Electronic supplementary information

Design of Cr-Ba-doped γ-Ga_2O_3 Persistent Luminescence Nanoparticles for Ratiometric Temperature Sensing and Encryption Information Transfer

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Table S1 Solution volume compositions of different samples

Samples	V_{Ga}/ mL	$V_{Ethylene\ glycol}$/ mL	V_{Cr}/ mL	V_{Ba}/ mL
1	4	2	0	0
2	4	2	0.05	0
3	4	2	0.10	0
4	4	2	0.15	0
5	4	2	0.20	0
6	4	2	0.25	0
7	4	2	0.30	0
8	4	2	0.25	0
9	4	2	0.25	0.08
10	4	2	0.25	0.12
11	4	2	0.25	0.16

Note: C_{Ga}=0.5 mol·L^{-1}; C_{Cr}=0.01 mol·L^{-1}; C_{Ba}=0.01 mol·L^{-1}; n_{Ga2O3} : n_{Cr} : n_{Ba}=1 : x : y

Table S2 The result of γGCB XRD refinement

Samples	γGCB
Space group	*Fd*3*m*
2θ-interval (°)	10-80
a (Å)	8.224
b (Å)	8.224
c (Å)	8.224
Alpha	90.00
Beta	90.00
Gamma	90.00
Crystal density (g/cm^3)	5.97
V (Å^3)	556.15
R_{wp} (%)	7.21
R_p (%)	5.72
χ^2	1.88
GOF	1.37

Table S3 Fitting parameters of γ-Ga_2O_3: 0.0025Cr and γGCB decay curve

Parameters	γ-Ga_2O_3: 0.0025Cr	γGCB
τ_1/s	3.084	4.661
A_1	1.608	1.400
τ_2/s	44.471	62.014
A_2	1.005	0.888
τ_3/s	421.608	509.628
A_3	1.145	1.185
τ_{av}/s	141.670	191.560
R^2	0.996	0.997

Table S4 Comparison of LIR-based materials for temperature sensing

Material composition	Temperature range/ K	S_a (%K^{-1})	S_r (%K^{-1})	Reference
$NaYF_4$: Er^{3+}	303-423	-	1.06 (303K)	1
$Na_5Y_9F_{32}$: Ce^{3+},Tb^{3+}	298-473	1.57	1.18 (473K)	2
Ba_2LaTaO_6: Bi^{3+}, Mn^{4+}	80-473	2.91 (350K)	3.81 (350K)	3
$Sr_2Y_8(SiO_4)_6O_2$: Ce^{3+},Tb^{3+}	298-498	-	0.74 (298K)	4
$SrLu_2O_4$: Bi^{3+},Eu^{3+}	315-543	1.1 (543K)	0.87 (315K)	5
γ-Ga_2O_3: Cr^{3+}, Ba^{2+}	300-420	3.4	1.5 (300K)	This work

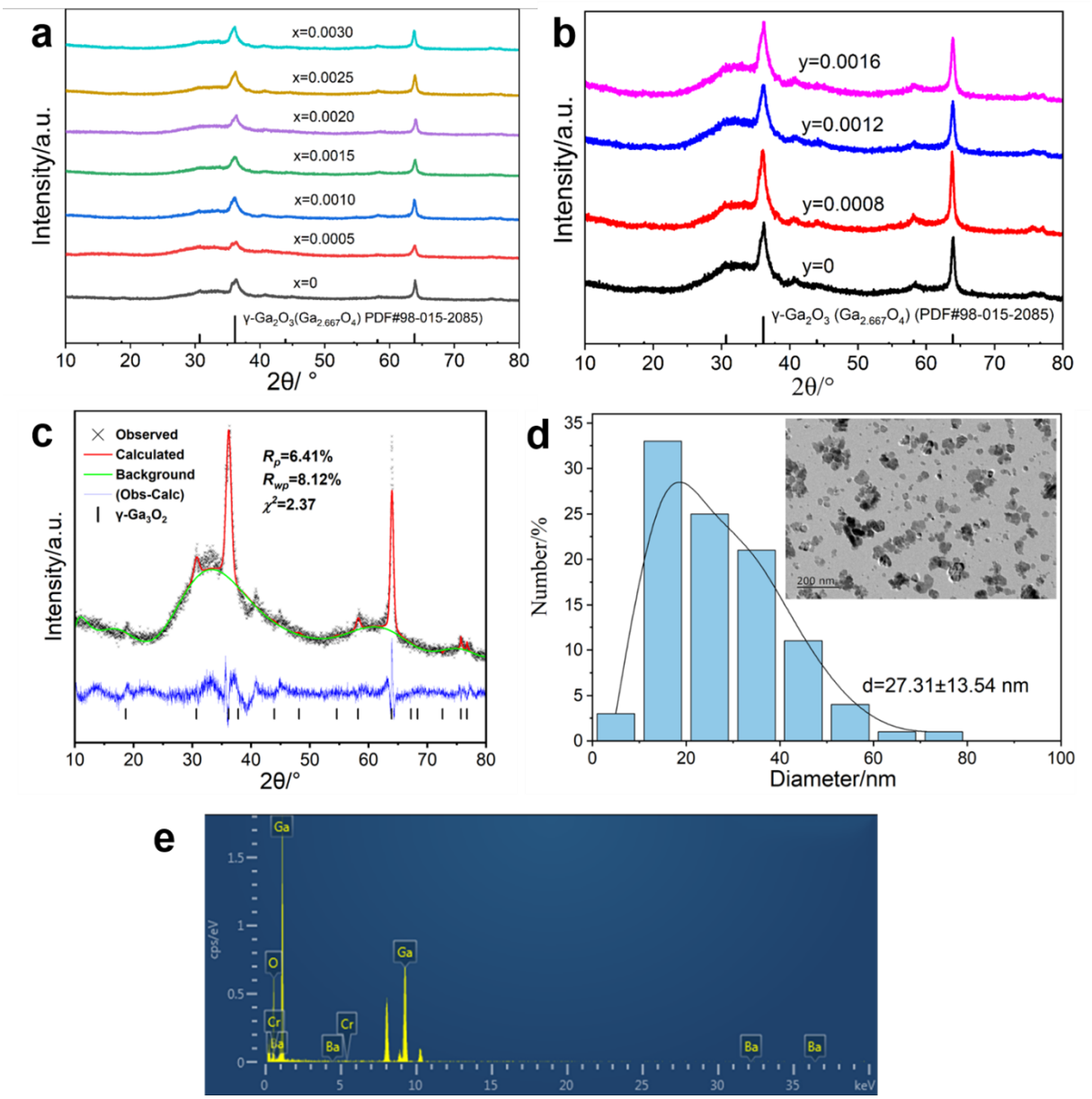

Figure S1 The XRD pattern of a) γ-Ga_2O_3: xCr and b) γ-Ga_2O_3: 0.0025Cr, yBa. c) The XRD refined pattern of γ-Ga_2O_3 using GSAS software. d) Particle size distribution and TEM pattern (insert) of γ-Ga_2O_3: 0.0025Cr. e) EDS spectrogram pattern of γGCB.

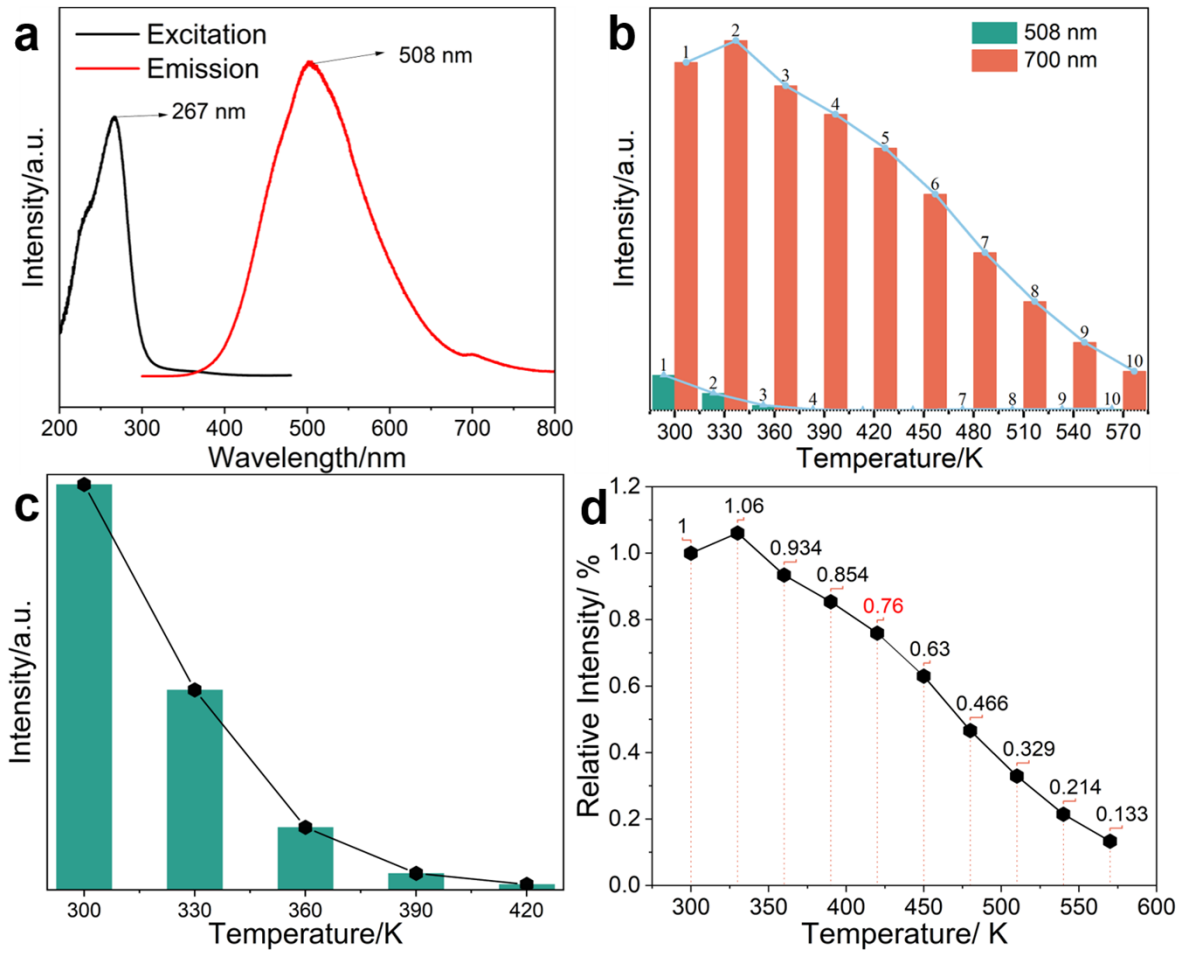

Figure S2 a) Excitation spectrum of γ-Ga_2O_3 with the emission at 508 nm and emission spectrum of γ-Ga_2O_3 under 278 nm excitation. b) Luminescence intensity histogram at 508 nm and 700 nm of γGCB at temperature from 300 to 570 K. c) Luminescence intensity histogram at 508 nm of γGCB at temperature from 300 to 420 K. d) Linear between relative emission intensity and the temperature from 300 to 570 K.

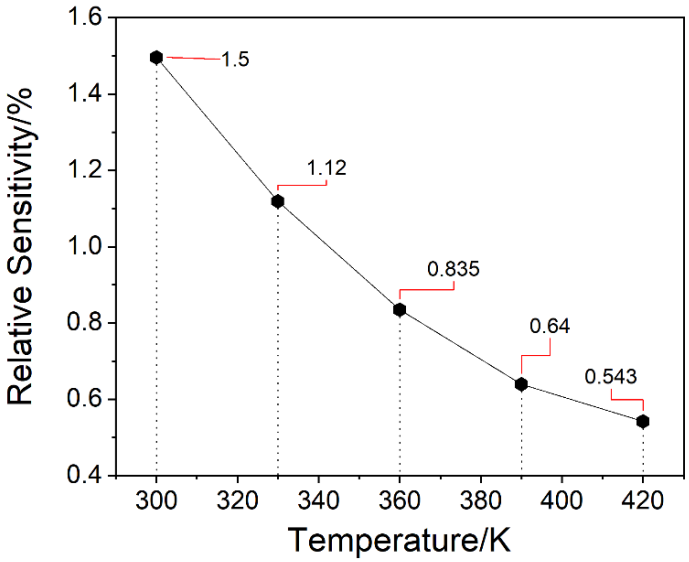

Figure S3 Relative sensitivity of γGCB in the temperature range 300-420K.

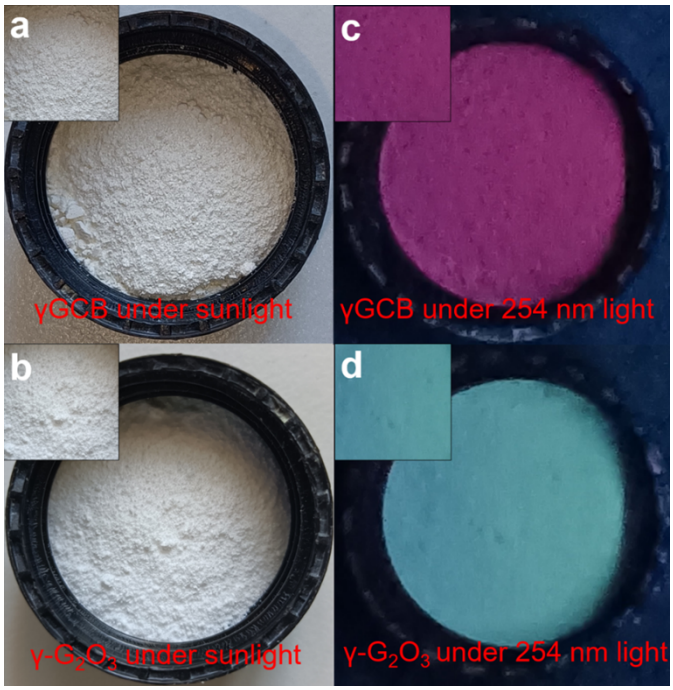

Figure S4 The photographs of γGCB and γ-Ga_2O_3 powder taken under a) and b) sunlight as well as c) and d) under 254 nm UV lamps.

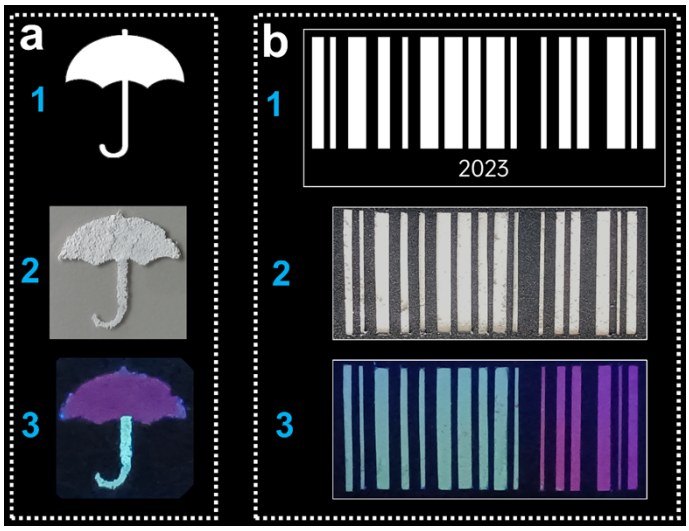

Figure S5 The differentiation of a) umbrella pattern and b) barcode with the different color from γGCB and γ-G_2O_3 under the excitation with sunlight and 254 nm 1, 2, and 3 represent the designed pattern, and that under sunlight and 254 nm UV lamp, respectively.

References

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