

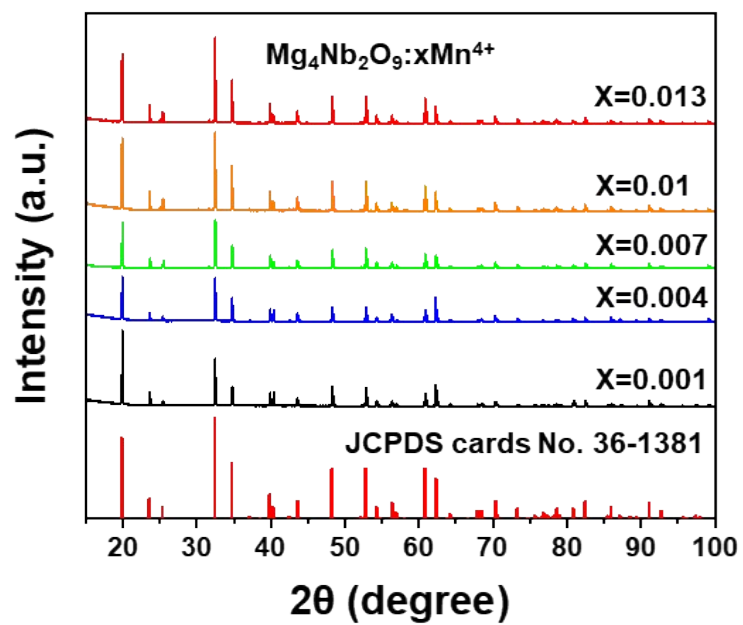
## **Electronic supplementary information (ESI)**

### **Mn<sup>4+</sup>-doped rare-earth-free Mg<sub>4</sub>Nb<sub>2</sub>O<sub>9</sub> phosphors for optical temperature sensing**

Weiwei Xiang and Jae Su Yu\*

*Department of Electronic and Information Convergence Engineering, Institute for Wearable Convergence Electronics, Kyung Hee University, Yongin-si, Gyeonggi-do, 17104, Republic of Korea*

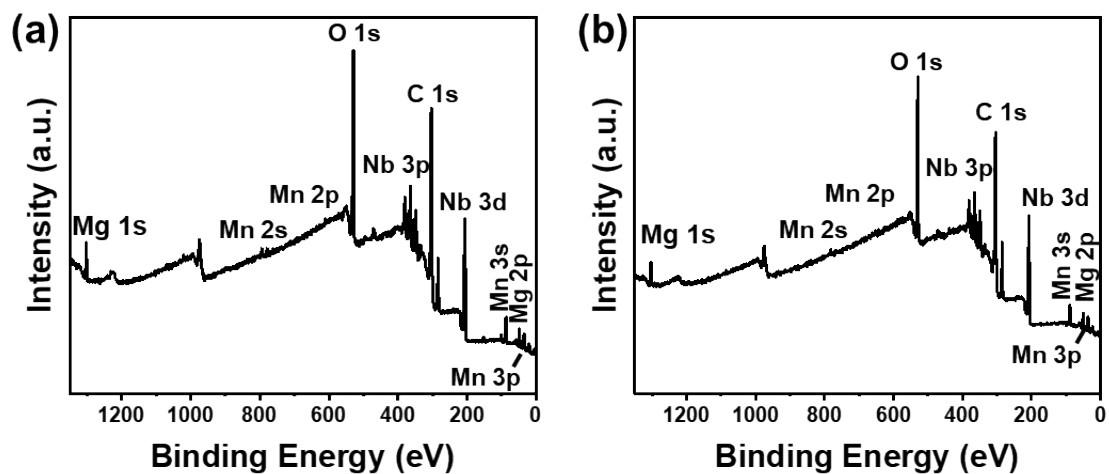
*Corresponding author: E-mail: [jsyu@khu.ac.kr](mailto:jsyu@khu.ac.kr) (J. S. Yu)*



**Fig. S1.** XRD patterns of  $\text{Mg}_4\text{Nb}_2\text{O}_9:\text{xMn}^{4+}$  phosphors (x = 0.001, 0.004, 0.007, 0.01, and 0.013, in mol) and standard  $\text{Mg}_4\text{Nb}_2\text{O}_9$  data.

**Table S1.** XRD refinement results of the  $\text{Mg}_4\text{Nb}_2\text{O}_9:0.001\text{Mn}^{4+}$  and  $\text{Mg}_4\text{Nb}_2\text{O}_9:0.004\text{Mn}^{4+}$  phosphors.

	$\text{Mg}_4\text{Nb}_2\text{O}_9:0.001\text{Mn}^{4+}$	$\text{Mg}_4\text{Nb}_2\text{O}_9:0.004\text{Mn}^{4+}$	$\text{Mg}_4\text{Nb}_2\text{O}_9:0.013\text{Mn}^{4+}$
Space group	$\text{P}\bar{3}\text{c}1$	$\text{P}\bar{3}\text{c}1$	$\text{P}\bar{3}\text{c}1$
a (Å)	5.1632	5.16289	5.1584
b (Å)	5.1632	5.16289	5.1584
c (Å)	14.03034	14.02987	14.01701
$\alpha$ (°)	90	90	90
$\beta$ (°)	90	90	90
$\gamma$ (°)	120	120	120
V (Å <sup>3</sup> )	323.919	323.869	323.011
$R_{\text{wp}}$	9.62%	9.27%	11.2%
$R_{\text{p}}$	6.66%	6.17%	8.23%
$\chi^2$	1.87	1.86	1.2



**Fig. S2.** Total XPS survey scan spectra of the (a)  $\text{Mg}_4\text{Nb}_2\text{O}_9:0.001\text{Mn}^{4+}$  and  $\text{Mg}_4\text{Nb}_2\text{O}_9:0.004\text{Mn}^{4+}$  phosphors.

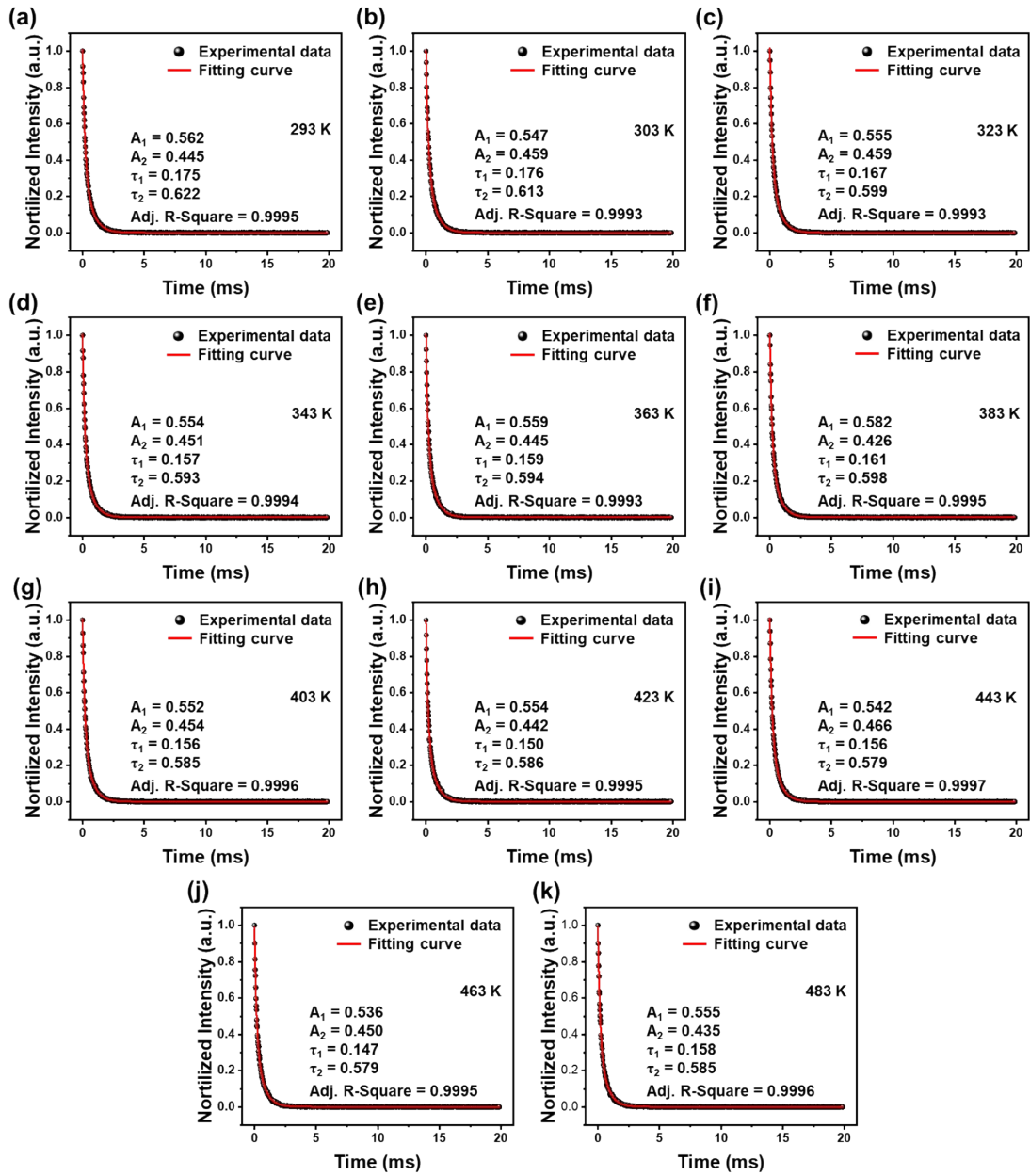


Fig. S3. Decay curves of the  $\text{Mg}_4\text{Nb}_2\text{O}_9:0.004\text{Mn}^{4+}$  phosphor at different temperatures.

**Table S2.** Comparison of  $S_R$  between  $Mg_4Nb_2O_9:Mn^{4+}$  and several lifetime-based temperature sensing phosphor materials.

Sensing materials	Temperature	Maximum $S_R$ (%K <sup>-1</sup> )	Ref.
$SrAl_2Si_2O_8:Eu^{2+}/Eu^{3+}$	303-583 K	0.22	1
$Ca_3Y_2Ge_3O_{12}:Bi^{3+}/Eu^{3+}$	297.8-480 K	0.338	2
$YF_3:Nd^{3+}, Yb^{3+}$	100-320 K	0.31	3
$Ca_8ZnLa(PO_4)_7:Tb^{3+}, Eu^{3+}$	298-498 K	0.34	4
$Mg_4Nb_2O_9:Mn^{4+}$	293-483 K	0.48	This work

## References

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