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

Supporting information

A NIR phosphor with Ultra-broadband emission enabled by dual Energy transfer within two Cr^{3+} emitters and Cr^{3+}→Yb^{3+}

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Supplementary Notes:

The PL decay curves were fitted using bi (n = 2) exponential functions:

$$I = \sum_{i=1}^{n} I_0 exp\left(-\frac{t}{\tau}\right)$$

where I represent luminescence intensity, t denotes lifetime, and τ refers to decay time for different components. The PL average lifetime τ can be calculated by the following formula:

$$\tau = \frac{A_1\tau_1^2 + A_2\tau_2^2}{A_1\tau_1 + A_2\tau_2}$$

where A_1 and A_2 are the corresponding fitting constants; τ_1 and τ_2 are the decay time for different components. With the increase of Cr^{3+} dopant concentration, the fluorescence decay time gradually decreases from 200.72 ns to 16.00 ns, proving that energy transfer occurs between Cr^{3+} ions.

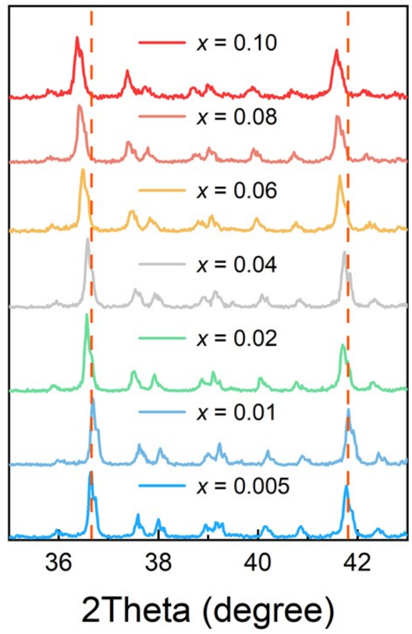

Figure S1. Enlarged XRD patterns of the SSAO:xCr^{3+} (x = 0.005 - 0.10) samples (35°-43°).

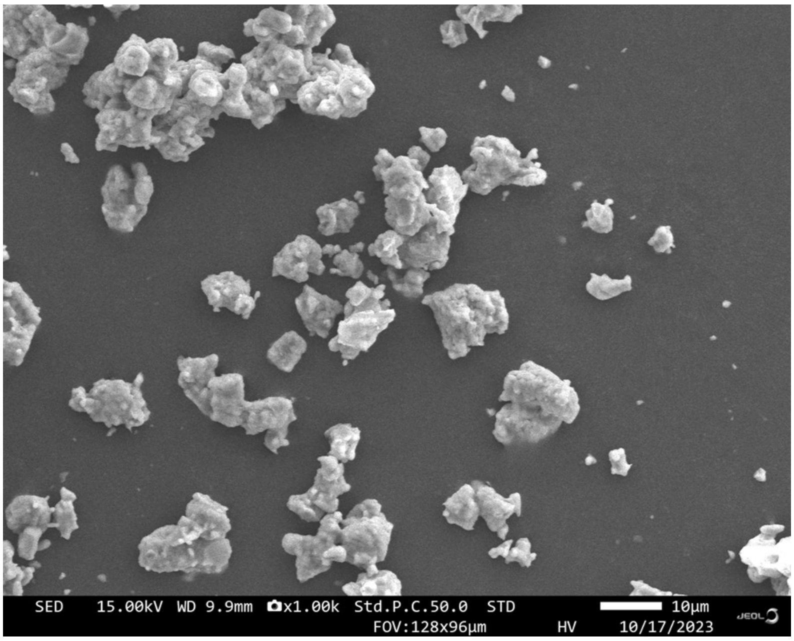

Figure S2. SEM image of SSAO:$0.02Cr^{3+}$,$0.01Yb^{3+}$ phosphor.

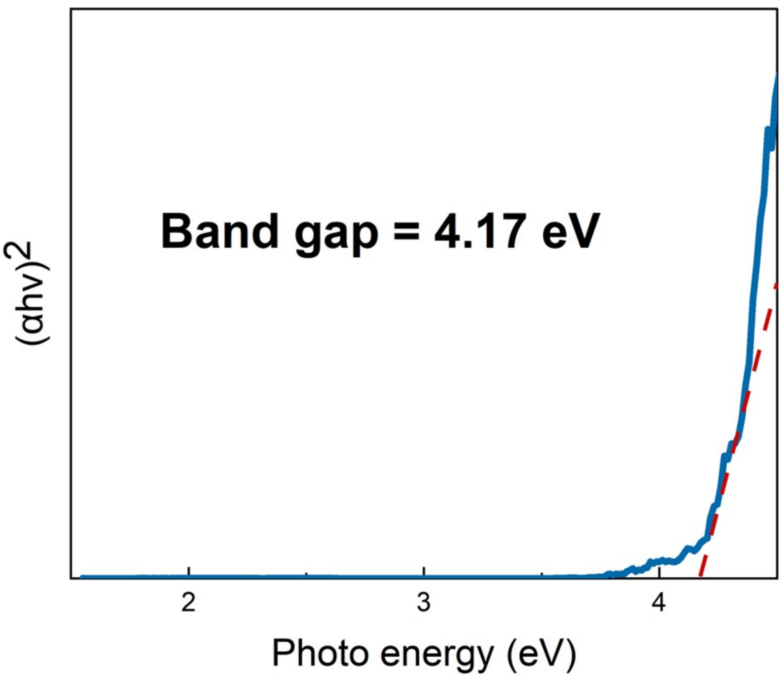

Figure S3. the plot of $(\alpha h\upsilon)^2$ vs photon energy $h\upsilon$ for SSAO.

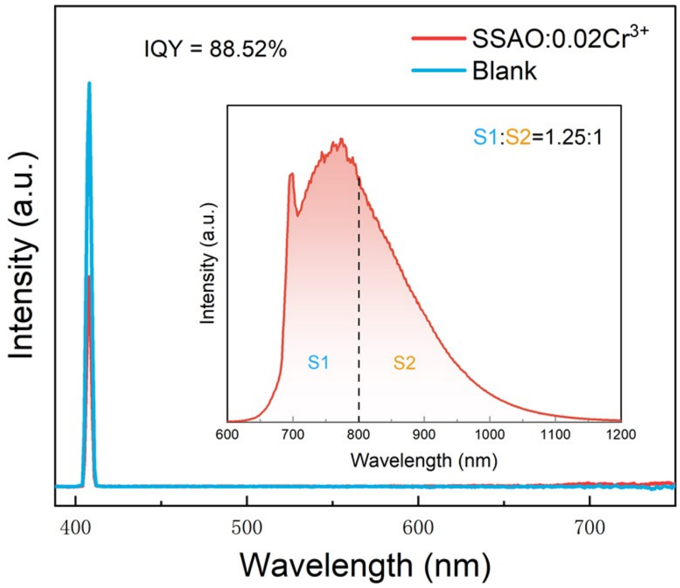

Fig S4. IQY of SSAO:0.02Cr^{3+} phosphor.

The absorption efficiency (ξabs), internal quantum efficiency (IQE), and external quantum efficiency (EQE) can be respectively calculated by the following formula:

$$\xi_{abs} = \frac{\int E_R - \int E_s}{\int E_R}$$

$$IQE = \frac{\int L_s}{\int E_R - \int E_s}$$

$$EQE = IQE \times \xi_{abs}$$

where $\int L_s$ represents the integral area of emission spectrum, $\int E_R$ and $\int E_s$ represent the integral area of excitation spectrum without and with the phosphor in the integrating sphere, respectively. As shown in the Figure S4, S1 and S2 area ratio of approximately 1.25:1, the values of IQE, ξabs and EQE of and SSAO:0.02Cr^{3+} are calculated to be 88.52%, 48.14% and 42.61% under 408 nm excitation, respectively.

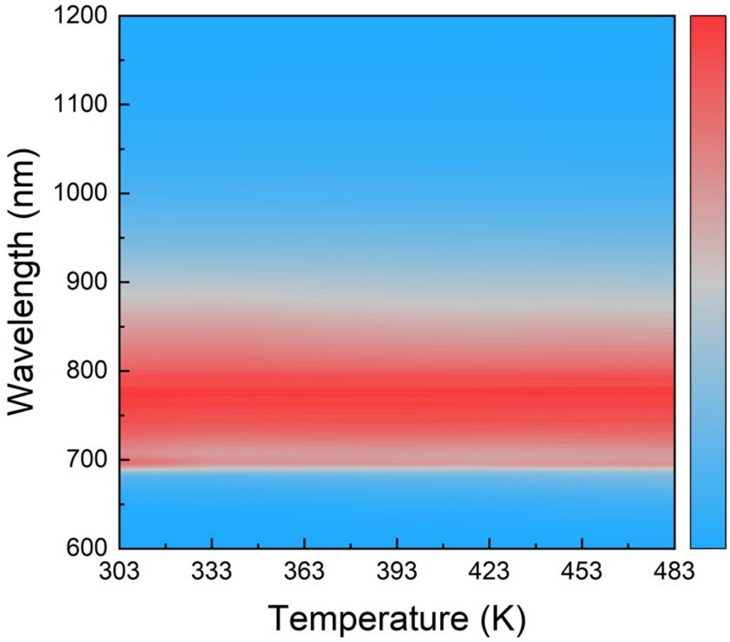

Fig S5. Normalized emission spectra as a function of temperature.

Table S1. Refined structural data of SSAO samples.

Samples	Cell parameters (Å)			Volume ($Å^3$)	R_{wp}, R_p, (%), χ^2
	a	b	c		
SSAO	15.149682	11.194379	4.906047	790.752	8.245, 5.82, 1.854
SSAO:0.02Cr^{3+}	15.160907	11.200595	4.911974	792.63	8.04, 5.63, 1.823
SSAO:0.02Cr^{3+}, 0.01Yb^{3+}	15.155392	11.201921	4.912127	792.494	8.4, 5.925, 1.847