Electronic Supplementary Material (ESI) for Dalton Transactions.

Supporting Information

Construction of thermally stable Tb^{3+}-activated green-emitting phosphors: doping concentration and excitation wavelength dual driving strategy

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Figure S1

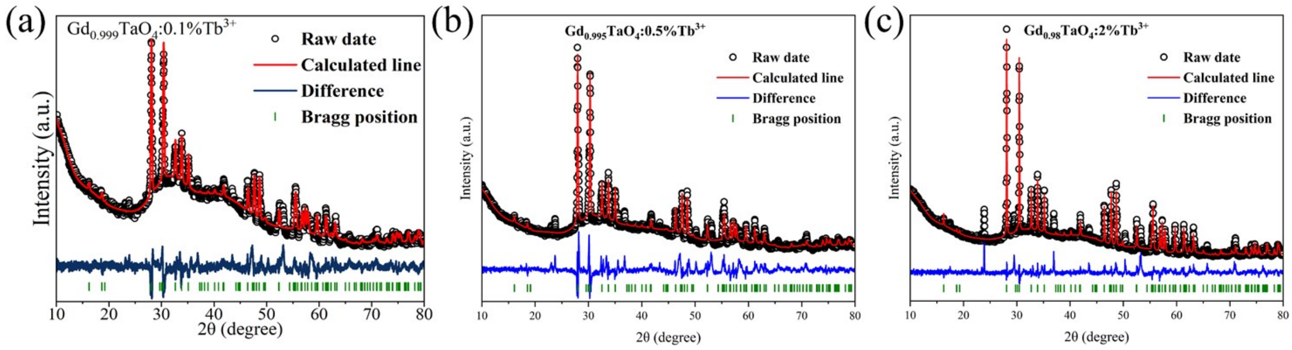

Figure S1. Rietveld refinement patterns for X-ray diffraction patterns of (a) $Gd_{0.999}TaO_4$:0.1%Tb^{3+} (b) $Gd_{0.995}TaO_4$:0.5%Tb^{3+} (c) $Gd_{0.98}TaO_4$:2%Tb^{3+}.

Figure S2

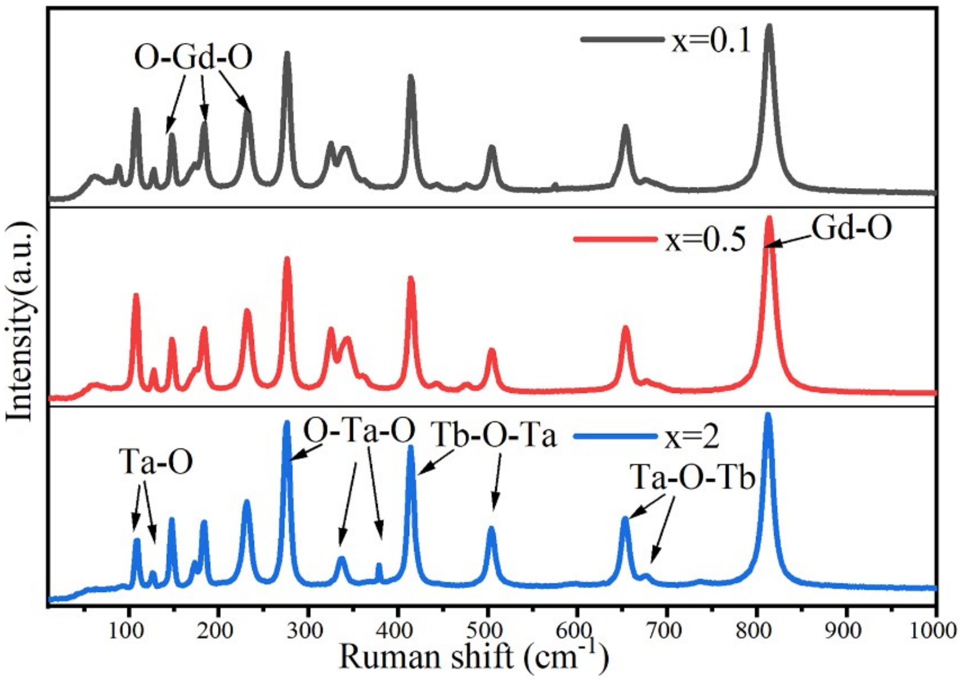

Figure S2. Raman spectra of $Gd_{1-x}TaO_4$:xTb^{3+} (x = 0.1%, 0.5%, 2%).

Figure S3

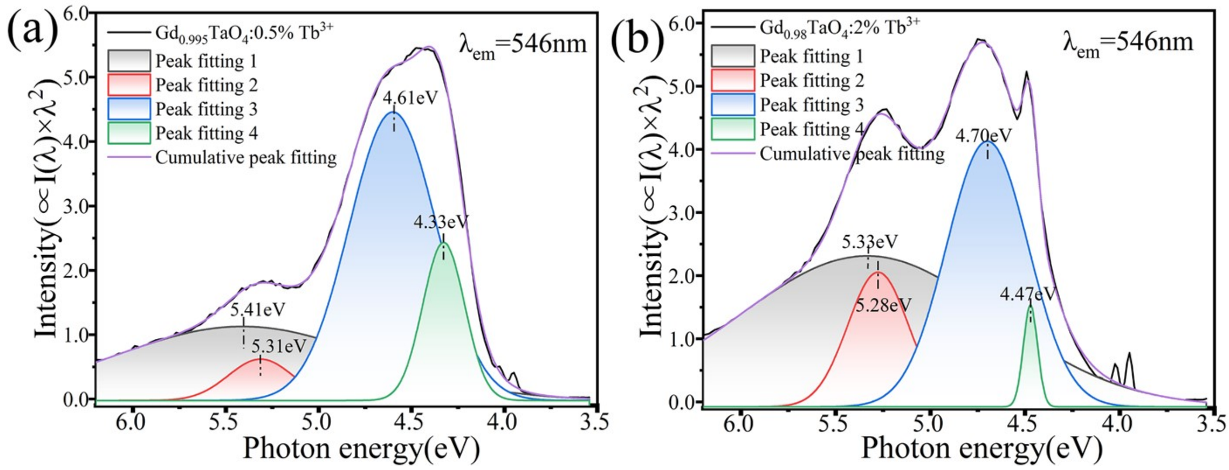

Figure S3. Gaussian fit to the excitation spectrum of photoluminescence of $Gd_{0.999}TaO_4$:0.1%Tb^{3+}. The wavelength expressed in terms of photon energy (eV) is the horizontal coordinate. $I(E) = I(\lambda)\times\lambda^2$.

Figure S4

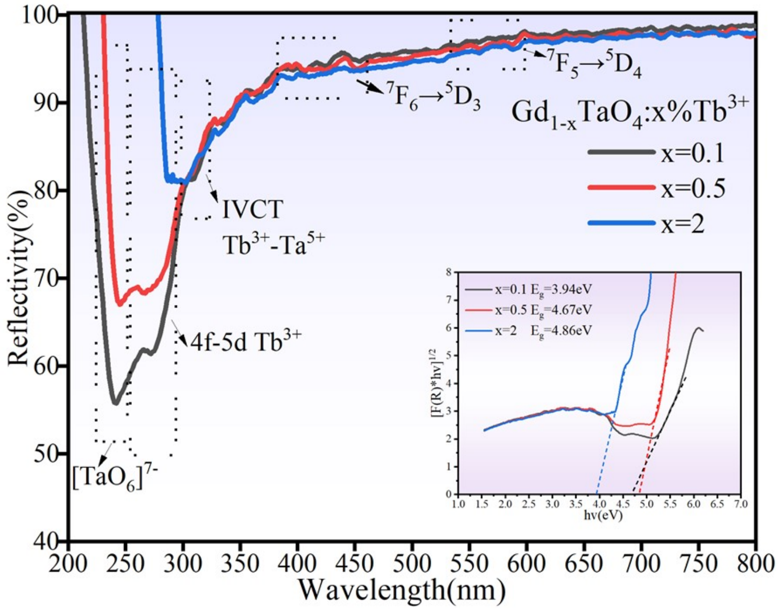

Figure S4. Diffuse reflectance spectrum of $Gd_{1-x}TaO_4$:xTb^{3+} (x =0.1%, 0.5%, 2%) and computed band gap spectrum fitted with Kubelka-Munk formula.

Figure S5

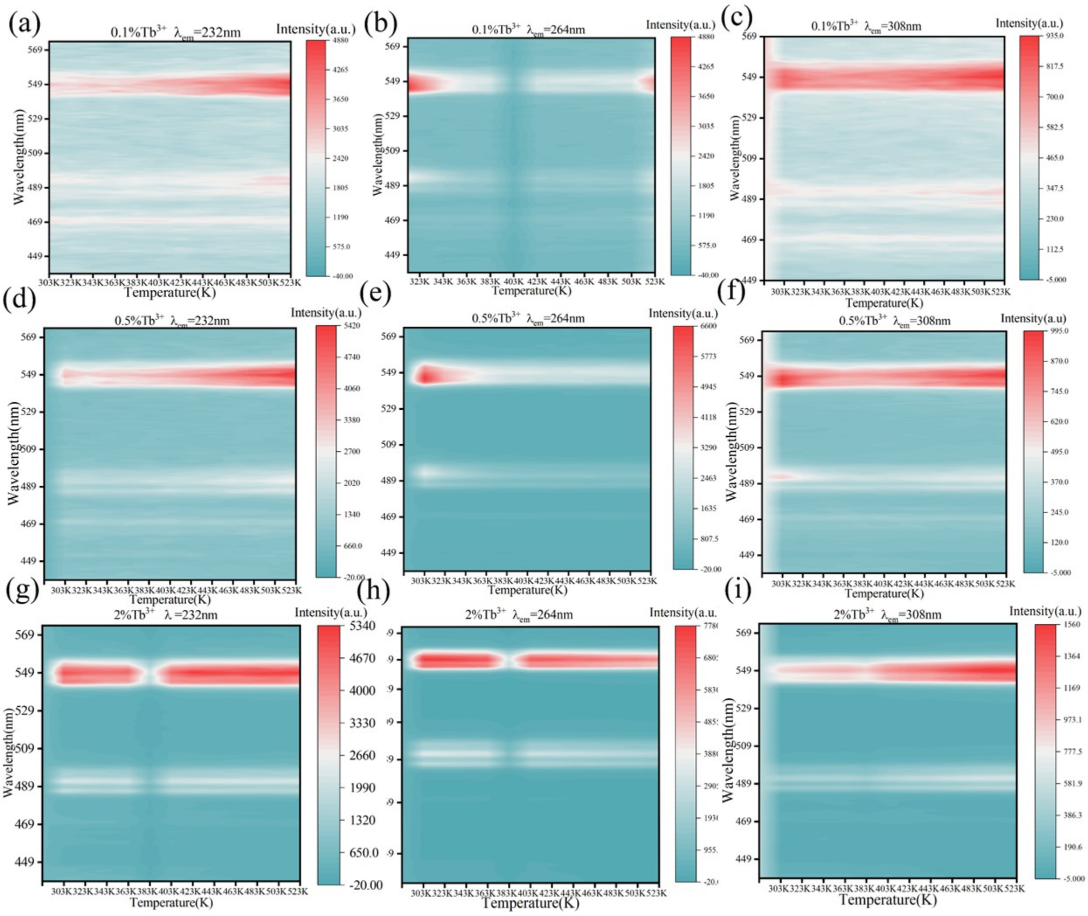

Figure S5. Contour plots of 303-523K variable temperature emission of $Gd_{1-x}TaO_4$:xTb^{3+} (x = 0.1%, 0.5%, 2%) phosphor at 232, 264 and 308 nm at different excitation wavelengths (a-c: x = 0.1%, d-f: x = 0.5%, g-i: x = 2%).

Figure S6

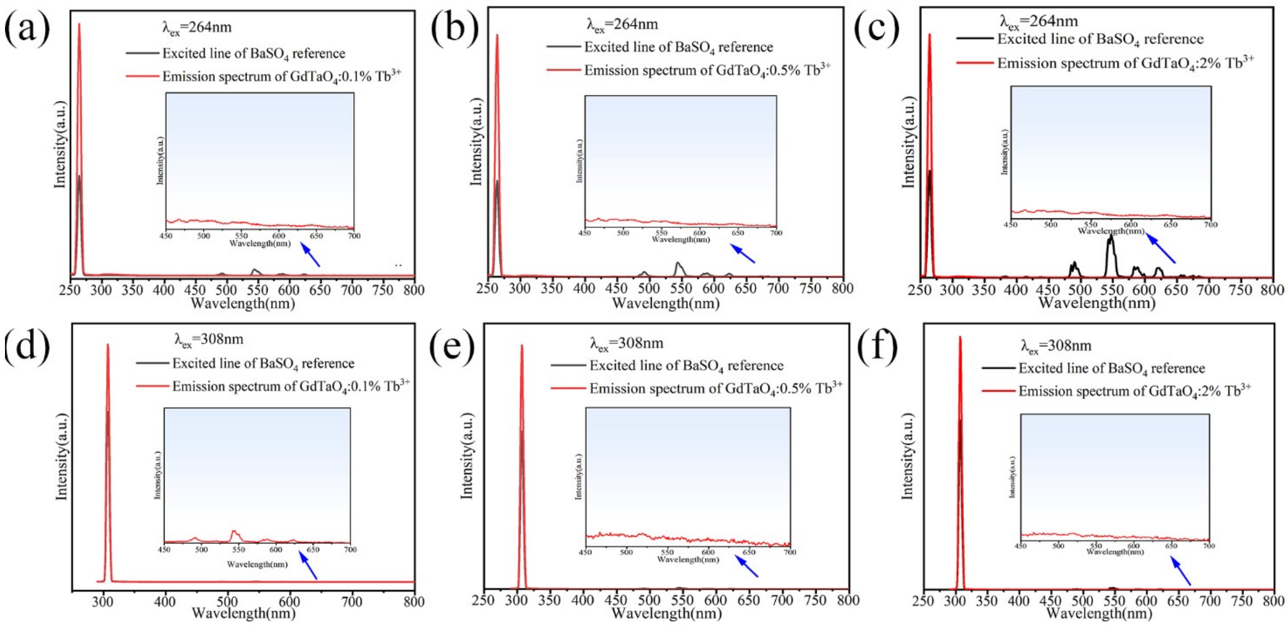

Figure S6. Excitation line of $BaSO_4$ and the emission spectrum of $Gd_{1-x}TaO_4$:xTb^{3+} (x =0.1%, 0.5%, 2%) phosphor. (a) λ_{ex}=264nm x=0.1%, (b) λ_{ex}=264nm x=0.5%, (c) λ_{ex}=264nm x=2%, (d) λ_{ex}=308nm x=0.1%, (e) λ_{ex}=308nm x=0.5%, (f) λ_{ex}=308nm x=2%. The data was collected by using an integrating sphere. The inset shows a magnification of the emission spectrum from 450 nm to 700 nm.

Figure S7

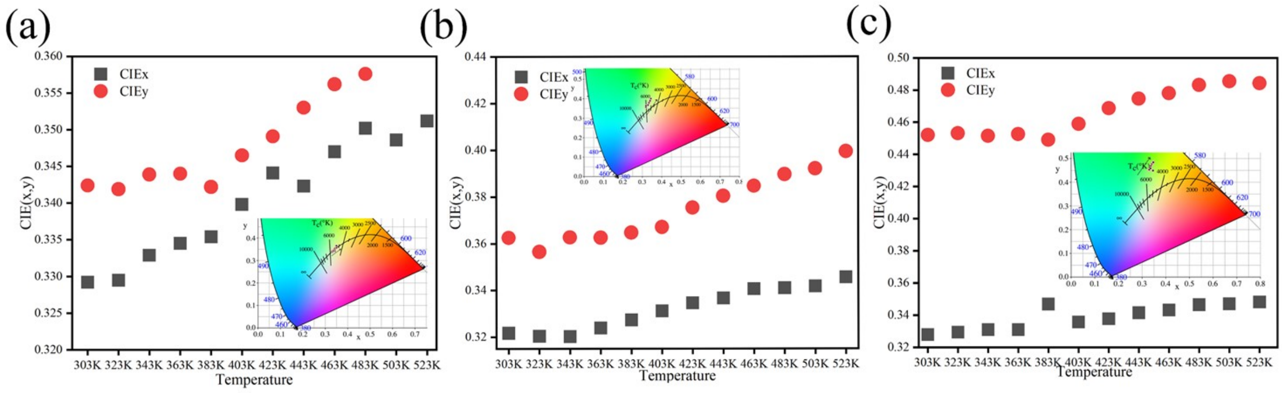

Figure S7 (a-c) $Gd_{1-x}TaO_4$:xTb^{3+} (x = 0.1%, 0.5%, 2%) in variable temperature chromaticity coordinates (x, y), and the insets are the corresponding CIE chromaticity diagrams.

Figure S8

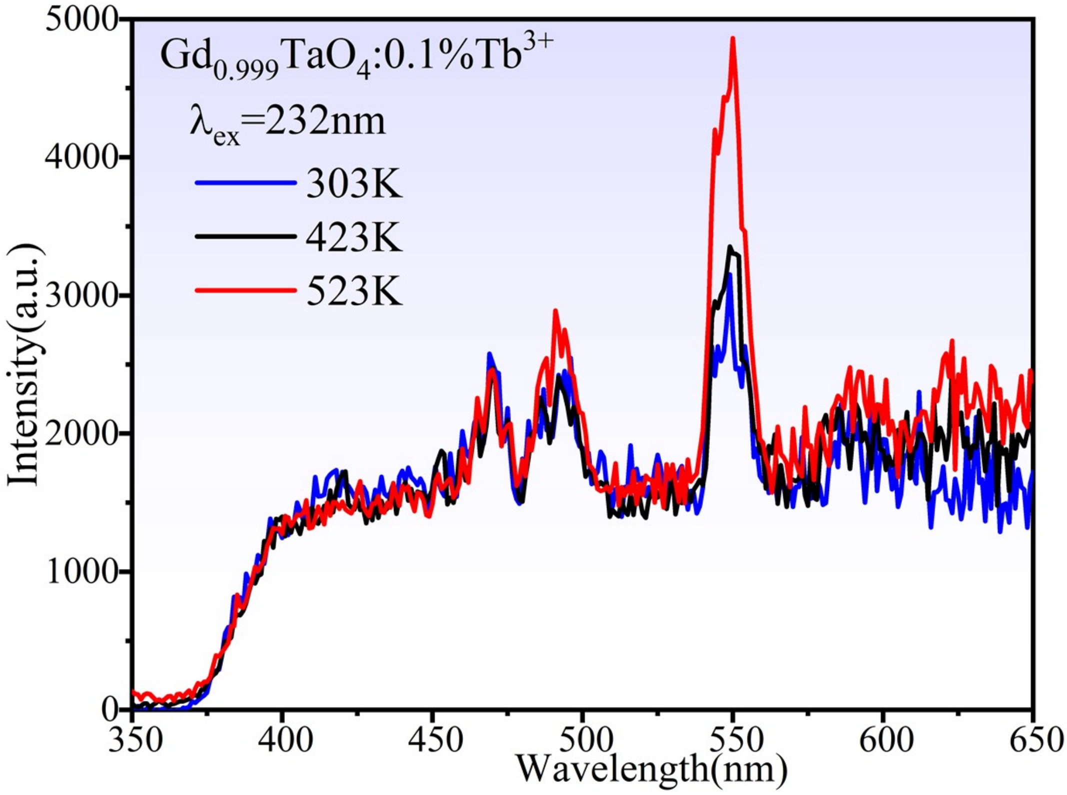

Figure S8 Photoluminescence of $Gd_{0.999}TaO_4$:0.1%Tb^{3+}.

Figure S9

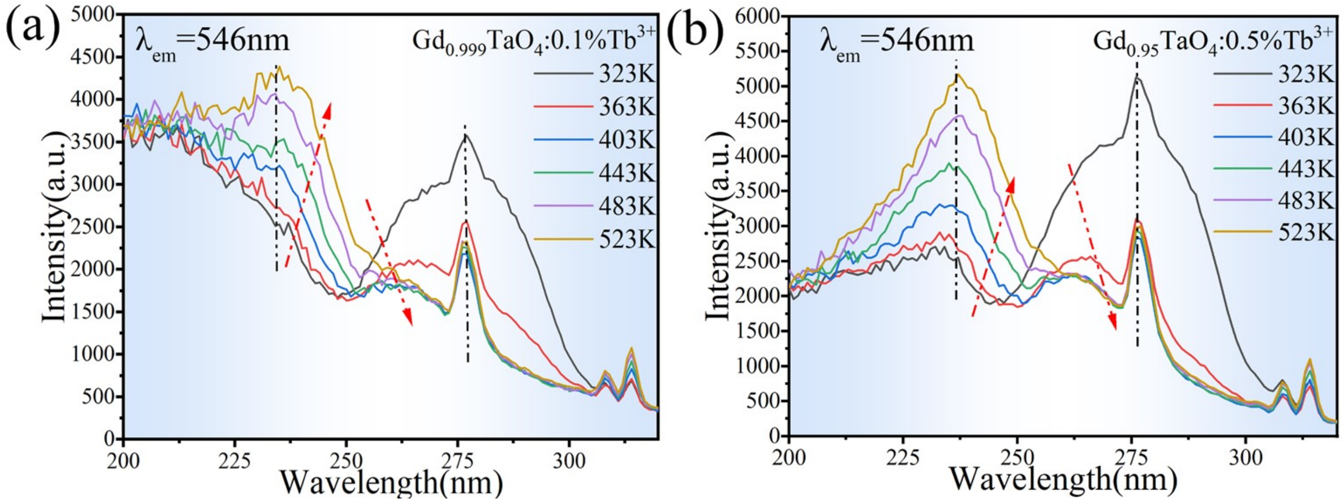

Figure S9 Variable temperature excitation spectrum of $Gd_{1-x}TaO_4$:xTb^{3+} (x = 0.1%, 0.5%) under monitored excitation at 546 nm (a)x = 0.1% (b)x = 0.5%.

Table S1 Data of moles of all reagents used in the synthesis of $Gd_{1-x}TaO_4:xTb^{3+}$ (x = 0.1%, 0.5%, 2%). and masses.

Samples prepared	raw materials	relative molecular mass	mole number/mol	theoretical value/g	Actual weighing value/g
$Gd_{0.999}TaO_4:0.1\%Tb^{3+}$	Gd_2O_3	362.4982	0.0050	0.9053	0.9052
	Ta_2O_5	441.8928	0.0050	1.1047	1.1048
	Tb_4O_7	747.6972	0.0050	0.0009	0.0009
	Li_2CO_3	73.8909	0.0050	0.0020	0.0022
$Gd_{0.995}TaO_4:0.5\%Tb^{3+}$	Gd_2O_3	362.4982	0.0050	0.9017	0.9017
	Ta_2O_5	441.8928	0.0050	1.1047	1.1044
	Tb_4O_7	747.6972	0.0050	0.0046	0.0048
	Li_2CO_3	73.8909	0.0050	0.0020	0.0022
$Gd_{0.98}TaO_4:2\%Tb^{3+}$	Gd_2O_3	362.4982	0.0050	0.8881	0.8882
	Ta_2O_5	441.8928	0.0050	1.1047	1.1047
	Tb_4O_7	747.6972	0.0050	0.0187	0.0185
	Li_2CO_3	73.8909	0.0050	0.0020	0.0020

Table S2 The relevant Rietveld refinement parameters and crystallographic data.

Parameter	$Gd_{0.999}TaO_4$:0.1%Tb^{3+}	$Gd_{0.995}TaO_4$:0.5%Tb^{3+}	$Gd_{0.98}TaO_4$:2%Tb^{3+}
Space group	*I 2/a*	*I 2/a*	*I 2/a*
Structure	Monoclinic	Monoclinic	Monoclinic
a (Å)	5.3541	5.3478	5.3508
b (Å)	11.0199	11.0108	11.0083
c (Å)	5.1620	5.1579	5.1633
$\alpha = \gamma$ (deg)	90.000	90.000	90.000
β(deg)	96.480	96.506	96.646
Unit cell volume ($Å^3$)	302.623	301.759	302.090
R_p (%)	3.25	3.03	2.91
R_{wp} (%)	4.49	4.10	3.81
χ^2	1.828	1.888	1.574

Table S3 The bond length in GSAS Refined Phosphors.

Sample (Bond length(Å))	$Gd_{0.999}TaO_4$: 0.1%Tb^{3+}	$Gd_{0.995}TaO_4$: 0.5%Tb^{3+}	$Gd_{0.98}TaO_4$: 2%Tb^{3+}
Ta-Tb^{3+}	3.5029	3.5013	3.4972
Ta-Tb^{3+}	3.9855	3.9457	3.9279
Ta-Tb^{3+}	3.9230	3.9457	3.9943
Ta-Tb^{3+}	3.9629	3.9223	3.9943
Ta-Tb^{3+}	3.6648	3.6737	3.6320
Average	3.8078	3.7977	3.8091

Table S4 The data of the lifetime of $Gd_{1-x}TaO_4$:xTb^{3+} (x = 0.1%, 0.5%, 2%) under different excitations.

Excitation wavelength	$Gd_{0.999}TaO_4$: 0.1%Tb^{3+} (ms)	$Gd_{0.995}TaO_4$: 0.5%Tb^{3+} (ms)	$Gd_{0.98}TaO_4$: 2%Tb^{3+} (ms)
232 nm	1.301	1.307	1.249
264 nm	2.425	2.330	1.165
308 nm	1.419	2.345	1.157

Table S5 The data of I_{abs}, IQE and EQE on $Gd_{1-x}TaO_4$:xTb^{3+} (x = 0.1%, 0.5%, 2%). (λ_{ex}= 264 nm)

Sample	$Gd_{0.999}TaO_4$: 0.1%Tb^{3+}	$Gd_{0.995}TaO_4$: 0.5%Tb^{3+}	$Gd_{0.98}TaO_4$: 2%Tb^{3+}
I_{abs}	60.35%	60.71%	55.71%
IQE	12.33%	27.89%	95.29%
EQE	7.44%	16.93%	53.09%

Table S6 The data of I_{abs}, IQE and EQE on $Gd_{1-x}TaO_4$:xTb^{3+} (x = 0.1%, 0.5%, 2%). (λ_{ex}=308nm)

Sample	$Gd_{0.999}TaO_4$: 0.1%Tb^{3+}	$Gd_{0.995}TaO_4$: 0.5%Tb^{3+}	$Gd_{0.98}TaO_4$: 2%Tb^{3+}
I_{abs}	25.60%	32.15%	27.60%
IQE	3.45%	5.61%	10.07%
EQE	0.88%	1.80%	2.78%