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

Supporting Information

Blue-light-excitable pure and efficient short-wave infrared luminescence via Cr^{3+}→Yb^{3+} energy transfer in $KYbP_2O_7$:Cr^{3+} phosphor

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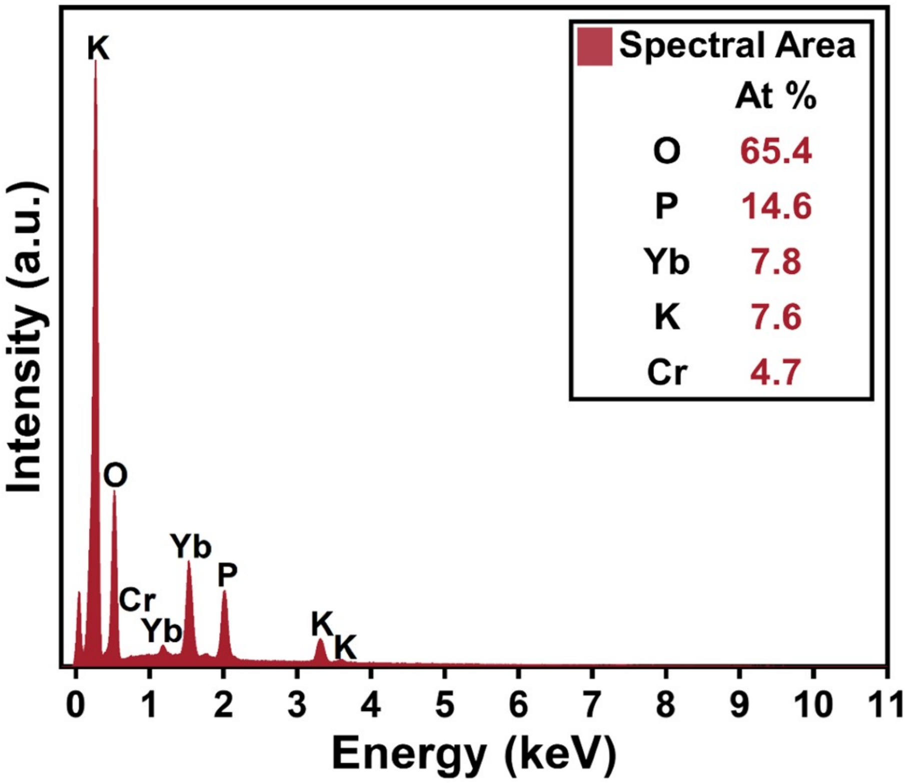

Fig. S1 EDS spectrum of the $KYbP_2O_7$:0.01Cr^{3+} phosphor.

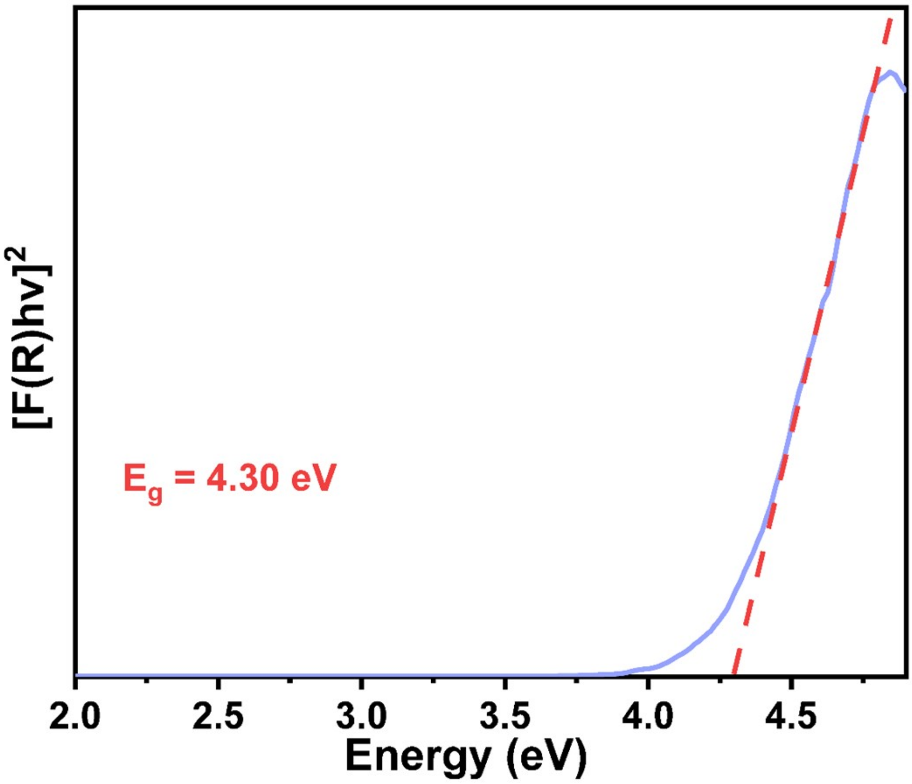

Fig. S2 Calculated Kubelka−Munk absorption spectrum.

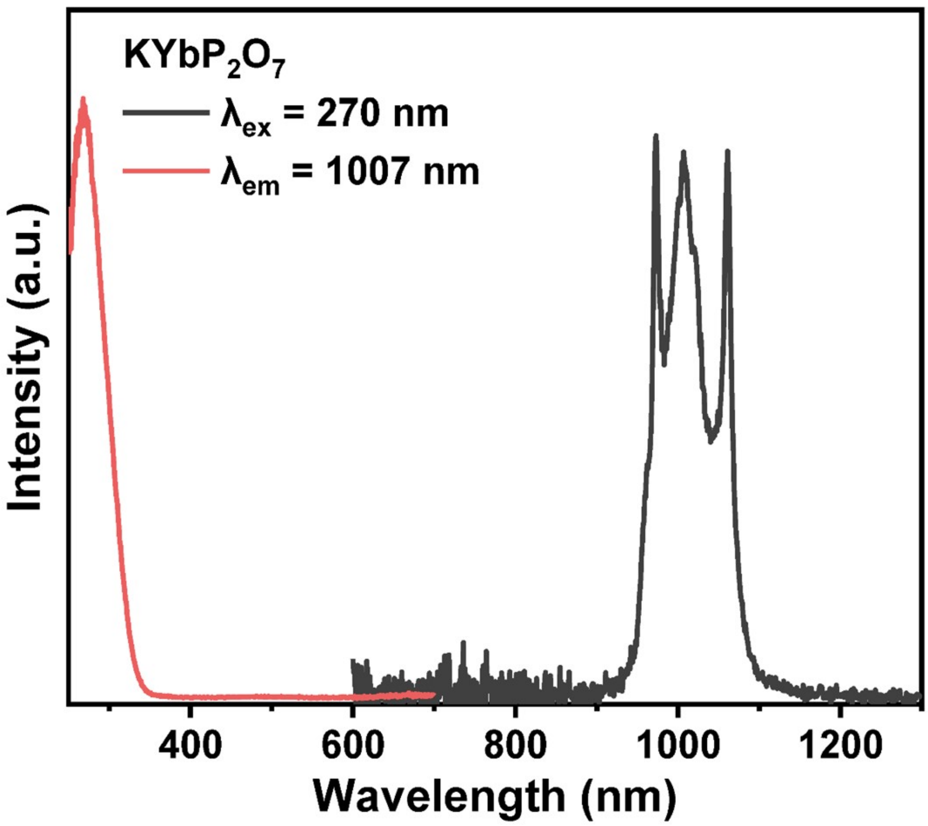

Fig. S3 Excitation and emission spectra of the $KYbP_2O_7$.

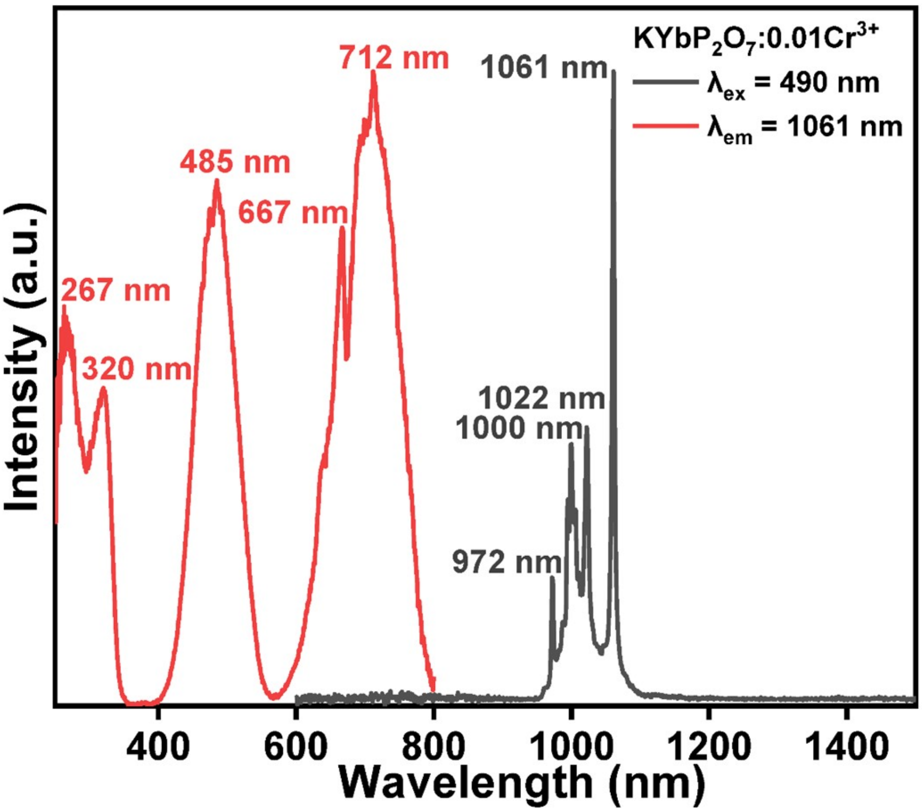

Fig. S4 Excitation and emission spectra of the $KYbP_2O_7$:$0.01Cr^{3+}$ phosphor at 77 K.

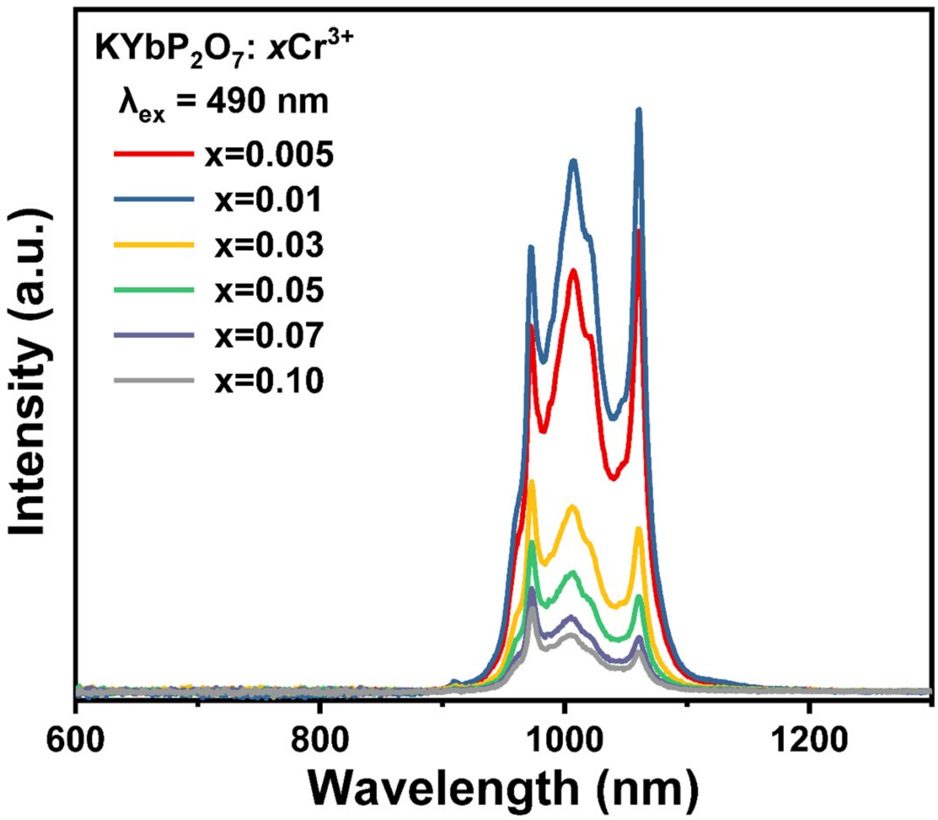

Fig. S5 Photoluminescence spectra of the $KYbP_2O_7$:xCr^{3+} (x = 0.005–0.10) phosphors upon 490 nm excitation.

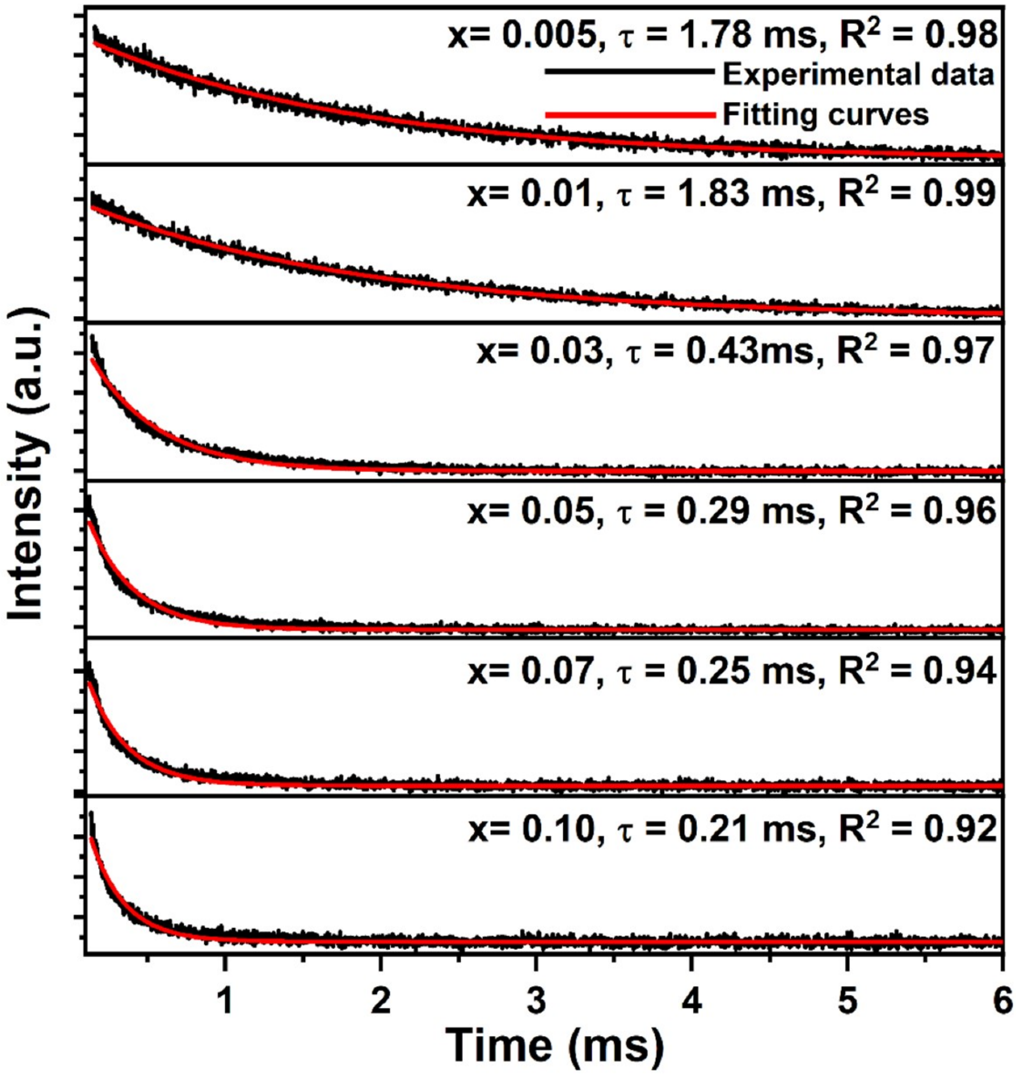

Fig. S6 Luminescence decay curves and the fitting data of the $KYbP_2O_7$:$x$$Cr^{3+}$ phosphor (λ_{ex} = 490 nm, λ_{em} = 1007 nm). All the decay curves can be fitted by a single exponential function.

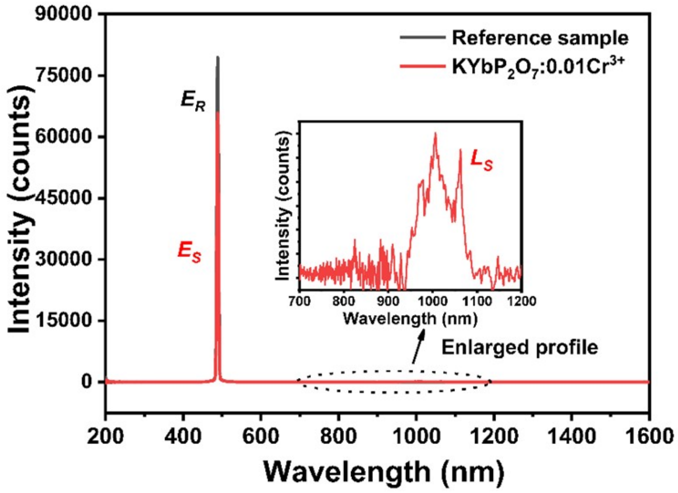

Fig. S7 The excitation line of $BaSO_4$ and the emission spectrum of the $KYbP_2O_7$:0.01Cr^{3+} phosphors collected using an integrating sphere. The inset shows a magnification of the emission spectrum. The internal quantum efficiency (IQE) refers to the ratio of the emitted photons to the absorbed photons, which can be calculated by the following equation:

$$\eta_{IQE} = \frac{\int L_S}{\int E_R - \int E_S} \times 100\%$$

where L_S is the emitted photons of the sample, E_S is the number of photons of the light to excite the sample and E_R is the numbers of the reflected photons of $BaSO_4$ reference. The measured IQE is determined to be 51.4%.

The absorption efficiency refers to the percentage of the ratio of absorbed photons of the sample to the photons of the excitation light, which can be calculated by the following equation:

$$AE = \frac{\int E_R - \int E_S}{\int E_R}$$

The external quantum efficiency (EQE) refers to the ratio of the number of emitted photons of the sample to the number of photons of the light to excite the sample:

$$EQE = IQE \times AE \times 100\%$$

The measured QE, AE, and EQE of the $KYbP_2O_7$:0.01Cr^{3+} phosphor are determined to be 51.4%, 17.1%, and 8.8%, respectively.

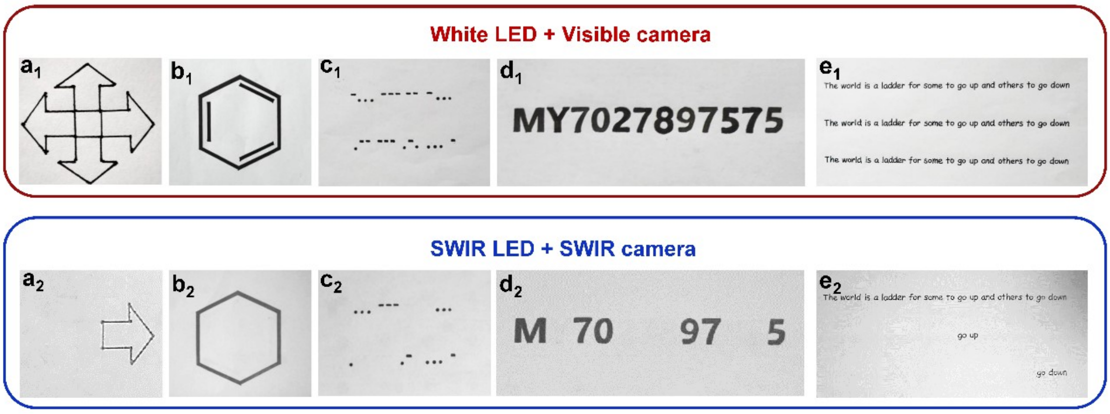

Fig. S8 (a_1–e_1) Visible images taken by a digital camera under indoor ambient light. (a_2–e_2) SWIR images taken by a SWIR camera under the illumination of the fabricated SWIR LED.

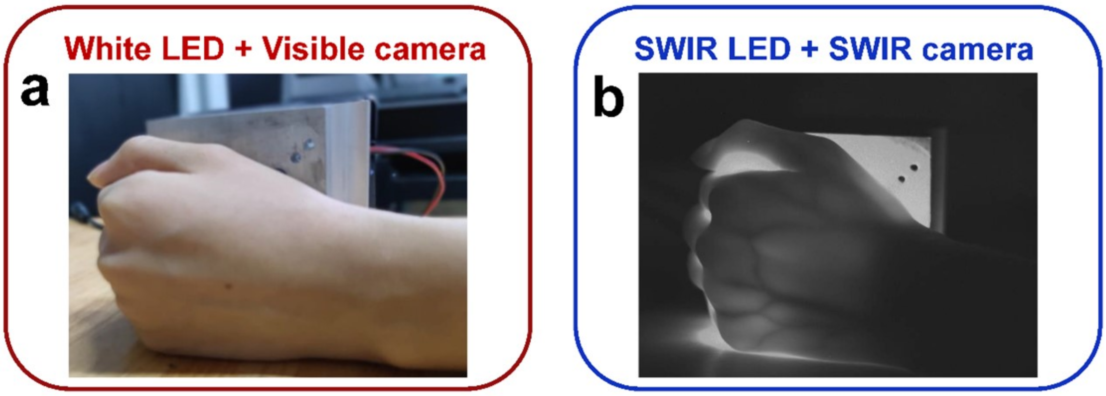

Fig. S9 Transmission photographs of the veins in the palm taken with a digital camera under indoor ambient light (a) and a SWIR camera under the illumination of the fabricated SWIR LED (b).

Table S1. Refined structural parameters and cell parameter values of $KYbP_2O_7$:0.01Cr^{3+} phosphor from Rietveld refinement.

Formula		$KYbP_2O_7$	
Crystal system		monoclinic	
Space group		$P2_1/c$	
Cell parameters	a = 7.5490 Å	b = 10.8264 Å	c = 8.5466 Å
	Alpha = 90	Beta = 106.714	Gamma = 90
Cell volume		668.991 $Å^3$	
Reliability factors	R_p = 5.18%	R_{wp} = 7.89%	χ^2 = 5.988

Atom	x	y	z
Yb	0.23307	0.09613	0.75138
K	0.81974	0.31524	0.43526
P1	0.13493	0.40198	0.81268
P2	0.44901	0.35395	0.69187
O1	0.12562	0.41023	0.9836
O2	0.06791	0.26758	0.72500
O3	0.01747	0.50908	0.71483
O4	0.33688	0.44025	0.80655
O5	0.34406	0.37694	0.51565
O6	0.63183	0.41278	0.74493
O7	0.46204	0.21687	0.73402