Supplementary Information

Structure and luminescence properties of $Sr_4Gd_3Na_3(PO_4)_6F_2:Ce^{3+},Tb^{3+}$ green phosphor with zero-thermal quenching of Tb^{3+} for WLEDs

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Table S1. Final refined structure parameters of $Sr_4Gd_3Na_3(PO_4)_6F_2$ derived from the Rietveld refinement of X-ray diffraction data

Atom	Wyckoff position	x	Y	z	Frac	Uiso
Sr1	6g	0.25071	0.02221	0.25991	0.6667	0.0231
Gd1	6g	0.25071	0.02221	0.25991	0.1667	0.0250
Na1	6g	0.25071	0.02221	0.25991	0.1667	0.0250
Gd2	2d	0.33333	0.66667	0.01440	1.00	0.0358
Na2	2d	0.33333	0.66667	0.54053	1.00	0.0250
P1	6g	0.36637	0.39892	0.25352	1.00	0.0192
O1	6g	0.48950	0.58900	0.27298	1.00	0.0024
O2	6g	0.50644	0.33676	0.23641	1.00	0.0250
O3	6g	0.28739	0.37246	0.05526	1.00	0.0250
O4	6g	0.26587	0.32070	0.39977	1.00	0.0284
F1	2c	0.00000	0.00000	0.22546	0.50	0.0250
F2	1b	0.00000	0.00000	0.50000	1.00	0.7947

Cell parameters: $a = b = 9.27204$ Å, $c = 6.86173$ Å, $V = 510.873$Å^3; $Z = 1$;

space group: P-3 (no.147);

Reliability factors: $\chi^2 = 4.328$, $R_{wp} = 5.38\%$, $R_p = 3.87\%$

Table S2. The lengths of selected bonds in $Sr_4Gd_3Na_3(PO_4)_6F_2$ host

Selected bond	Length (Å)	Selected bond	Length (Å)	Selected bond	Length (Å)
M1-O(1)	2.273(31)	M1-O(4'')	2.550(11)	M2-O(2)	2.284(41)
M1-O(2)	2.690(50)	M1-F(1)	2.241(31)	M2-O(2')	2.283(81)
M1-O(3)	2.373(41)	M1-F(2)	2.771(51)	M2-O(2'')	2.284(11)
M1-O(3')	2.857(01)	M2-O(1)	2.608(71)	M2-O(3)	2.557(71)
M1-O(4)	2.402(01)	M2-O(1')	2.609(21)	M2-O(3')	2.557(31)
M1-O(4')	2.865(50)	M2-O(1'')	2.608(61)	M2-O(3'')	2.556(81)

*M1 represents the Sr1/Gd1/Na1 caiton site; M2 represents the Gd2 site

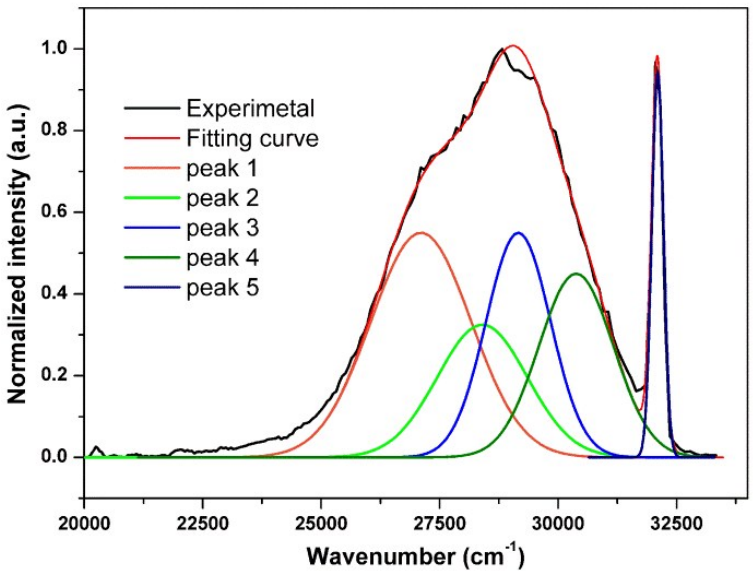

Fig. S1. Emission spectrum of SGNPF:0.01Ce^{3+} at 80 K and its corresponding Gaussian components.

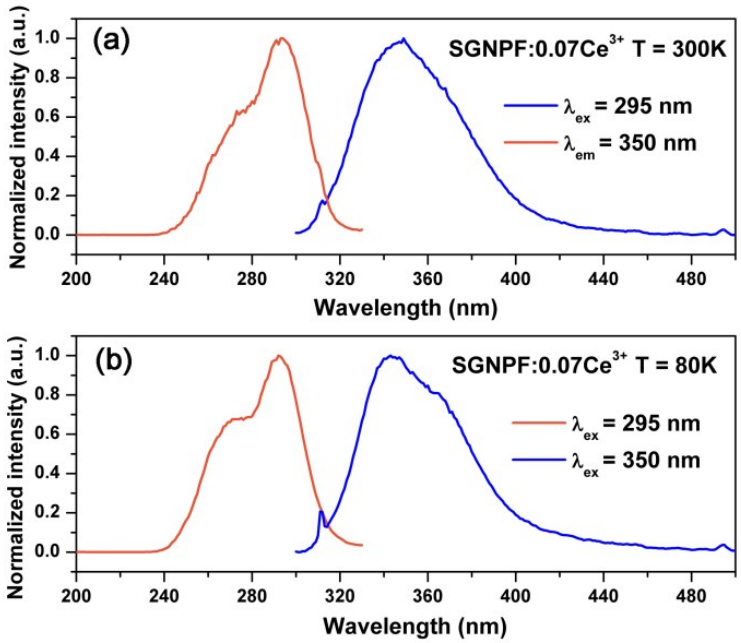

Fig. S2. Photoluminescence spectra of SGNPF:0.07Ce^{3+} at (a) 300 K and (b) 80 K.

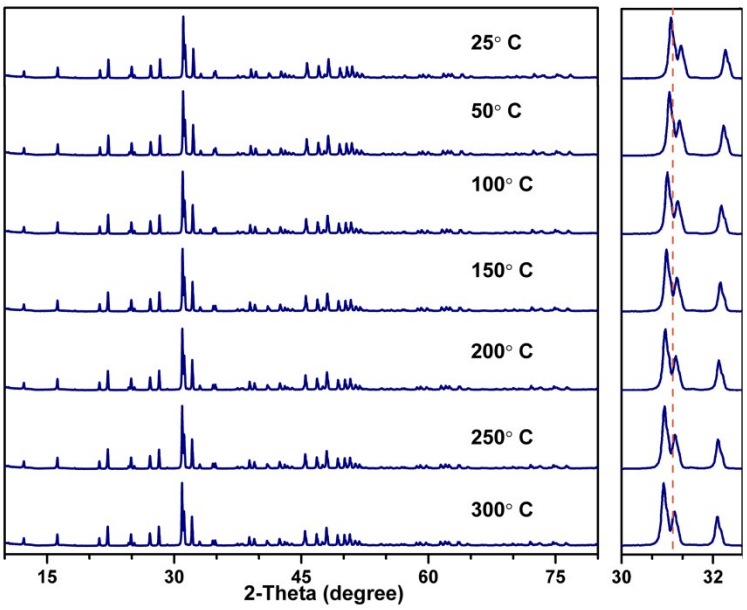

Fig. S3. XRD patterns of SGNPF:0.06Ce^{3+} sample at different temperatures. Right: The enlarged reflection peaks at 2θ =31.11˚.

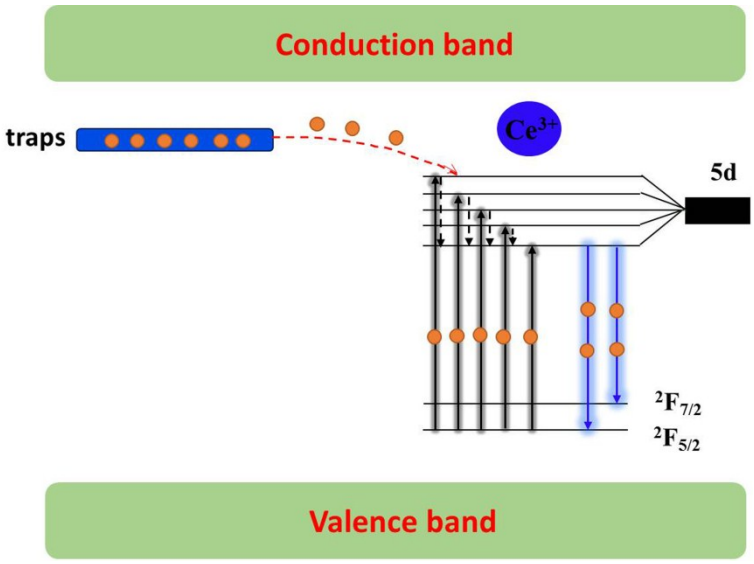

Fig. S4. Schematic illustration of the mechanism for thermal-enhanced luminescence in SGNPF:0.06Ce^{3+} sample.