SUPPORTING INFORMATION

Controlling of Structural Ordering and Rigidity of *β*-SiAlON:Eu through Chemical Cosubstitution to Approach Narrow-Band-Emission for Light-Emitting Diodes Application

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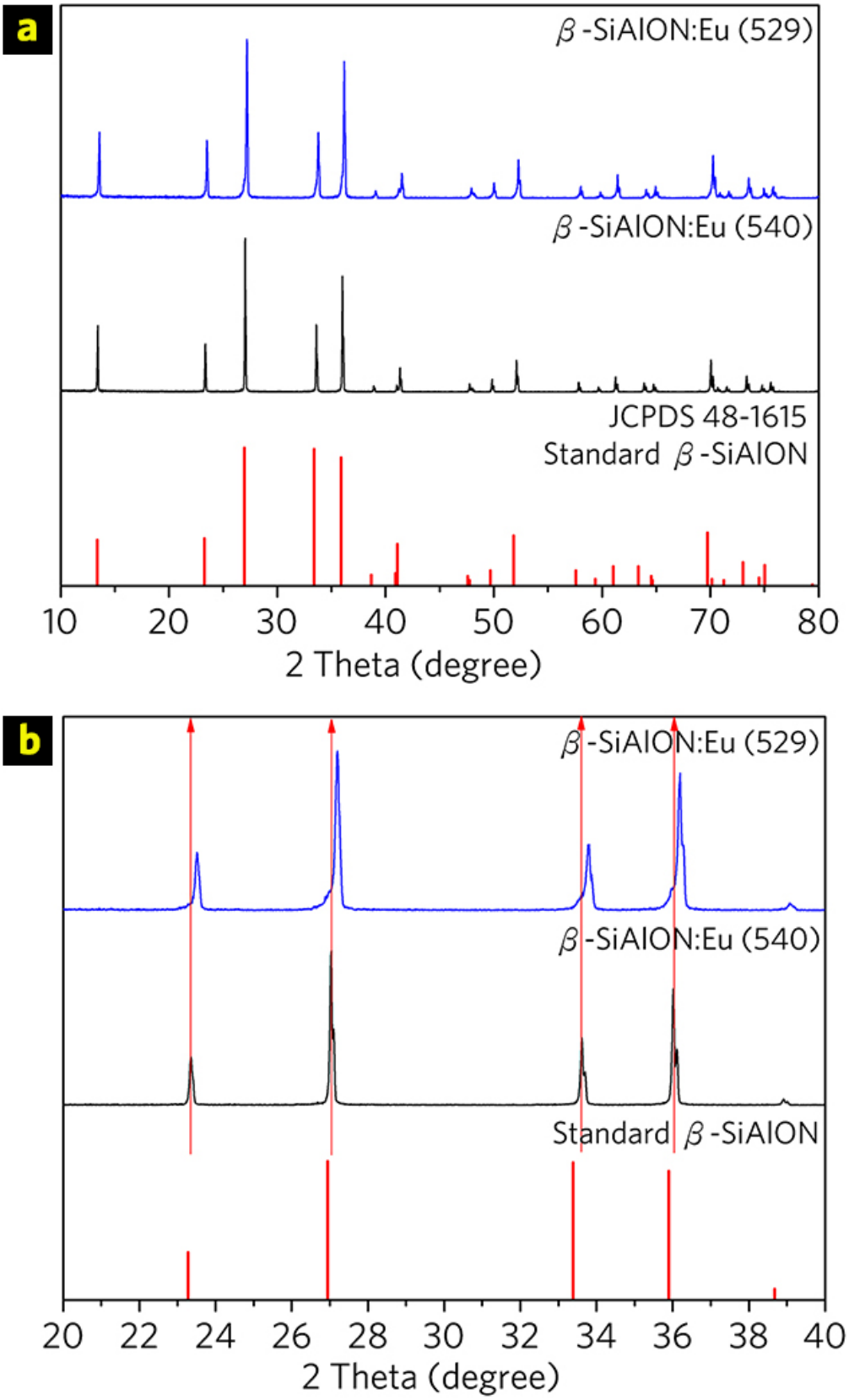

Figure S1. XRD patterns of *β*−SiAlON:Eu (529) and *β*-SiAlON:Eu (540) green-emitting phosphors.

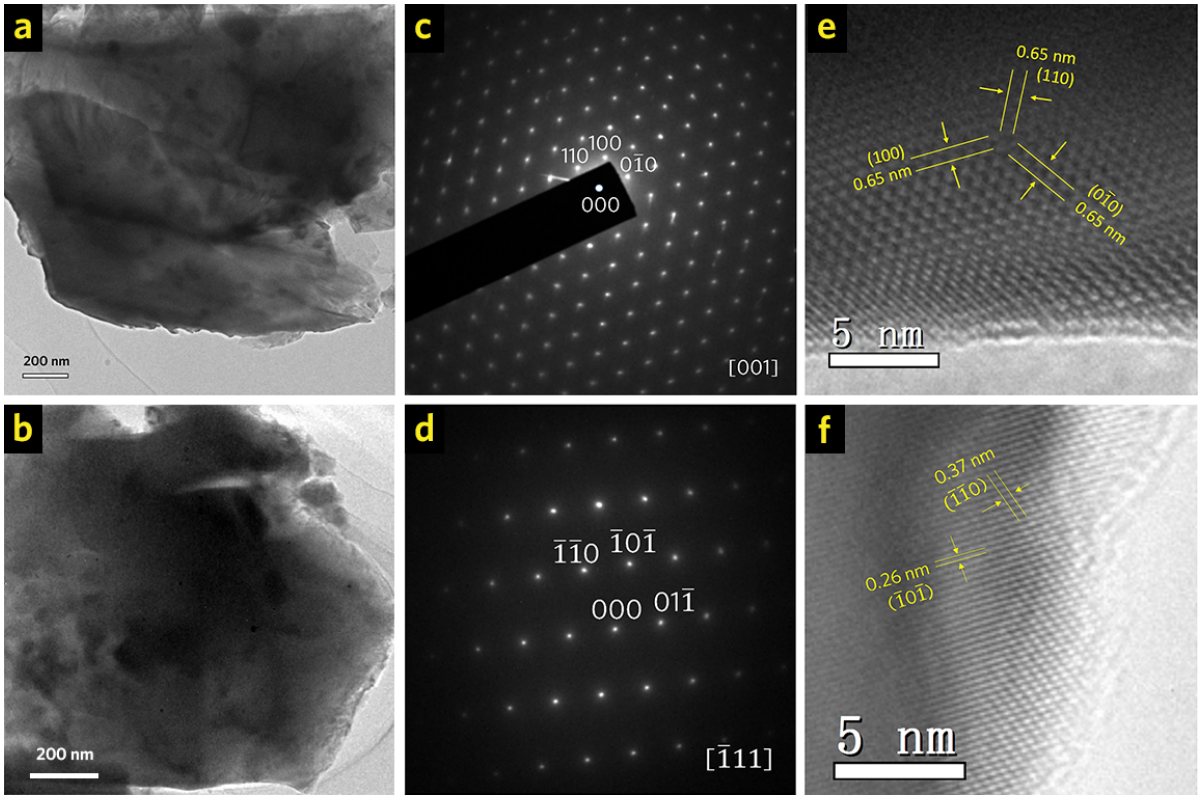

Figure S2. TEM, SAED, and HR-TEM images of *β*-SiAlON:Eu (529) (a,c,e) and *β*-SiAlON:Eu (540) (b,d,f).

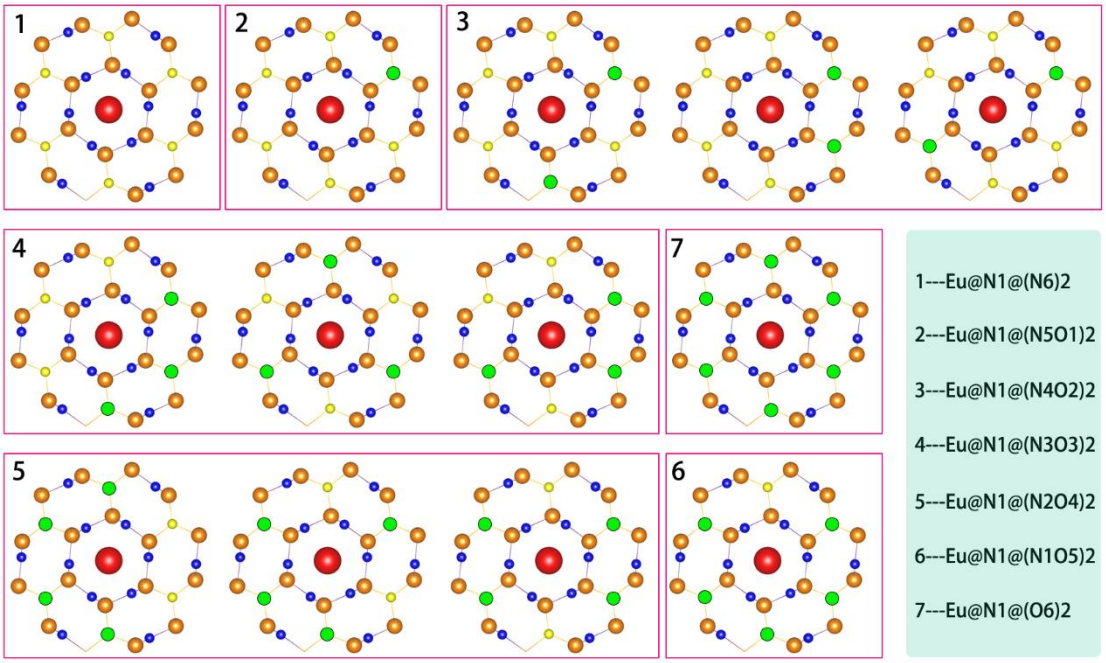

Figure S3. Possible microenvironments around Eu^{2+} in the channel viewed in *c*-direction.

Table S1. Crystallographic Details of *β*-SiAlON:Eu (529) and *β*-SiAlON:Eu (540) from Neutron Rietveld Refinement

β-SiAlON:Eu (529)[a] (space group = $P6_3/m$) $a = b = 7.6056(1)$ Å and $c = 2.9084(1)$ Å, $\alpha = \beta = 90°$, $\gamma = 120°$, V = 145.697(4) Å^3						
atom	site	*x*	*y*	*z*	Occ.	B_{iso}/ Å^2
Si	*6h*	0.1751(2)	0.7666(2)	1/4	0.995	0.12(1)
Al	*6h*	0.1751(2)	0.7666(2)	1/4	0.005	0.12(1)
N1	*6h*	0.3309(1)	0.0311(0)	1/4	1	0.140(5)
N2	*2c*	1/3	2/3	1/4	0.985(5)	0.09(1)
O2	*2c*	1/3	2/3	1/4	0.015(5)	0.09(1)
Eu	*2a*	0	0	1/4	0.003357	0.11(1)

[a] $R_{wp} = 5.789\%$, $R_p = 4.667\%$, $x^2 = 2.731$.

β-SiAlON:Eu (540)[b] (space group = $P6_3/m$) $a = b = 7.6121(1)$ Å and $c = 2.9116(1)$ Å, $\alpha = \beta = 90°$, $\gamma = 120°$, V = 146.105(3) Å^3						
atom	site	*x*	*y*	*z*	Occ.	B_{iso}/ Å^2
Si	*6h*	0.1740(1)	0.7668(2)	1/4	0.968	0.12(1)
Al	*6h*	0.1740(1)	0.7668(2)	1/4	0.032	0.12(1)
N1	*6h*	0.3308(1)	0.03090(7)	1/4	1	0.167(4)
N2	*2c*	1/3	2/3	1/4	0.91(2)	0.07(1)
O2	*2c*	1/3	2/3	1/4	0.09(2)	0.07(1)
Eu	*2a*	0	0	1/4	0.000193	0.11(1)

[b] $R_{wp} = 3.485\%$, $R_p = 2.767\%$, $x^2 = 2.027$.

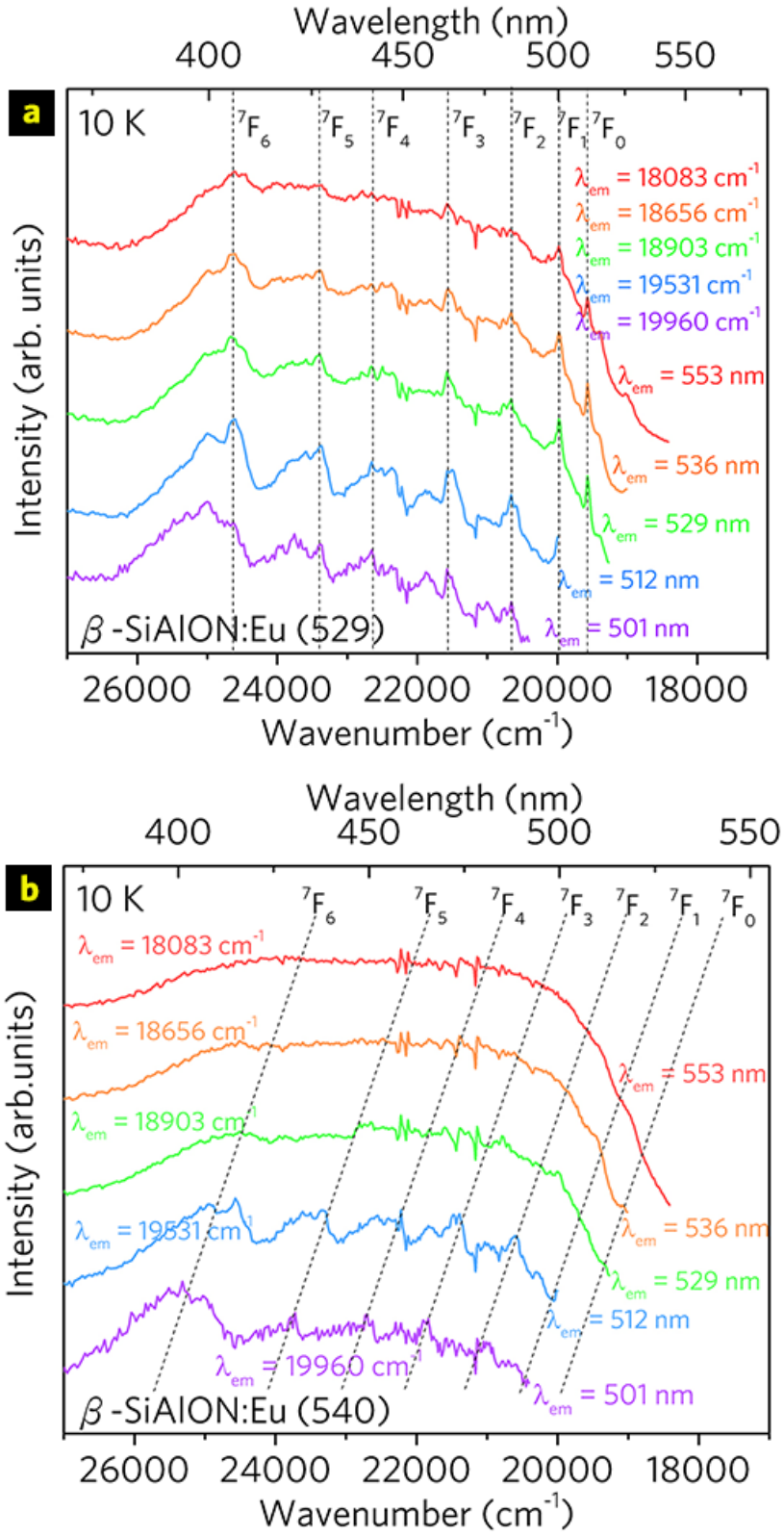

Figure S4. PLE spectra of β-SiAlON:Eu (529) and β-SiAlON:Eu (540) green-emitting phosphors at 10 K.

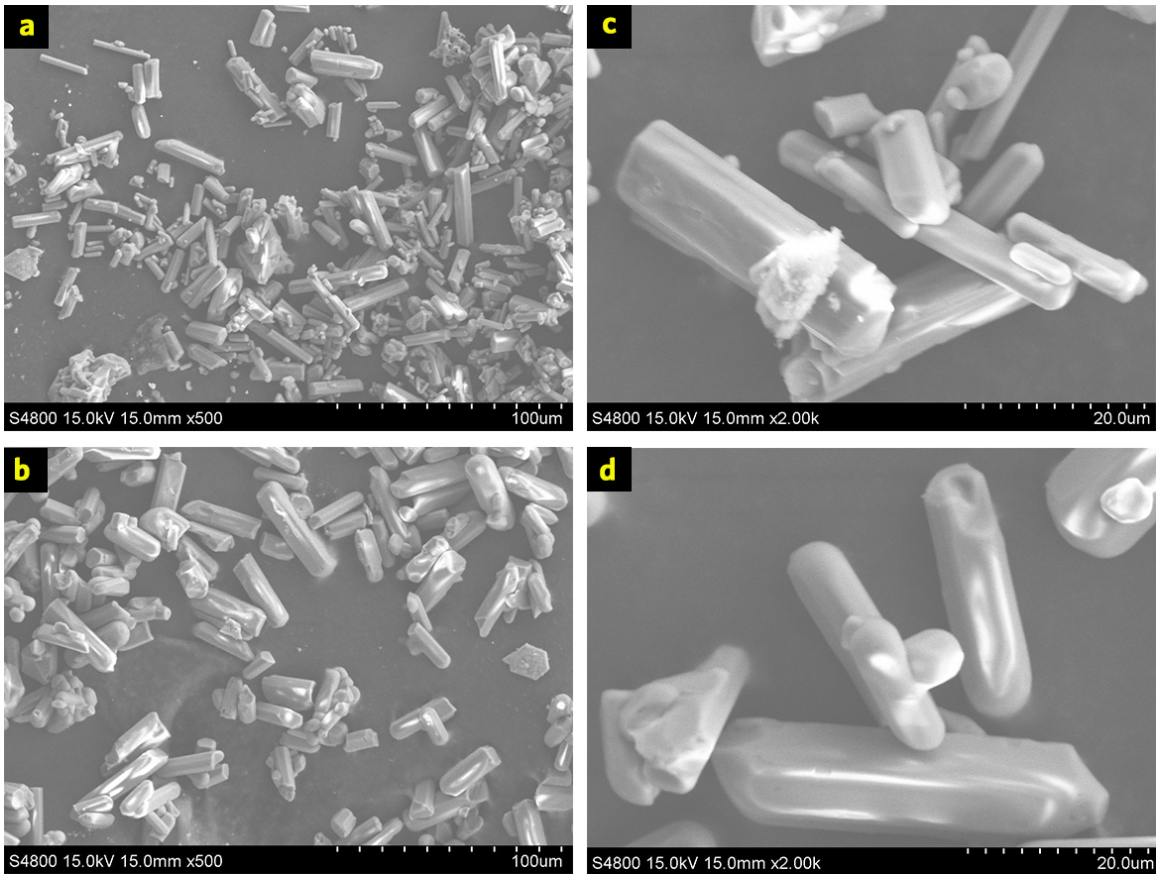

Figure S5. SEM images of *β*-SiAlON:Eu (529) (a, c) and *β*-SiAlON:Eu (540) (b,d) green-emitting phosphors.

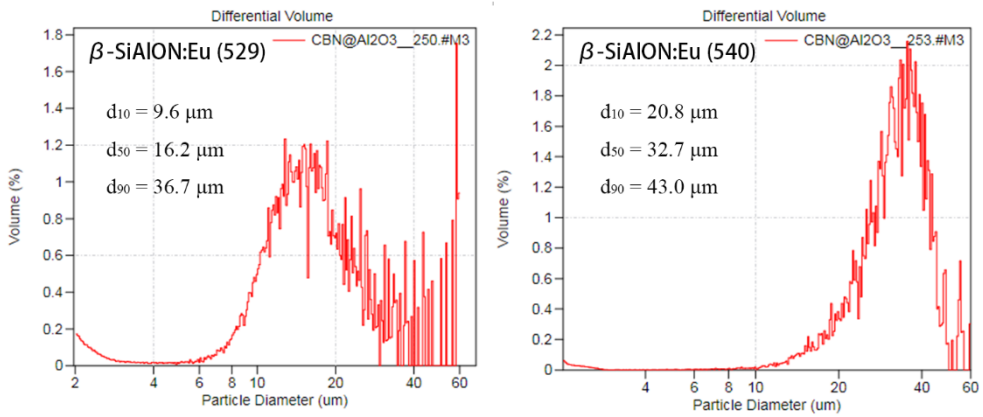

Figure S6. Particle size data of *β*-SiAlON:Eu (529) and *β*-SiAlON:Eu (540) green-emitting phosphors.

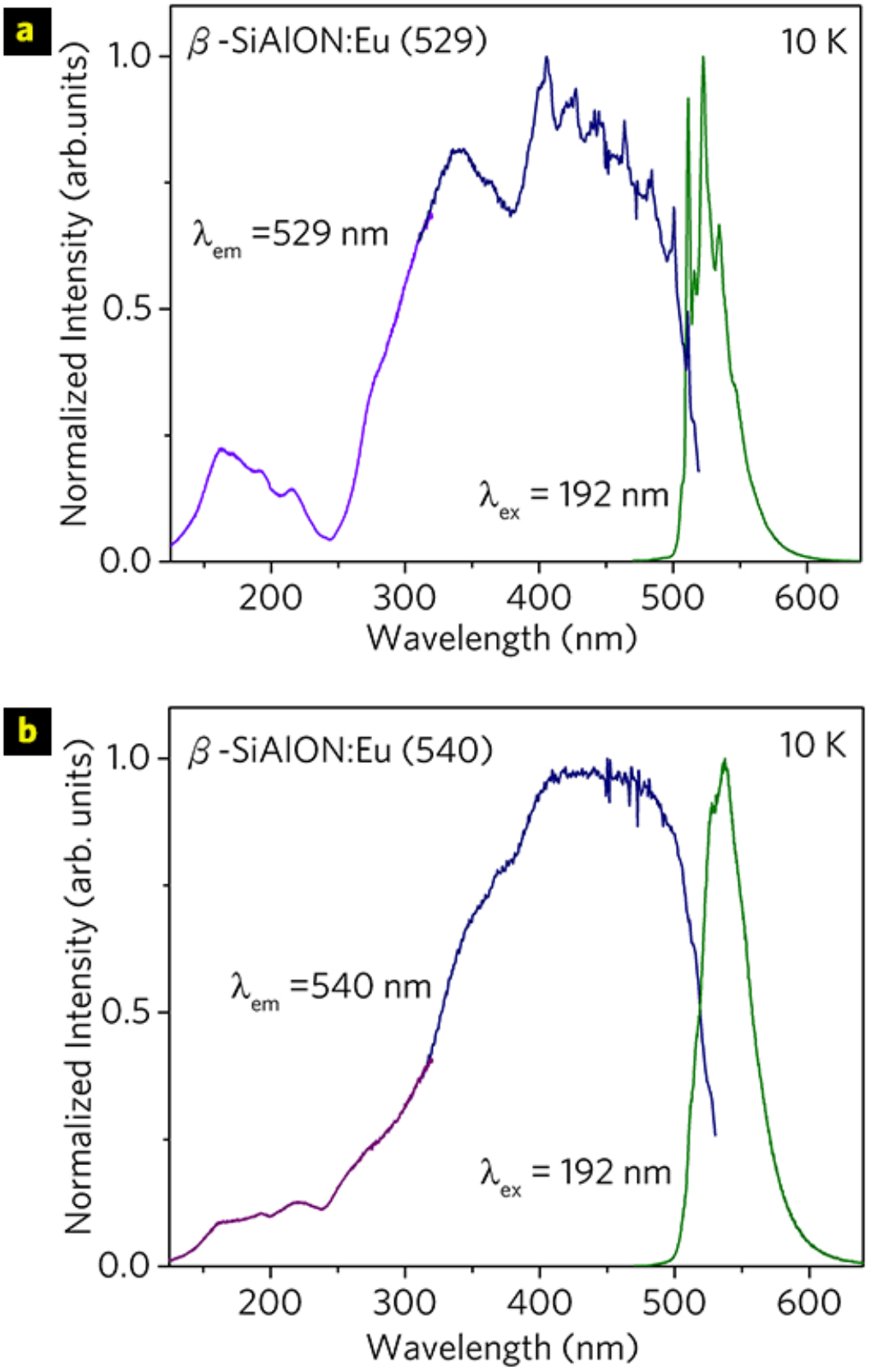

Figure S7. VUV photoluminescence spectra of *β*-SiAlON:Eu (529) and *β*-SiAlON:Eu (540) green-emitting phosphors at 10 K.

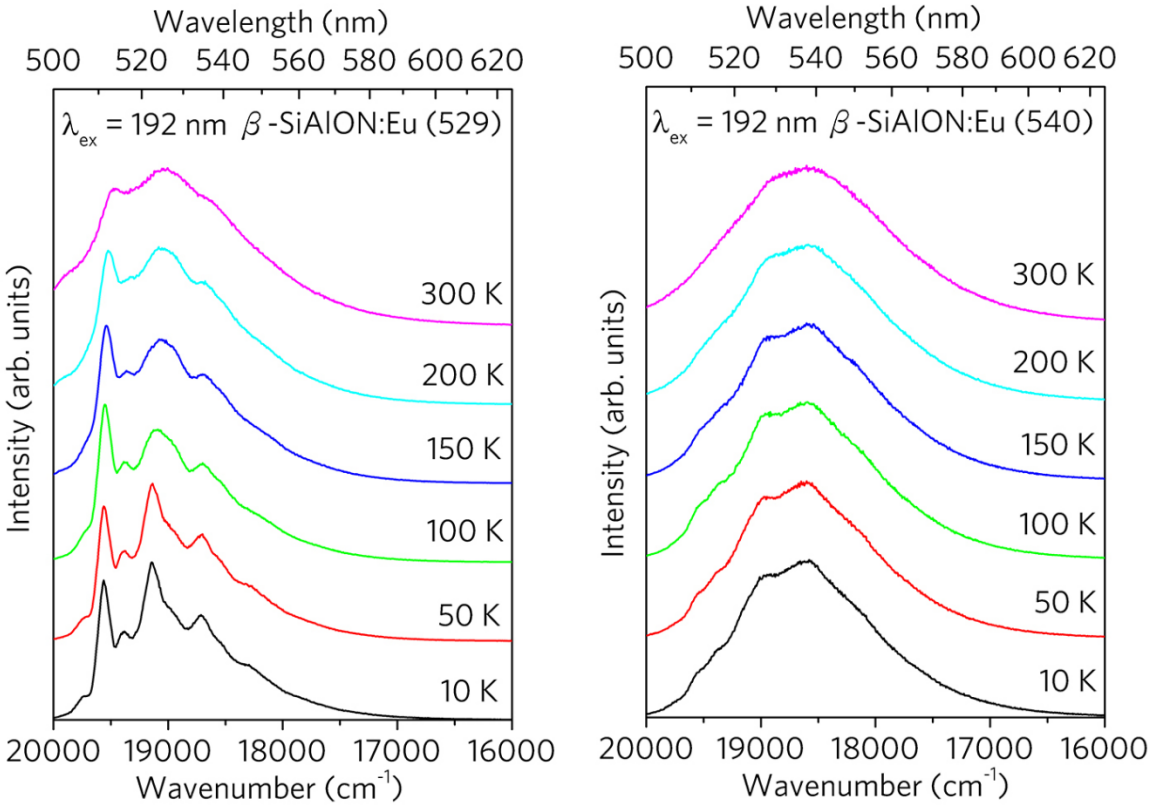

Figure S8. Temperature-dependent emission spectra of *β*-SiAlON:Eu (529) and *β*-SiAlON:Eu (540) oxynitride phosphors under 192 nm excitation, respectively.

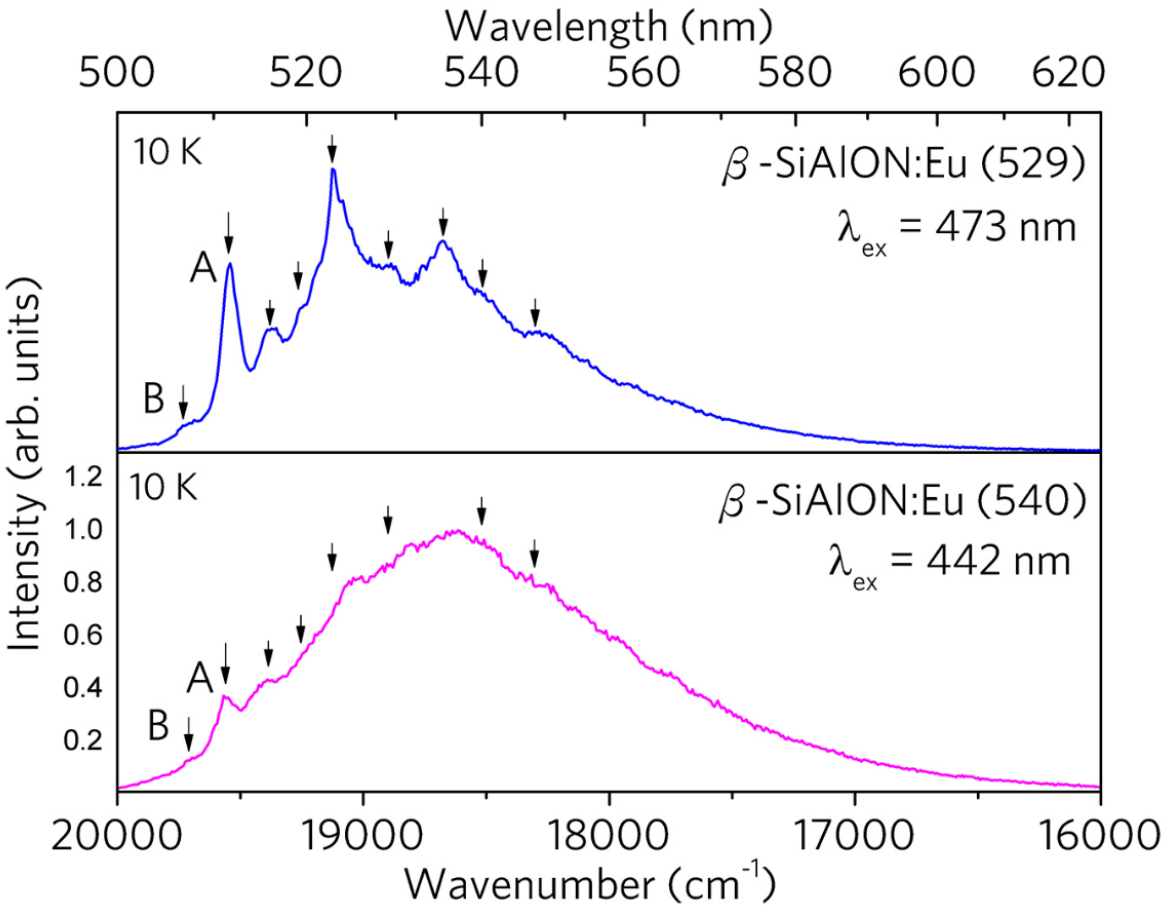

Figure S9. Monitored wavelengths in PL spectra of *β*-SiAlON:Eu (529) and *β*-SiAlON:Eu (540) green-emitting phosphors.

Table S2. Lifetimes of β-SiAlON:Eu (529) and β-SiAlON:Eu (540) green-emitting phosphors as a function of wavelength.

	β-SiAlON:Eu (529) (μs)	β-SiAlON:Eu (540) (μs)
507 nm (19701 cm^{-1})	0.73	0.5
512 nm (19538 cm^{-1})	0.86	0.59
517 nm (19326 cm^{-1})	0.94	0.68
520 nm (19235 cm^{-1})	0.90	0.73
523 nm (19119 cm^{-1})	0.97	0.79
536 nm (18671 cm^{-1})	1.06	1.06
539 nm (18538 cm^{-1})	1.13	1.1
546 nm (18305 cm^{-1})	1.15	1.17

Note: All of the decay curves were single exponential and the decay times, presented in Table S2, were calculated from single exponential fit.

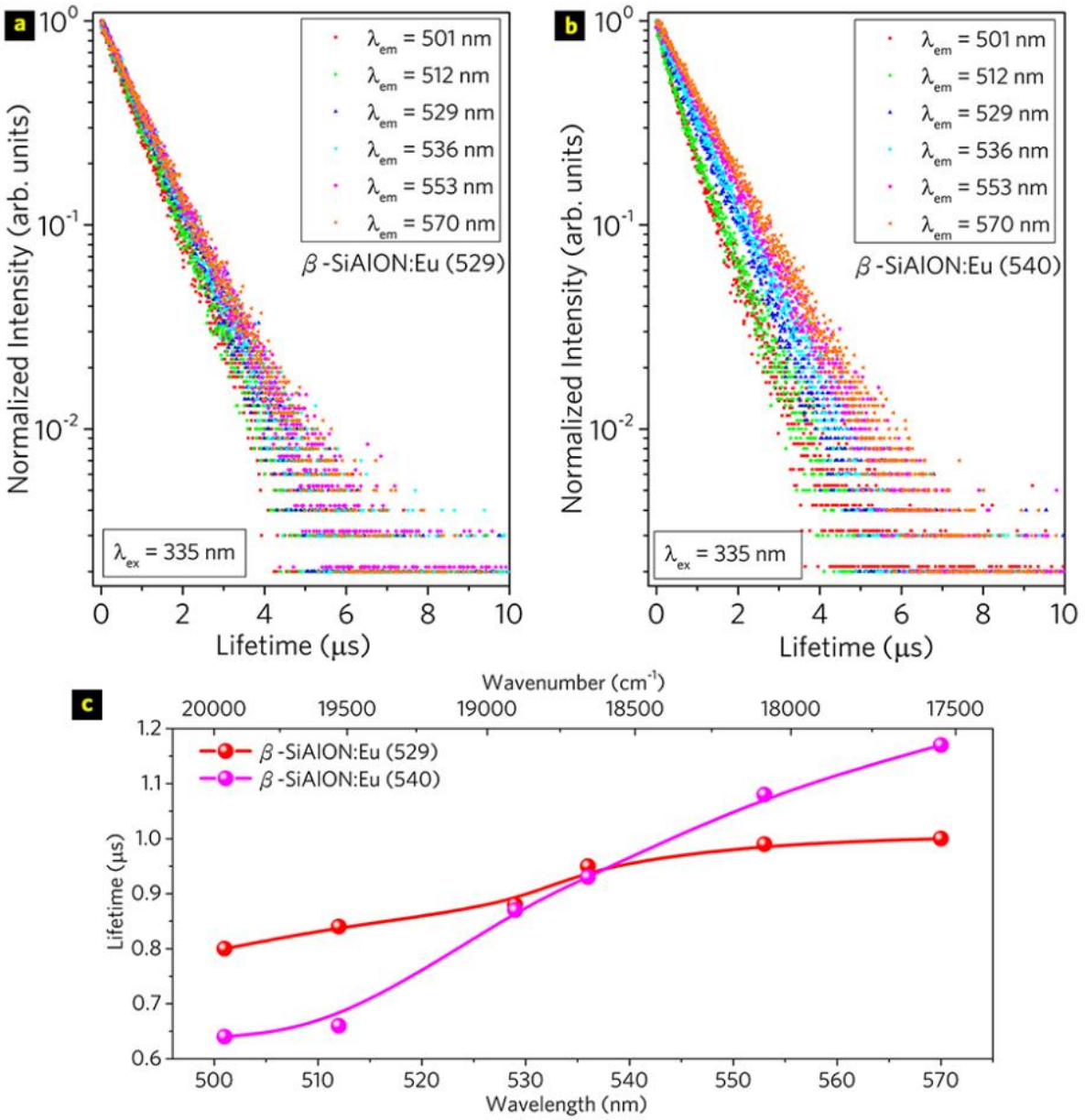

Figure S10. Decay curves of *β*-SiAlON:Eu (529) (a) and *β*-SiAlON:Eu (540) (b) green-emitting phosphors measured at RT; (c) Wavelength-dependent lifetimes of *β*-SiAlON:Eu (529) (a) and *β*-SiAlON:Eu (540).

Table S3. Lifetimes of *β*-SiAlON:Eu (529) and *β*-SiAlON:Eu (540) green-emitting phosphors as a function of wavelength at RT.

	β-SiAlON:Eu (529) (μs)	*β*-SiAlON:Eu (540) (μs)
501 nm (19960 cm^{-1})	0.80	0.64
512 nm (19531 cm^{-1})	0.84	0.66
529 nm (18903 cm^{-1})	0.88	0.87
536 nm (18656 cm^{-1})	0.95	0.93
553 nm (18083 cm^{-1})	0.99	1.08
570 nm (17543 cm^{-1})	1.00	1.17

Note: The lifetime was calculated by the following equation of effective lifetime:

$$\tau = \frac{\int_0^\infty tI(t)dt}{\int_0^\infty I(t)dt}$$

the effective lifetimes were determined and shown in Table S3.

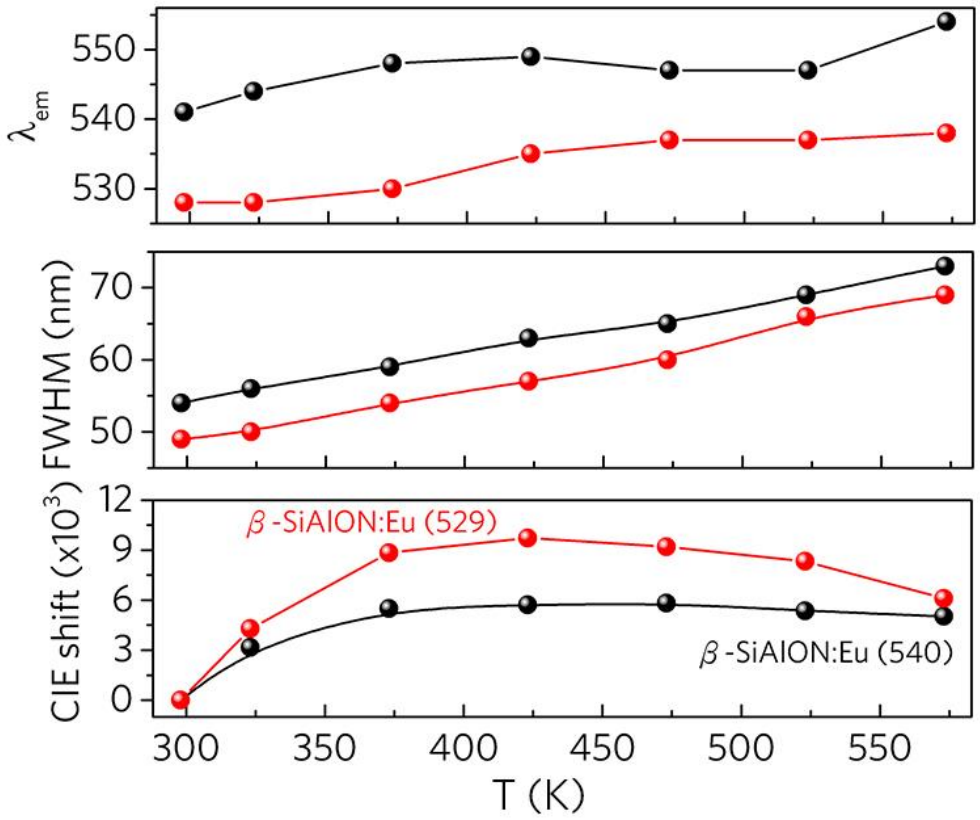

Figure S11. Peak emission wavelength, FWHM, and CIE shift variation with the temperature increase.

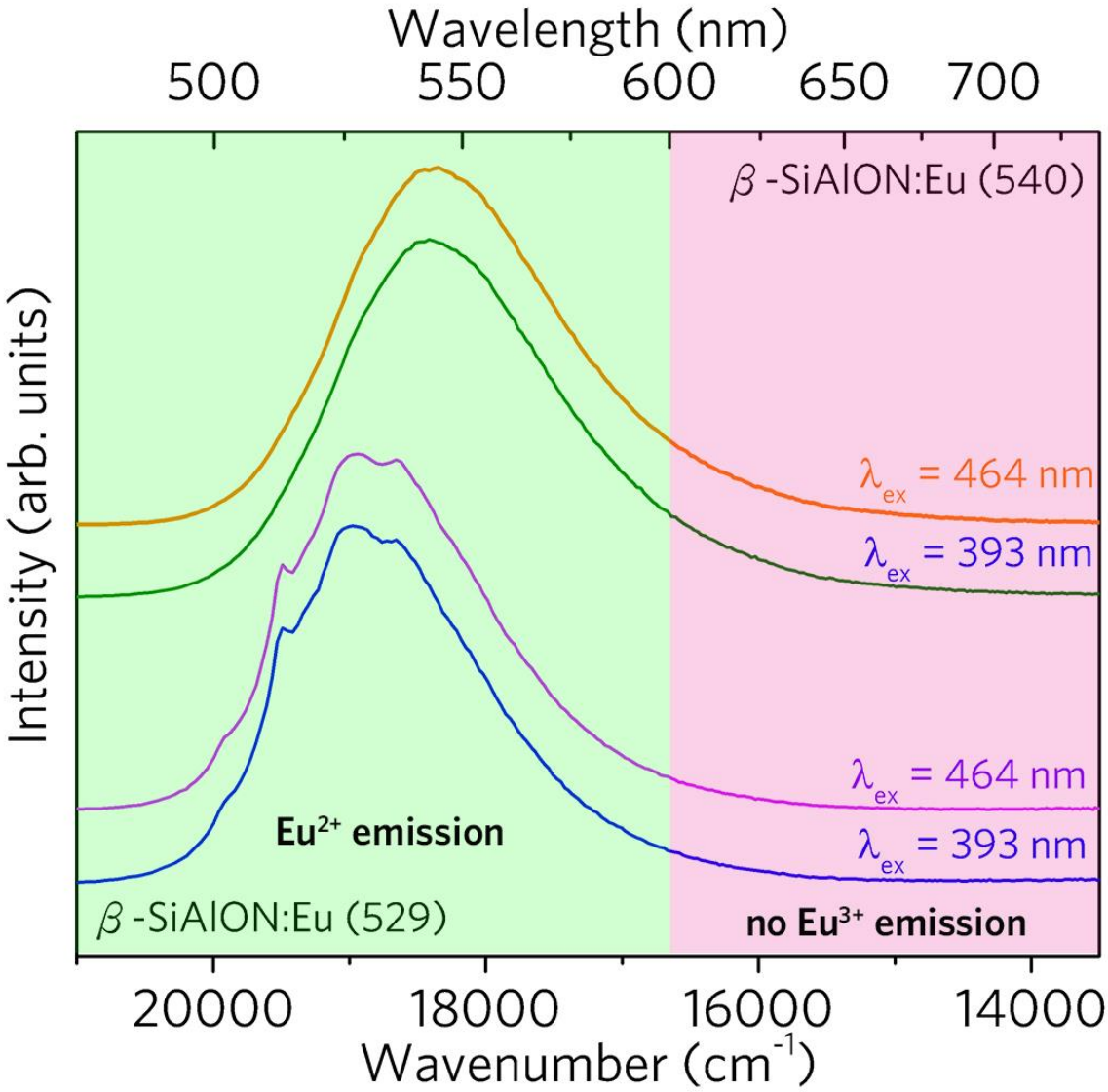

Figure S12. PL spectra of *β*-SiAlON:Eu (529) and *β*-SiAlON:Eu (540) under characteristic excitation wavelength of 393 nm and 464 nm.

Table S4. Optical properties of the displays with the fabricated white LEDs.

White LEDs	*CIE x*	*CIE y*	Efficacy (lm/W)	NTSC (%)	CCT (K)
Blue LED + β-SiAlON:Eu (529) + $K_2SiF_6:Mn^{4+}$	0.26	0.23	111	89	33266
Blue LED + β-SiAlON:Eu (540) + $K_2SiF_6:Mn^{4+}$	0.26	0.23	128	83	33266