

Supplementary material

1. Synthesis of the 18Yb/2Er-doped NaYF₄ nanocrystals

The NaYF₄: Yb³⁺(18 mol%)/Er³⁺(2 mol%), nanocrystalline powder of around 50-60nm size sample were prepared by using a hybrid sol-gel/thermal decomposition route outlined in: C. Bartha, C. E. Secu, E. Matei, M. Secu, Crystallization kinetics mechanism investigation of sol-gel-derived NaYF₄:(Yb,Er) up-converting phosphors, **Cryst. Eng. Comm.** **19** (2017) 4992-5000.

2. X-ray Diffraction

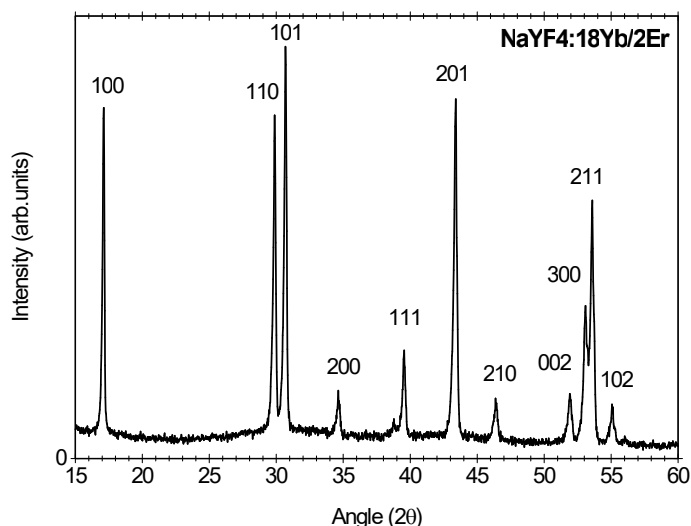


Figure XRD pattern of the β-NaYF₄: Yb³⁺(18 mol%)/Er³⁺(2 mol%) nanocrystals (JCPDS 28-1192) obtained after calcination at T=500 °C with the peaks assignment.

3. Optical reflectance

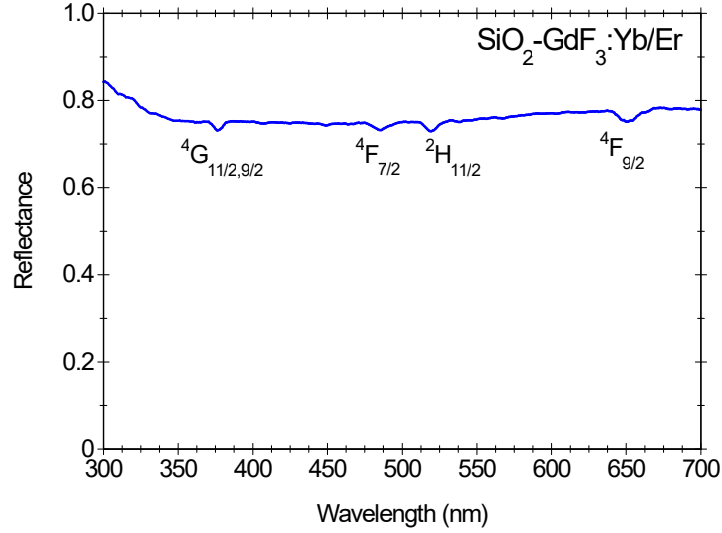


Figure Reflectance spectrum recorded on GCLiYb/Er glass ceramic (after 525 °C annealing)

4. UP-conversion luminescence

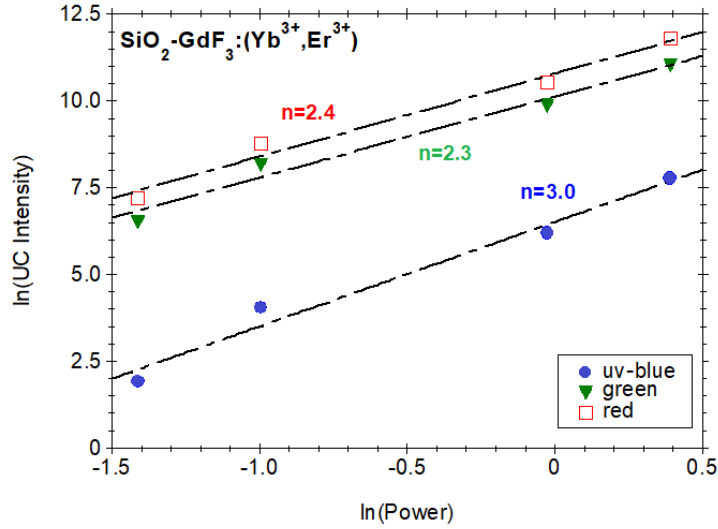


Figure. Double logarithmic plot of luminescence intensity vs. incident laser power for the uv-blue ($^2H_{9/2} \rightarrow ^4I_{15/2}$), green ($(^2H_{11/2}, ^4S_{3/2}) \rightarrow ^4I_{15/2}$) and red ($^4F_{9/2} \rightarrow ^4I_{15/2}$) UC luminescences.

The quantitative measurement of absolute quantum yield QY of the up-conversion were performed by using the method proposed by J.C. Boyer et al. [35] - the measurements set-up is shown below. For the UC luminescence excitation, we used a 200 mW laser module centered at 980nm, focused to a spot of about 2 mm². The luminescence signal was acquired by using a 50mm diameter Thorlab integrating sphere coupled to a commercial spectrophotometer (Ocean Optics usb2000) sensitive in the 370-1050 nm spectral range, through an optical fiber. The absolute quantum yield QY is given by “QY=L_{sample}/(E_{reference} -E_{sample})”, where L_{sample} is the emission intensity of the sample and

$E_{\text{reference}}$ and E_{sample} are the intensities of the excitation light recorded on the reference and sample, respectively [34].

We obtained QY of $0.2 \pm 0.1\%$ for GCLiYb/Er glass ceramic and $0.3 \pm 0.1\%$ for the β -NaYF₄:18Yb/2Er.

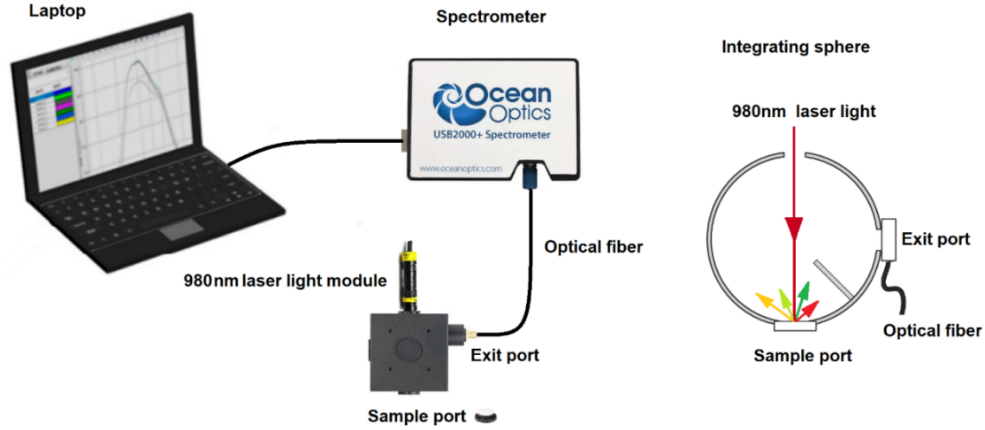


Figure The scheme of the experimental set-up used for the UC luminescence efficiency QY measurements.

4. Colorimetry analysis

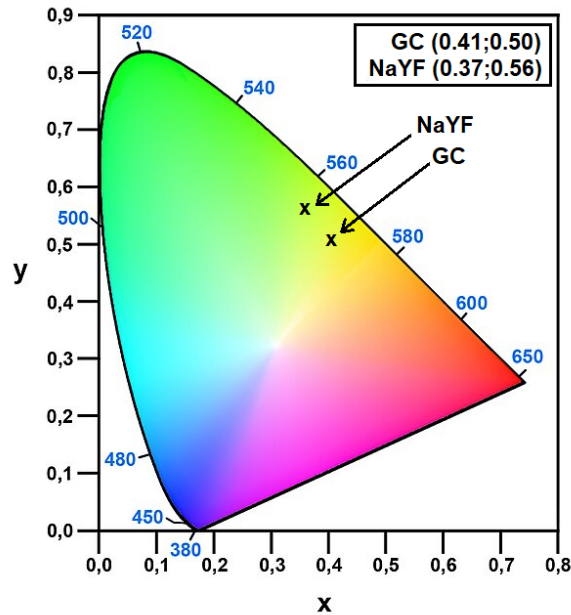


Figure The chromaticity coordinates according to the Commission Internationale de l'Eclairage (CIE) 1931 chromaticity diagram

The colorimetry analysis showed different slightly different parameters due to the stronger “red” luminescence component shown by GCLiYb/Er compared to the β -NaYF₄:18Yb/2Er phosphor.