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

Supporting Information

Anti-Thermal-Quenching Red-Emitting $GdNbO_4$: Pr^{3+} Phosphors Based on Metal-to-Metal Charge Transfer for Optical Thermometry Application

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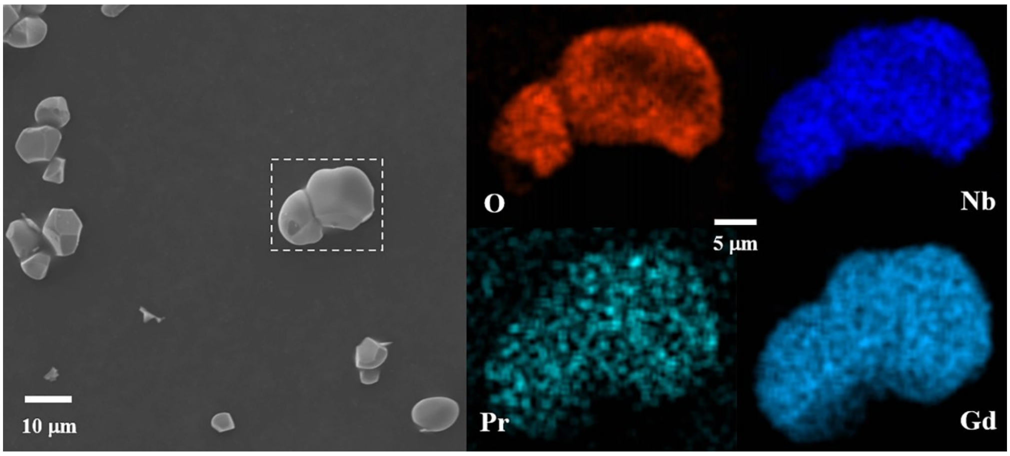

Figure S1 SEM and corresponding mapping images of $GdNbO_4$: 0.1%Pr^{3+}.

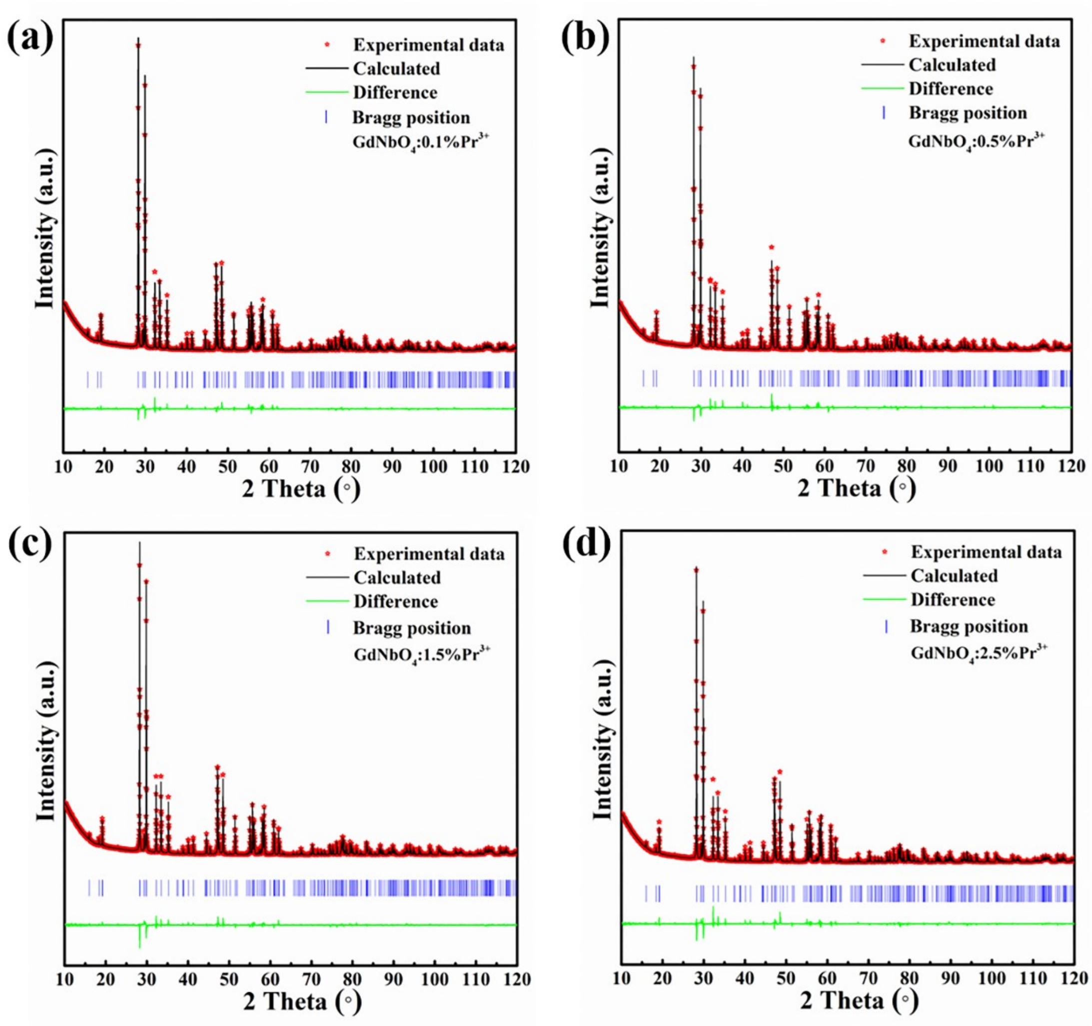

Figure S2. Experimental (points), calculated (solid line) and difference (bottom) X-ray diffraction patterns for $GdNbO_4$: x%Pr^{3+} (x= 0.1, 0.5, 1.5, 2.5) samples.

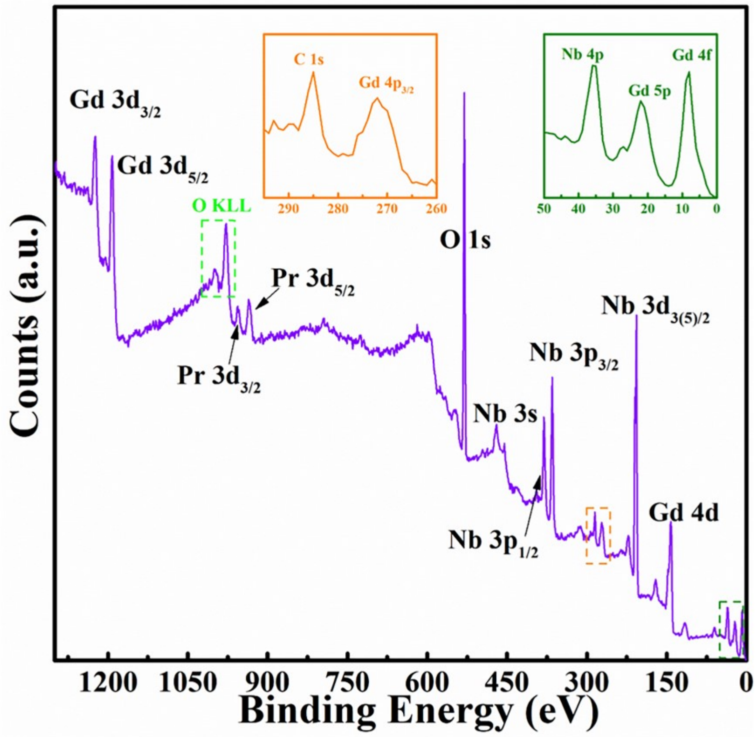

Figure S3. The XPS spectra of $GdNbO_4$: 30%Pr^{3+} phosphor.

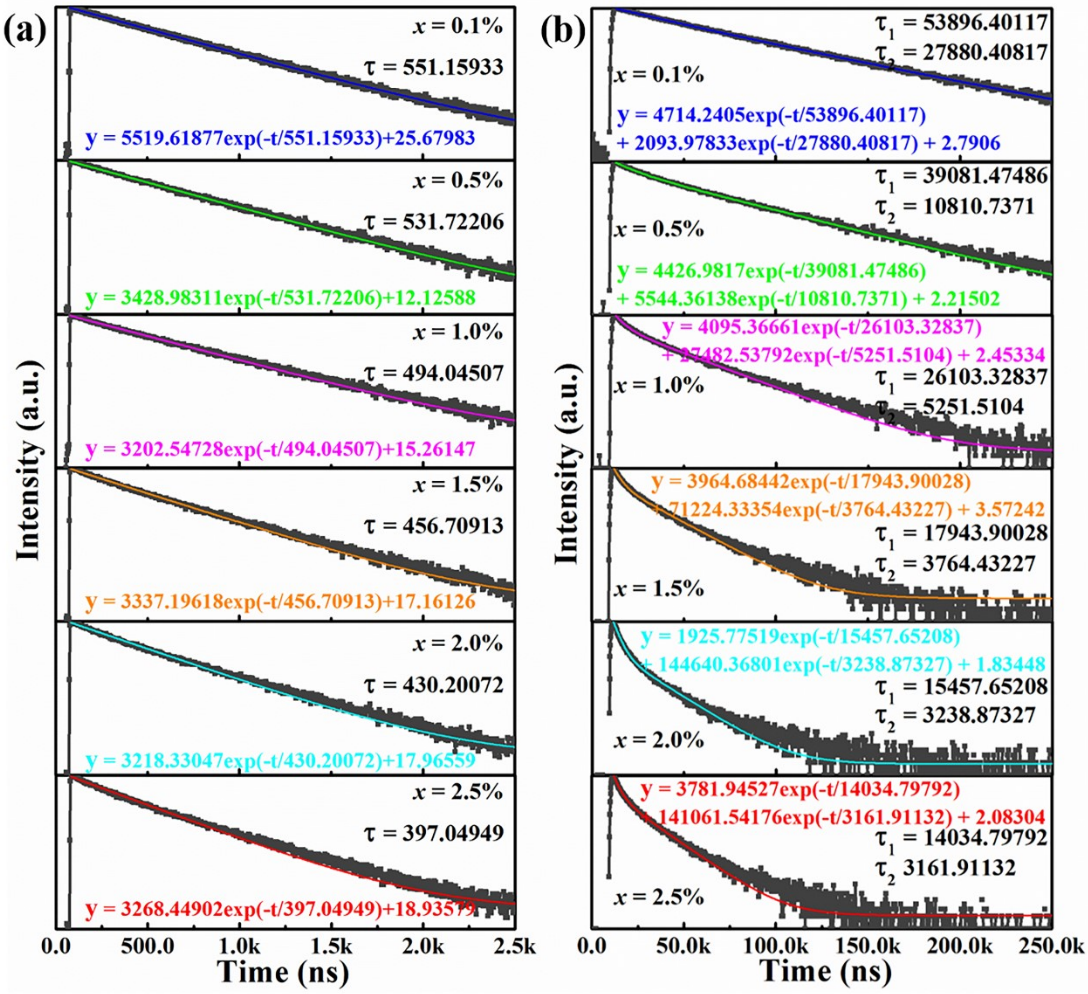

Figure S4. Experiment measured (at room temperature) and fitted PL decay curves of GNO: *x*%Pr^{3+} (x = 0.1-2.5) monitored at (a) 490 nm and (b) 605 nm.

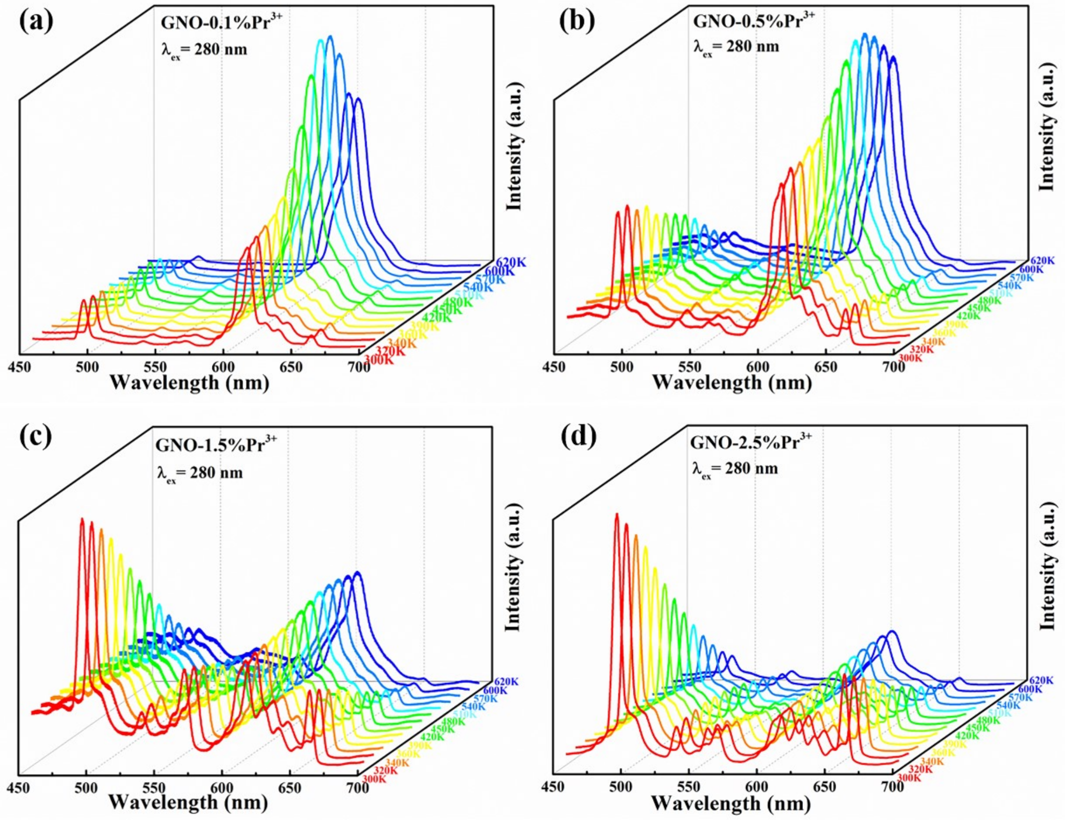

Figure S5. Temperature-dependent PL spectra of GNO: *x*% Pr^{3+} (a) *x*= 0.1, (b) *x*= 0.5, (c) *x*= 1.5 and (d) *x*= 2.5 under 280 nm excitation in the range of 300- 620 K.

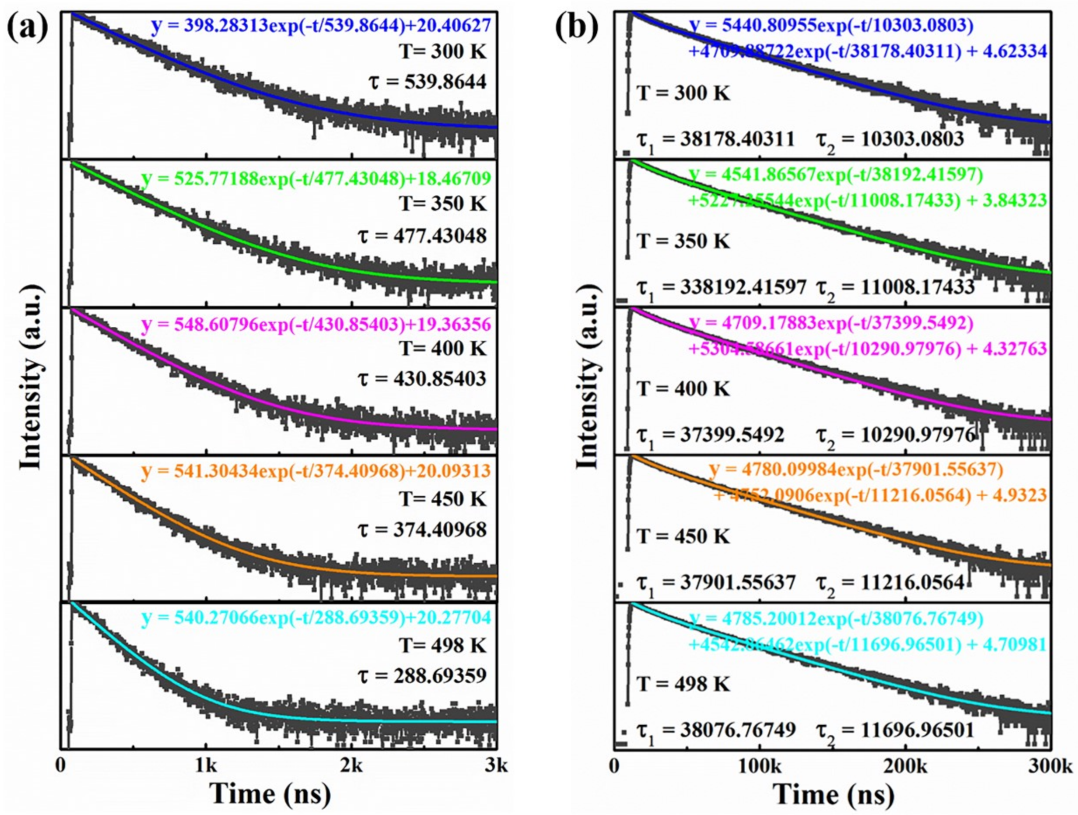

Figure S6. The temperature-dependent lifetimes of Pr^{3+} monitored at (a) λ_{em} = 490 and (b) 605 nm for GNO: x%Pr^{3+} (x = 0.5) with λ_{ex} = 280 nm.

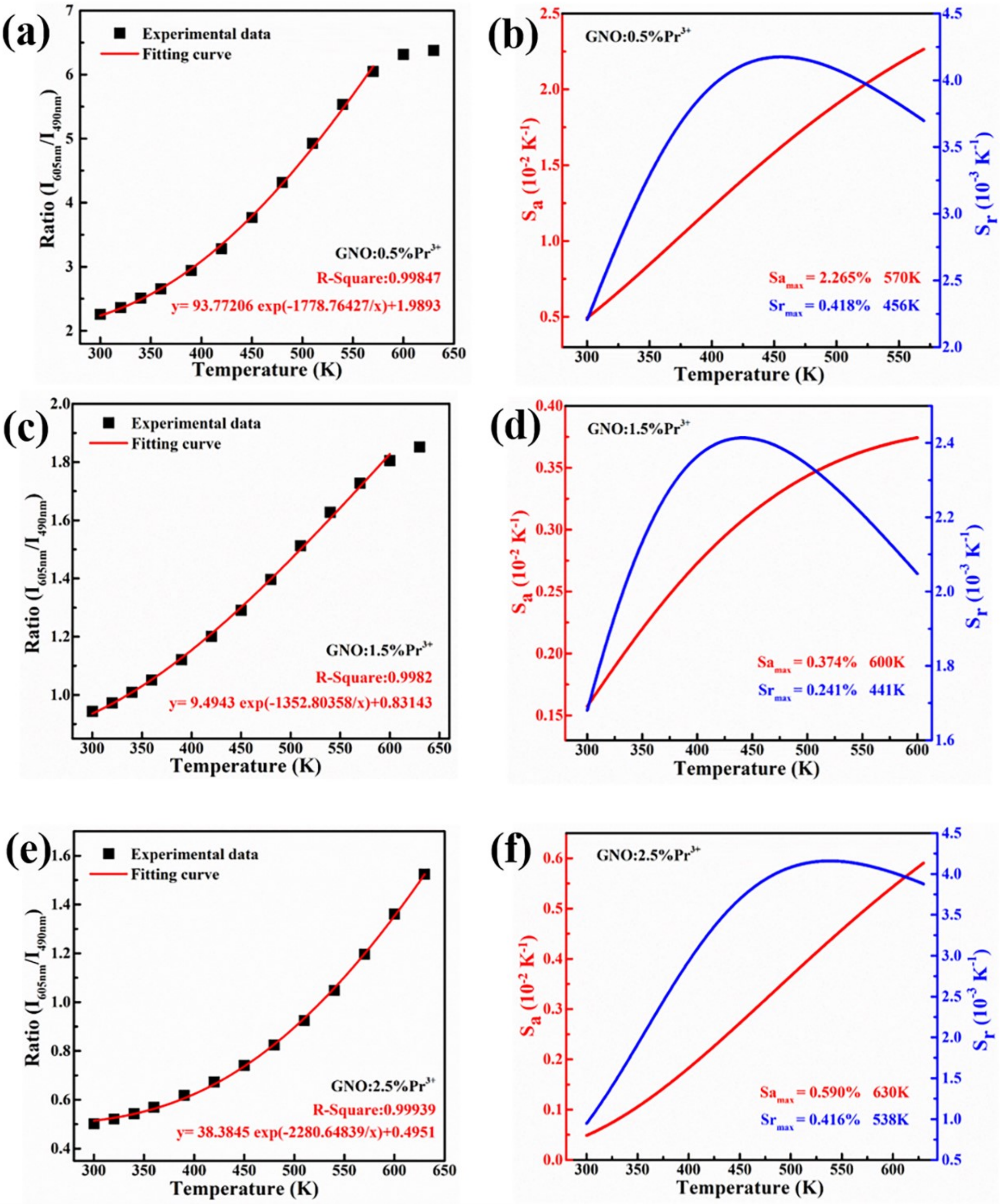

Figure S7. Experimental data and fitted plots of FIR (I_{605nm}/I_{490nm}) versus temperature for GNO: x%Pr^{3+} with (a) x= 0.5, (c) x= 1.5, (e) x= 2.5. Plot of absolute sensitivity S_a and relative sensitivity S_r vs temperature for GNO:x%Pr^{3+} with (b) x= 0.5, (d) x= 1.5, (f) x= 2.5.

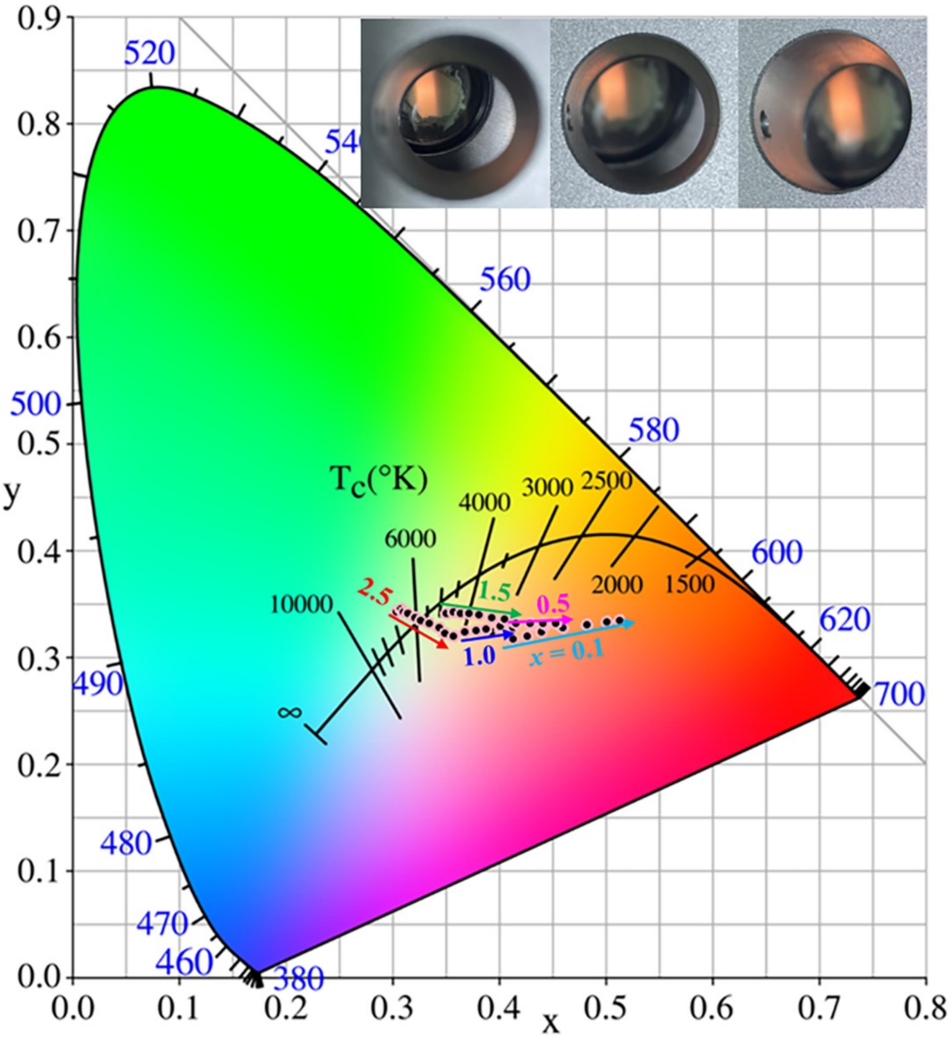

Figure S8. CIE coordinate diagram of the emission color (for GNO: *x*% (*x*= 0.1, 0.5, 1.0, 1.5, 2.5)) at various temperatures, insets show photos of the temperature-controlled heating device with a reflector.

Table S1. Refinement results of the atomic coordinates of $GdNbO_4$: x%Pr^{3+} (x= 0.1, 0.5, 1.5, 2.5)

Formula	Atom	*x*	*y*	*z*	Occupancy	Mult	B
GNO: 0.1%Pr^{3+}	Gd1	0.25000	0.62159	0.00000	0.49959	4	0.10428
	Pr1	0.25000	0.62159	0.00000	0.00041	4	0.10428
	Nb1	0.25000	0.14619	0.00000	0.50000	4	0.33063
	O1	0.09884	0.46374	0.23747	1.00000	8	0.31660
	O2	-0.00768	0.71687	0.29666	1.00000	8	0.34669
GNO: 0.5%Pr^{3+}	Gd1	0.25000	0.62199	0.00000	0.49807	4	0.16285
	Pr1	0.25000	0.62199	0.00000	0.00193	4	0.16285
	Nb1	0.25000	0.14618	0.00000	0.50000	4	0.65979
	O1	0.08825	0.46202	0.23492	1.00000	8	0.57812
	O2	-0.00301	0.71490	0.30074	1.00000	8	0.72014
GNO: 1.5%Pr^{3+}	Gd1	0.25000	0.62125	0.00000	0.49312	4	0.48339
	Pr1	0.25000	0.62125	0.00000	0.00688	4	0.48339
	Nb1	0.25000	0.14598	0.00000	0.50000	4	0.70733
	O1	0.10429	0.46255	0.24784	1.00000	8	1.32119
	O2	-0.00296	0.71348	0.30186	1.00000	8	0.83305
GNO: 2.5%Pr^{3+}	Gd1	0.25000	0.62175	0.00000	0.48891	4	0.45088
	Pr1	0.25000	0.62175	0.00000	0.01109	4	0.45088
	Nb1	0.25000	0.14592	0.00000	0.50000	4	0.63408
	O1	0.09536	0.46133	0.23208	1.00000	8	1.43814
	O2	-0.00402	0.71637	0.29757	1.00000	8	0.85473