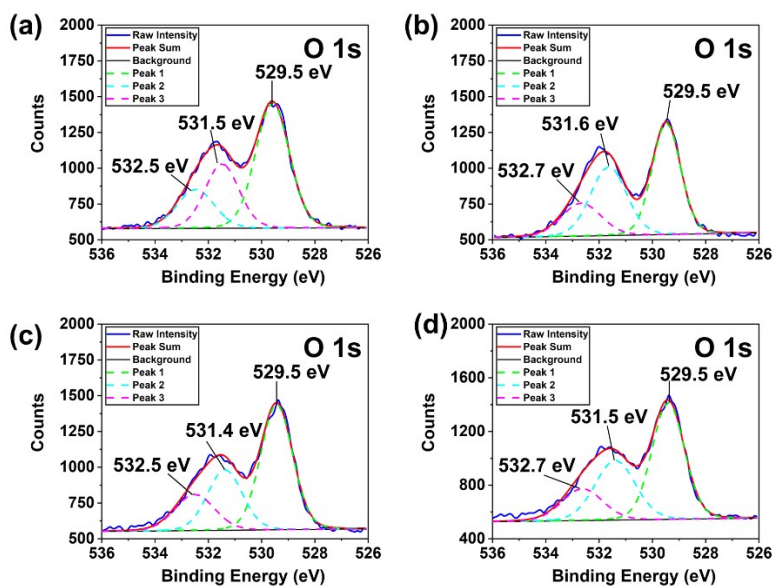


Figure S13 High-resolution XPS curve fitting for the O 1s signals obtained for: (a) YOF: 0.01 Tb³⁺, (b) YOF: 0.01 Eu³⁺, (c) YOF: 0.01 Tb³⁺, 0.005 Eu³⁺, and (d) YOF: 0.005 Tb³⁺, 0.01 Eu³⁺ nanophosphors.

Table S1 CIE chromaticity coordinates of YOF: 0.01 Tb³⁺, *x* Eu³⁺ ($0 \leq x \leq 0.02$)
nanophosphors excited at 241 nm.

Eu³⁺	x	y
0	0.2819	0.5395
0.001	0.2956	0.5349
0.002	0.3068	0.5281
0.005	0.3494	0.5104
0.01	0.4084	0.4866
0.02	0.4931	0.4438

Table S2 CIE chromaticity coordinates of YOF: *y* Tb³⁺, 0.01 Eu³⁺ ($0 \leq y \leq 0.02$)
nanophosphors excited at 241 nm.

Tb³⁺	x	y
0	0.6401	0.3465
0.001	0.5088	0.3482
0.002	0.4951	0.3552
0.005	0.4318	0.4215
0.01	0.4119	0.4855
0.02	0.4028	0.5286

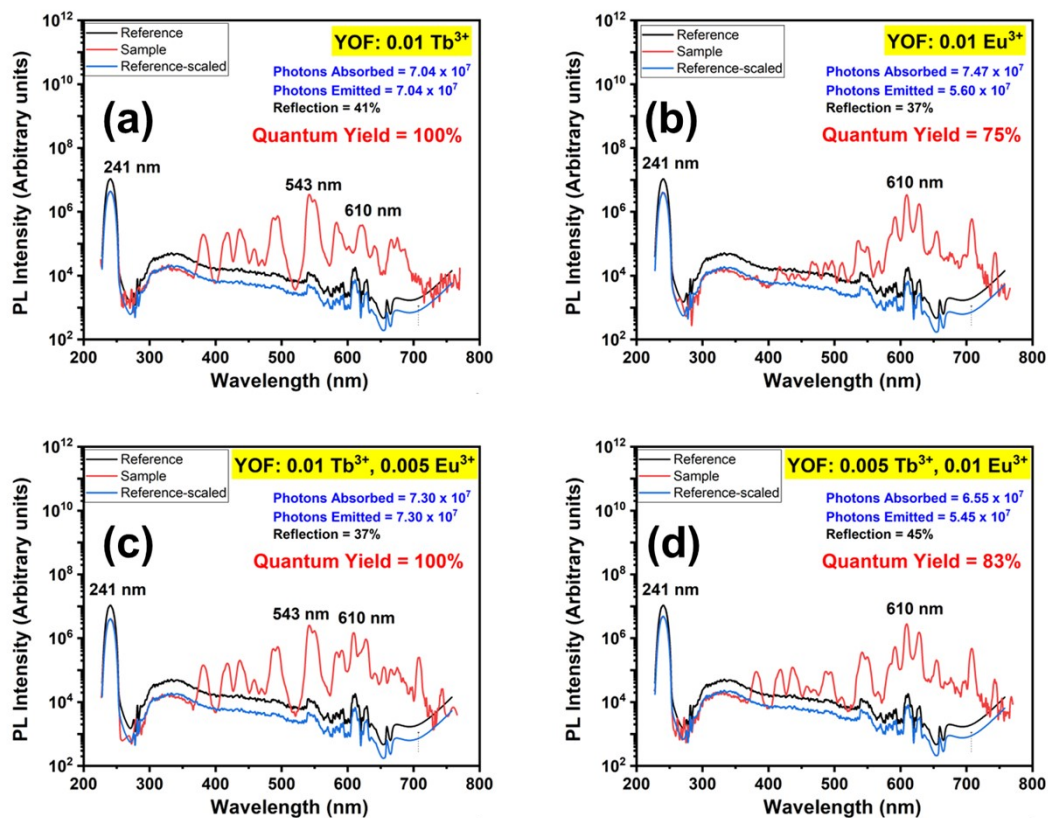


Figure S14 PLQY evaluation of: **(a)** YOF: 0.01 Tb³⁺, **(b)** YOF: 0.01 Eu³⁺, **(c)** YOF: 0.01 Tb³⁺, 0.005 Eu³⁺, **(d)** YOF: 0.005 Tb³⁺, 0.01 Eu³⁺ nanophosphors.

Table S3 Fitting parameters obtained for the PL decay curves of YOF: 0.01 Tb³⁺, x Eu³⁺ ($0 \leq x \leq 0.02$) nanophosphors excited at 241 nm and monitored at 543 nm.

Eu ³⁺	Decay time τ (ms)
$x = 0$	2.05 ± 0.003
$x = 0.001$	1.97 ± 0.003
$x = 0.002$	1.92 ± 0.003
$x = 0.005$	1.88 ± 0.003
$x = 0.01$	1.77 ± 0.003
$x = 0.02$	1.65 ± 0.003

Table S4 Fitting parameters obtained for the PL decay curves of YOF: 0.01 Tb³⁺, x Eu³⁺ (0 ≤ x ≤ 0.02) nanophosphors excited at 241 nm and monitored at 610 nm.

Eu ³⁺	Decay time τ (ms)
x = 0.001	1.42 ± 0.003
x = 0.002	1.50 ± 0.003
x = 0.005	1.54 ± 0.003
x = 0.01	1.59 ± 0.003
x = 0.02	1.61 ± 0.003

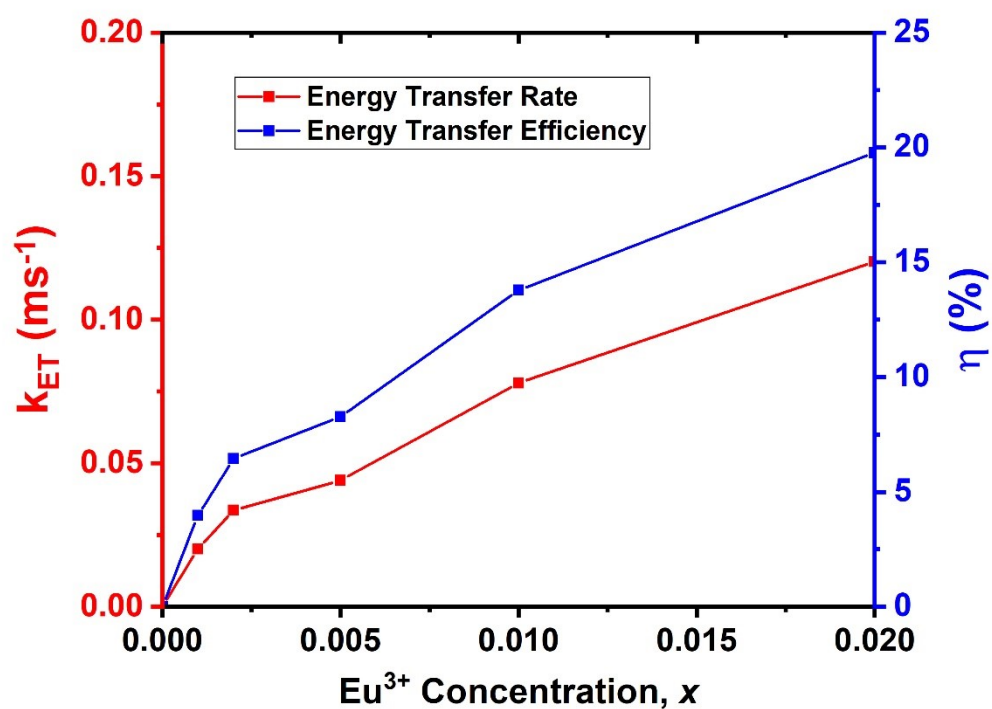


Figure S15 Variation of energy transfer rate and efficiency of YOF: 0.01 Tb³⁺, x Eu³⁺ (0 ≤ x ≤ 0.02) nanophosphors.



Figure S16 Bright-field image of LFP dusted with YOF: 0.01 Tb³⁺, 0.001 Eu³⁺ nanophosphors captured under a fluorescent lamp.