

1 **Supplementary information**

2 **Luminescence and Luminescence Quenching of K<sub>2</sub>Bi(PO<sub>4</sub>):Sm<sup>3+</sup> Phosphors for  
3 Horticultural and General Lighting Applications**

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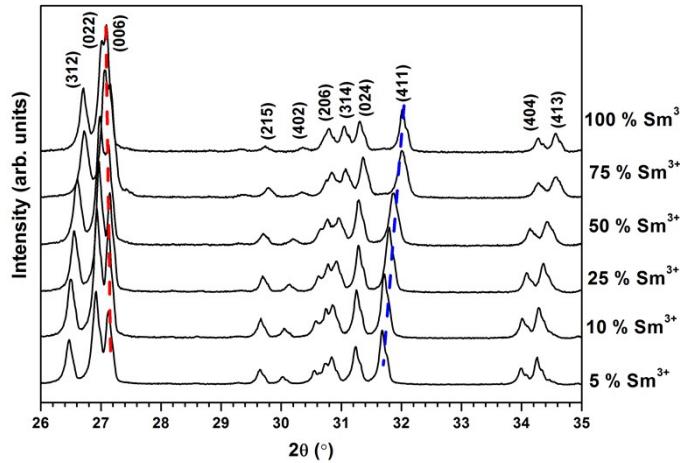
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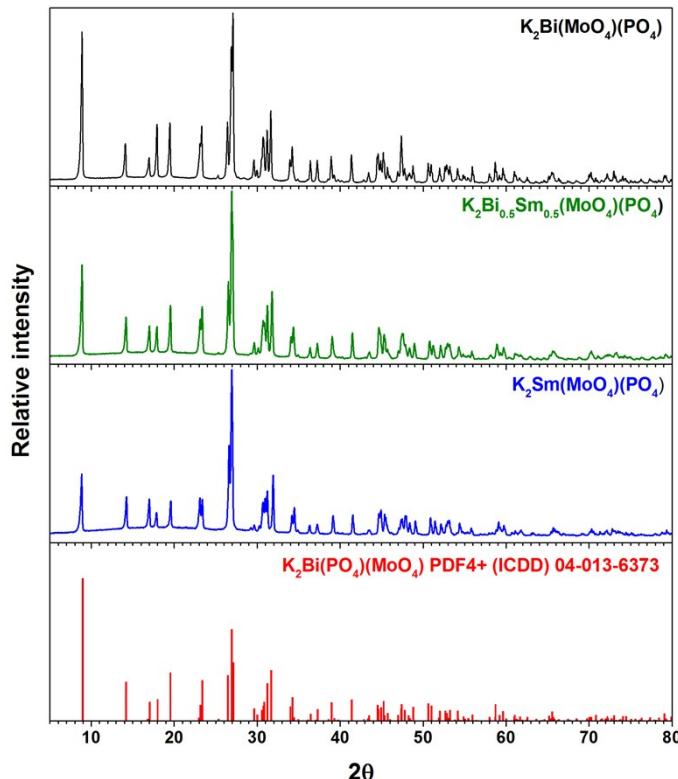
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21 **Figure S1.** Fragment of XRD patterns of K<sub>2</sub>Bi(PO<sub>4</sub>):Sm<sup>3+</sup> as a function of Sm<sup>3+</sup>  
22 concentration.

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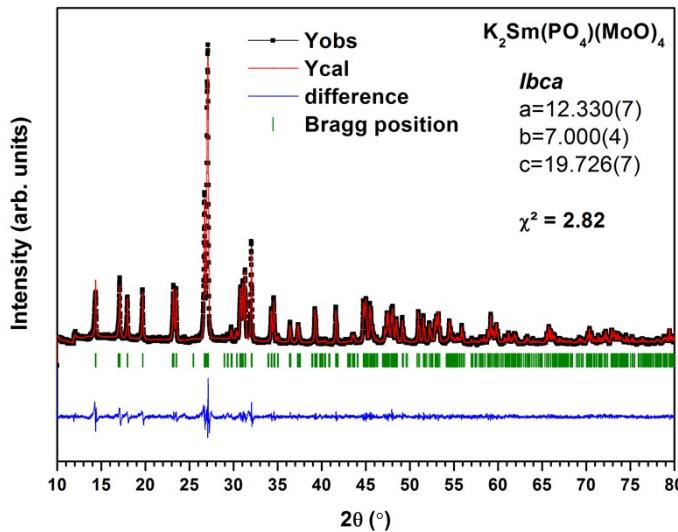
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3 **Figure S2.** XRD patterns of  $K_2Bi(PO_4)(MoO_4):Sm^{3+}$  as a function of  $Sm^{3+}$  concentration.

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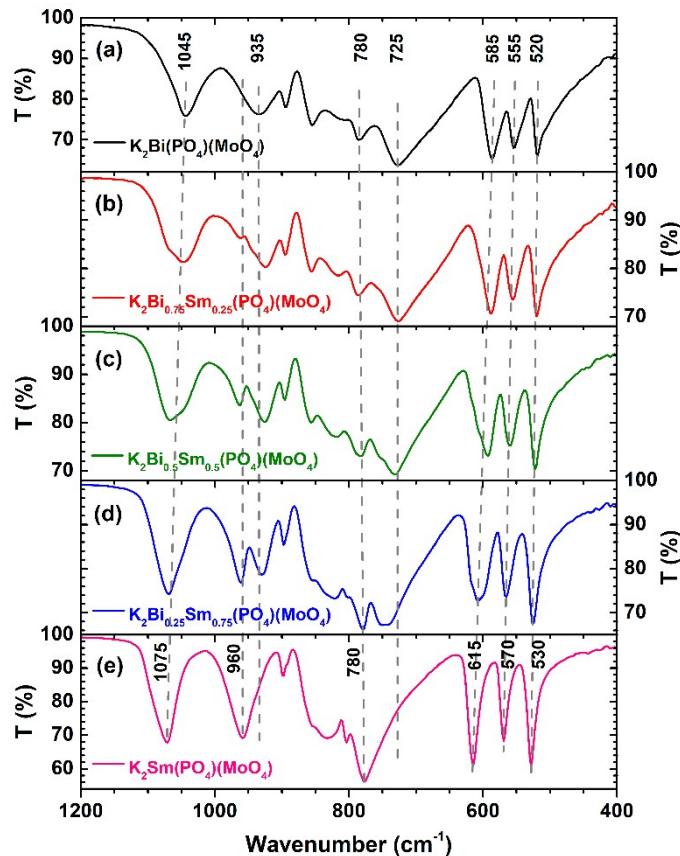


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6 **Figure S3.** Rietveld refinement of  $K_2Sm(PO_4)(MoO_4)$  powder XRD pattern.

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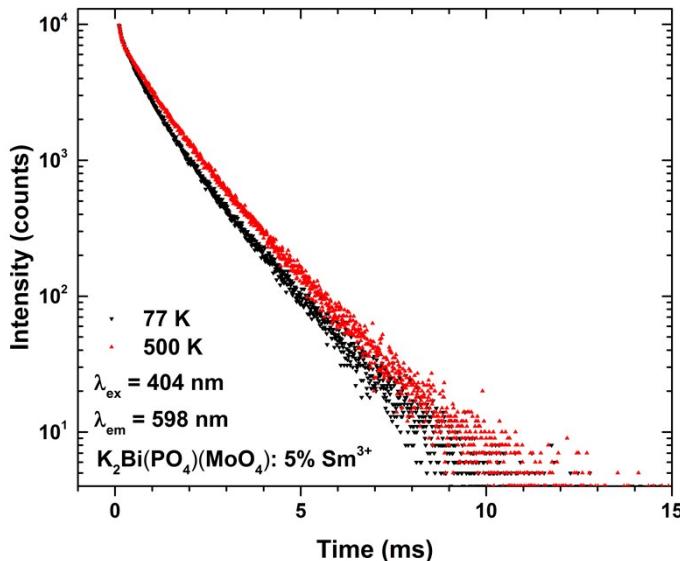
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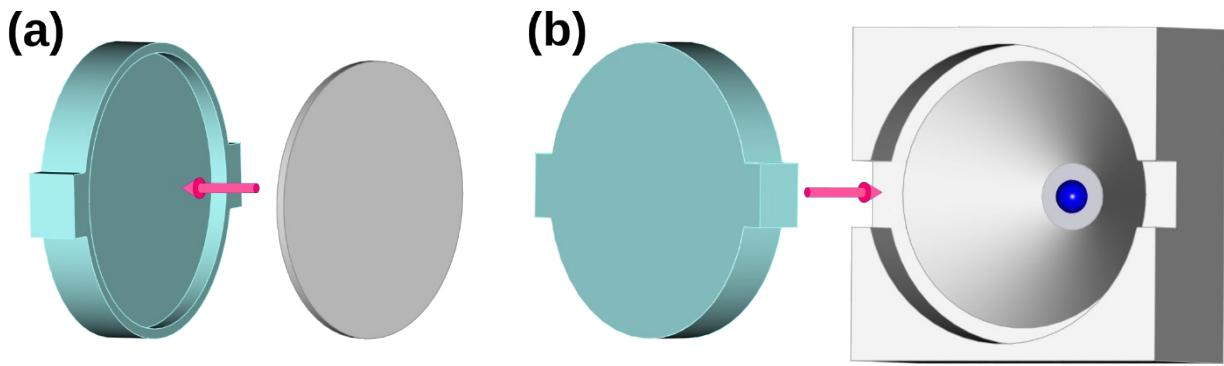
3 **Figure S4.** FTIR spectra of  $\text{K}_2\text{Bi}(\text{PO}_4)(\text{MoO}_4)$  doped with (a) 0%, (b) 25%, (c) 50%, (d) 75% and  
4 (e) 100%  $\text{Sm}^{3+}$ .

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7 **Figure S5.** PL decay curves of  $\text{K}_2\text{Bi}(\text{PO}_4)(\text{MoO}_4):5\%\text{Sm}^{3+}$  as a function of temperature.  
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2 **Figure S6.** A drawing of the designed pcLED for the plant growth. (a) The phosphor-silicone  
 3 converter (grey) is placed into a transparent poly(methyl methacrylate) holder (cyan); (b) the holder  
 4 containing the converter is used as a lid, to cover a near-UV LED (blue) mounted in a white  
 5 polyvinyl chloride foam reflector.

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8 **Table S1.** Unit cell parameters of  $\text{K}_2\text{Bi}(\text{PO}_4)(\text{MoO}_4):\text{Sm}^{3+}$  derived from the Rietveld refinement of  
 9 the XRD patterns.

$\text{Sm}^{3+}$ (%)	$a$ ( $\text{\AA}$ )	$b$ ( $\text{\AA}$ )	$c$ ( $\text{\AA}$ )	$V$ ( $\text{\AA}^3$ )
<b>5</b>	12.468(5)	7.022(3)	19.691(8)	1724
<b>10</b>	12.459(8)	7.020(3)	19.698(7)	1723
<b>25</b>	12.441(3)	7.017(4)	19.704(5)	1720
<b>50</b>	12.401(8)	7.010(8)	19.712(9)	1714
<b>75</b>	12.364(5)	7.005(2)	19.719(9)	1708
<b>100</b>	12.330(7)	7.000(4)	19.726(7)	1703

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12 **Table S2.** Colour coordinates (CIE 1931 and CIE 1976 colour space) and lumen equivalents (LE)  
 13 of synthesized phosphors as a function of  $\text{Sm}^{3+}$  concentration.

$\text{Sm}^{3+}$ (%)	$\lambda_{\text{ex}} = 404 \text{ nm}$				
	CIE 1931		CIE 1976		LE (lm/W <sub>opt</sub> )
	x	y	u'	v'	
<b>0.5</b>	0.61069	0.38870	0.37913	0.54296	273
<b>1</b>	0.61048	0.38891	0.37883	0.54301	274
<b>2.5</b>	0.61086	0.38854	0.37937	0.54293	273
<b>5</b>	0.61098	0.38842	0.37955	0.54290	273
<b>10</b>	0.61117	0.38823	0.37982	0.54286	272
<b>25</b>	0.61146	0.38794	0.38024	0.54280	272
<b>50</b>	0.61195	0.38744	0.38096	0.54268	268
<b>75</b>	0.61170	0.38763	0.38064	0.54272	258
<b>100</b>	0.61381	0.38548	0.38374	0.54224	286

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1 **Table S3.** Effective PL lifetime values of  $K_2Bi(PO_4)(MoO_4):Sm^{3+}$  phosphors as a function of  $Sm^{3+}$   
2 concentration, ( $\lambda_{ex} = 404$  nm,  $\lambda_{em} = 598$  nm).

$Sm^{3+}$ (%)	$\tau_{eff}$ (ms)
<b>0.5</b>	1.62
<b>1</b>	1.59
<b>2.5</b>	1.33
<b>5</b>	1.14
<b>10</b>	0.87
<b>25</b>	0.43

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5 **Table S4.** Extracted parameters of the PL decay curves fit by IH function.

$Sm^{3+}$ (%)	s	$I_0$	$\tau_{rad}$ (ms)	bckg	q	Err	Notes
0.05	6	10303	1.83	9.95	0.003	104	Equally good fits for all s.
	8	10402	1.81		0.007	103	
	10	10551	1.80		0.013	103	
0.5	6	10200	1.83	2.00	0.006	170	Slightly better fit for dq, s=8.
	8	10950	1.81		0.022	178	
	10	11300	1.80		0.041	168	
1	6	10000	1.83	4.00	0.008	184	Slightly better fit for dq, s=8.
	8	10648	1.81		0.024	179	
	10	11275	1.80		0.049	177	
2.5	6	10410	1.83	2.50	0.017	112	Slightly better fit for dd, s=6 and dq, s=8.
	8	12000	1.81		0.055	99	
	10	13643	1.80		0.105	221	
5	6	10730	1.83	1.49	0.026	270	Slightly better fit for dd, s=6.
	8	12200	1.81		0.080	275	
	10	13000	1.80		0.156	359	
10	6	x	x	x	x	x	Slightly better fit for dq, s=8. Unable to fit by dd, qq, s=6,10.
	8	12445	1.81	0.78	0.131	246	
	10	x	x	x	x	x	
25	6	x	x	0.42	x	x	Slightly better fit for dq, s=8 and qq, s= 10. Unable to fit by dd, s=6.
	8	14000	1.81		0.271	466	
	10	16000	1.80		0.502	594	

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2 **Table S5.** Colour coordinates (CIE 1931 and CIE 1976 colour space) and lumen equivalents (LE)  
 3 of  $\text{K}_2\text{Bi}(\text{PO}_4)(\text{MoO}_4):5\%\text{Sm}^{3+}$  as a  
 4 function of temperature.

T (K)	$\lambda_{\text{ex}} = 404 \text{ nm}$				
	CIE 1931		CIE 1976		LE (lm/W <sub>opt</sub> )
	x	y	u'	v'	
77	0.62565	0.37385	0.40139	0.53965	239
100	0.62386	0.37563	0.39864	0.54006	242
150	0.62007	0.37940	0.39290	0.54091	248
200	0.61709	0.38236	0.38846	0.54157	253
250	0.61452	0.38491	0.38468	0.54214	256
300	0.61235	0.38705	0.38153	0.54260	258
350	0.61035	0.38903	0.37865	0.54303	260
400	0.60823	0.39111	0.37563	0.54347	262
450	0.60602	0.39329	0.37251	0.54393	264
500	0.60415	0.39511	0.36990	0.54431	265

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14 **Table S6.** Temperature dependent effective PL lifetime values ( $\lambda_{\text{ex}} = 404 \text{ nm}$ ,  $\lambda_{\text{em}} = 598 \text{ nm}$ ) of  
 15  $\text{K}_2\text{Bi}(\text{PO}_4)(\text{MoO}_4):5\%\text{Sm}^{3+}$  phosphor.

T (K)	$\tau_{\text{eff}}$ (ms)
77	1.11
100	1.11
150	1.12
200	1.13
250	1.15
300	1.16
350	1.19
400	1.21
450	1.22
500	1.23

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