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

Supplementary

Table S1a: Number of cation cycles, thickness and growth rate for films deposited at 260 °C, with 4 p% $Yb(thd)_3$ and varying p% $VO(thd)_2$ and $Y(thd)_3$.

Pulse% $VO(thd)_2$	# Cycles	Thickness (nm)	Growth rate (pm/c)
44	5250	86	16.4 pm/c
48	5100	83	16.3 pm/c
52	5100	77	15.1 pm/c
56	5000	80	16.0 pm/c
60	5200	77	14.8 pm/c

Table S1b: Number of cation cycles, thickness and growth rate for films deposited at 260 °C, with 56 p% $VO(thd)_2$ and varying p% of $Y(thd)_3$ and $Yb(thd)_3$

Pulse% $Yb(thd)_3$	# Cycles	Thickness (nm)	Growth rate (pm/c)
0	5200	87	16.7 pm/c
1	5200	81	15.6 pm/c
2	5000	78	15.6 pm/c
4	5200	80	15.4 pm/c
6	5000	75	15.0 pm/c
8	5000	80	16.0 pm/c

Table S1c: Overview of number of cation cycles, thickness and growth rate for films deposited at 290 °C, with 50 p% $VO(thd)_2$ and varying p% of $Y(thd)_3$ and $Yb(thd)_3$

Pulse% $Yb(thd)_3$	# Cycles	Thickness (nm)	Growth rate (pm/c)
0	5200	112	21.5 pm /c
1	5200	108	20.8 pm/c
2	5200	107.5	20.6 pm/c
4	5200	105.5	20.3 pm/c
6	5200	104	20.0 pm/c

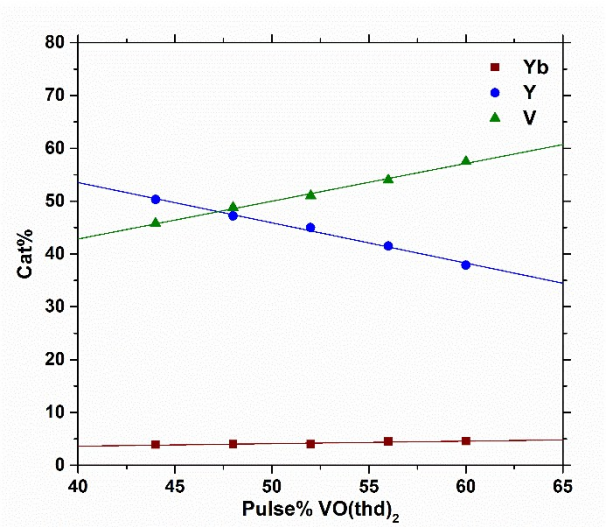

Figure S1: Cat% vs. p% $VO(thd)_2$ as determined by XRF for samples deposited at 260 °C and a fixed 4 p% $Yb(thd)_3$.

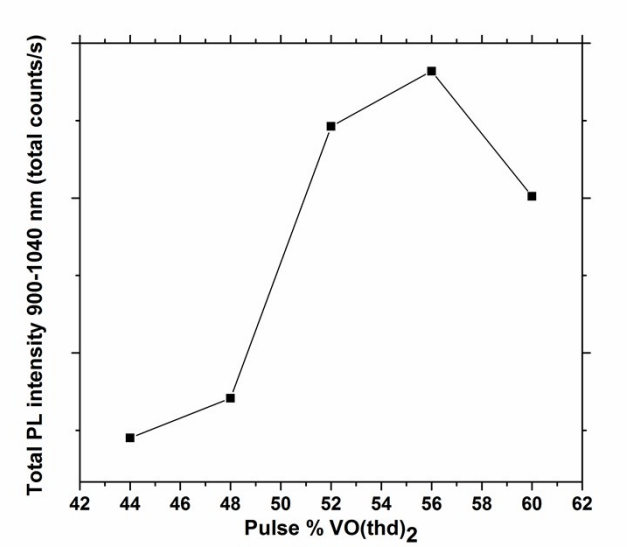

Figure S2: Total PL intensity detected in the NIR region vs. p% $VO(thd)_2$ for samples deposited at 260 °C, with a fixed 4 p% Yb and annealed at 1000 °C for 1 hour.

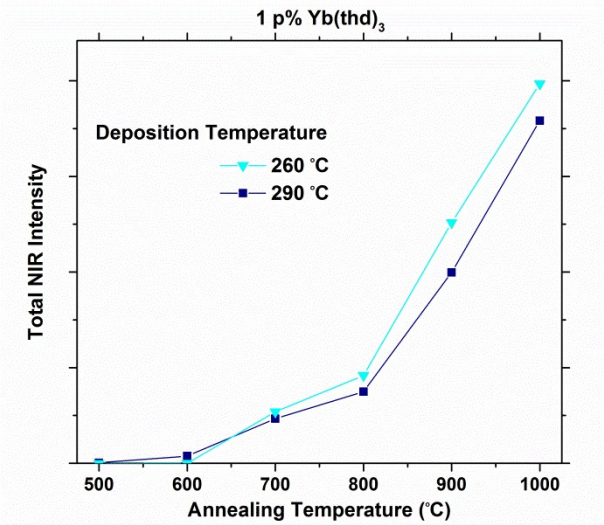

Figure S3: Total PL intensity detected in the NIR region vs. annealing temperature for samples with 1 p% Yb, deposited at 260 °C and 290 °C.

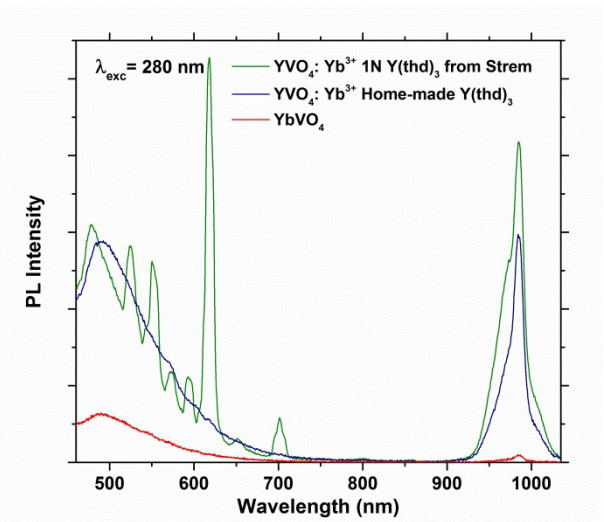

Figure S4: Comparison between samples with $Y(thd)_3$ precursor from Strem Chemicals (green) and home-made (blue). The red spectrum shows that samples without any yttrium do not exhibit peaks from impurities.

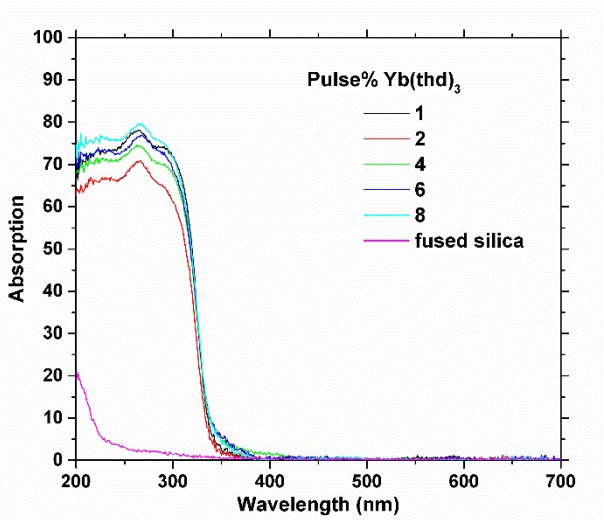

Figure S5: UV-Vis measurements of samples with 1-8 p% Yb deposited on fused silica at 260 °C and annealed at 1000 °C.

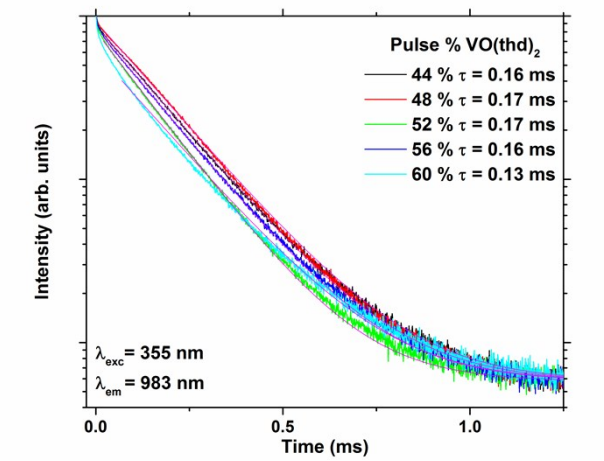

Figure S6: PL decay measurement of samples with 4 p% Yb and varying pulse% $VO(thd)_2$ and $Y(thd)_3$.

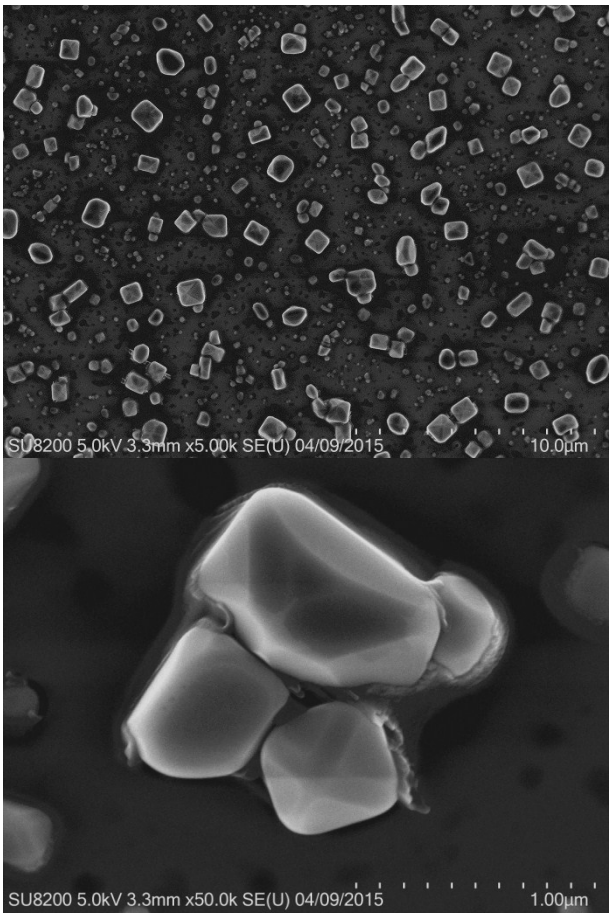

Figure S7: FE-SEM images of samples with 75 p% $VO(thd)_2$, 21 p% $Y(thd)_3$ and 4 p% $Yb(thd)_3$, deposited with $Y(thd)_3$ precursor from Strem Chemicals and responsible for the PL emission (green) in **Figure S2**.

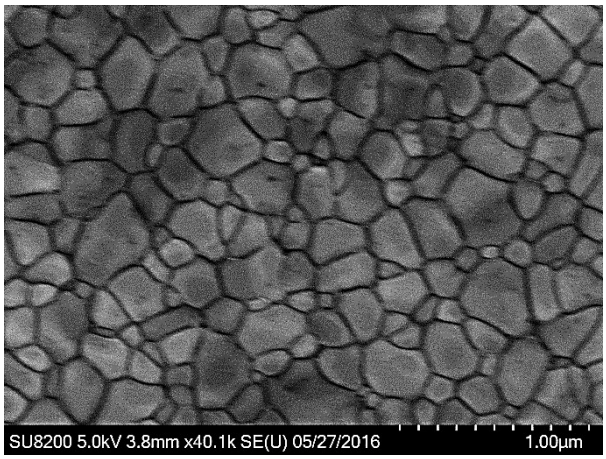

Figure S8: A sample with slightly less than 4 nm layers of YVO_4:$YbVO_4$ annealed at 800 °C for 10 min.

S9: Quantum Efficiency Measurement

The quantum efficiency of the YVO_4: 1 p% Yb phosphor was determined by using the overlapping spectral region of 795-825 nm of the two PMTs used to detect the visible and NIR emission. The emission of the Xe lamp was recorded with each detector at three different wavelengths using the same slits within this region and corrected using the correction file for the integrating sphere and the two detectors. Comparing the total recorded emission revealed a strong correlation between the two measurements, i.e. the PMT used to record visible emission is ~4.6 times more sensitive after taking the correction files into account. In order to compare the emission recorded by the two detectors, the emission detected by the NIR detector was multiplied by 4.6. The quantum efficiency measurement could then be conducted normally by measuring the UV emission escaping the sphere with and without the sample, followed by measuring the escaped visible and NIR emission and calculating the fraction of the absorbed UV light that produces emission.