

Supporting Information

Novel red phosphor of Gd³⁺, Sm³⁺ co-activated Ag_xGd_{((2-x)/3)-0.3-y}Sm_yEu³⁺0.30□_{(1-2x-2y)/3}WO₄ Scheelites for LED Lighting

Vladimir Morozov ¹, Bogdan I. Lazoryak ¹, Aleksandra A. Savina ^{2,3}, Elena G. Khaikina ³, Ivan I. Leonidov ⁴, Alexey V. Ishchenko ⁵, Dina Deyneko ^{1,6,*}

¹ Chemistry Department, Moscow State University, 119991 Moscow, Russia; morozov111vla@mail.ru (V.A.M.); bilazoryak@gmail.com (B.I.L.)

² Skolkovo Institute of Science and Technology, 121205, Moscow, Russia; a.savina@skoltech.ru

³ Baikal Institute of Nature Management, Siberian Branch, Russian Academy of Science, Ulan-Ude 670047, Russia

⁴ Institute of Solid State Chemistry, Ural Branch, Russian Academy of Sciences, Ekaterinburg 620990, Russia

⁵ NANOTECH Center, Ural Federal University, Ekaterinburg 620002, Russia

⁶ Laboratory of Arctic Mineralogy and Material Sciences, Kola Science Centre, Russian Academy of Sciences, 184209 Apatity, Russia

* Correspondence: deynekomu@gmail.com

Table S1. Positions ($\lambda_{\max}$, nm) and integral intensities (I_{int}) of two maximum bands on PL spectra of Ag_xR_{((2-x)/3)-0.3-y}Sm_yEu³⁺0.30□_{(1-2x-2y)/3}WO₄ (R = Eu, Gd, Sm; x = 0.50, 0.286, 0.20; y = 0, 0.01, 0.02, 0.03) scheelite-type phases. All samples are measured under the same conditions.

Phase	${}^5\text{D}_0\rightarrow{}^7\text{F}_0$	${}^5\text{D}_0\rightarrow{}^7\text{F}_1$	${}^5\text{D}_0\rightarrow{}^7\text{F}_2$		${}^a\text{R/O}$	${}^bI_{\text{int}}/I_0$	
	λ_{max}	I_{int}	λ_{max1}	λ_{max2}			
$x = 0.50$							
$\text{Ag}_{0.50}\text{Eu}_{0.20}\text{Eu}_{0.30}\text{WO}_4$	580	34	612.4	615.5	301	8.8	1.0
$\text{Ag}_{0.50}\text{Gd}_{0.20}\text{Eu}_{0.30}\text{WO}_4$	580	52	612.4	615.5	457	8.8	1.5
$\text{Ag}_{0.50}\text{Gd}_{0.19}\text{Sm}_{0.01}\text{Eu}_{0.30}\text{WO}_4$	580	218	612.4	615.5	1860	8.5	6.2
$\text{Ag}_{0.50}\text{Gd}_{0.18}\text{Sm}_{0.02}\text{Eu}_{0.30}\text{WO}_4$	580	175	612.4	615.5	1492	8.5	5.0
$\text{Ag}_{0.50}\text{Gd}_{0.17}\text{Sm}_{0.03}\text{Eu}_{0.30}\text{WO}_4$	580	173	612.4	615.5	1438	8.5	4.8
$\text{Ag}_{0.50}\text{Sm}_{0.20}\text{Eu}_{0.30}\text{WO}_4$	580	16	612.4	615.5	135	8.8	0.4
$x = 0.286$							
${}^1\text{Ag}_{0.286}\text{Eu}_{0.272}\text{Eu}_{0.30}\text{WO}_4$	580.2	17	612.7	615.7	149	8.8	0.5
$\text{Ag}_{0.286}\text{Gd}_{0.272}\text{Eu}_{0.30}\text{WO}_4$	580.2	172	612.8	615.6	1512	8.8	5.0
$\text{Ag}_{0.286}\text{Gd}_{0.262}\text{Sm}_{0.01}\text{Eu}_{0.30}\text{WO}_4$	580.2	260	612.9	615.6	2181	8.4	7.2
$\text{Ag}_{0.286}\text{Gd}_{0.252}\text{Sm}_{0.02}\text{Eu}_{0.30}\text{WO}_4$	580.2	308	612.9	615.6	2609	8.5	8.7
$\text{Ag}_{0.286}\text{Gd}_{0.242}\text{Sm}_{0.03}\text{Eu}_{0.30}\text{WO}_4$	580.3	199	612.8	615.6	1630	8.2	5.4
$\text{Ag}_{0.286}\text{Sm}_{0.272}\text{Eu}_{0.30}\text{WO}_4$	580.2	3	612.7	615.5	31	9.1	0.1
$x = 0.20$							
${}^1\text{Ag}_{0.20}\text{Eu}_{0.30}\text{Eu}_{0.30}\text{WO}_4$	580.1	16	612.8	615.7	140	8.5	0.5
$\text{Ag}_{0.20}\text{Gd}_{0.30}\text{Eu}_{0.30}\text{WO}_4$	580.3	163	613.0	615.5	1425	8.7	4.7
$\text{Ag}_{0.20}\text{Gd}_{0.29}\text{Sm}_{0.01}\text{Eu}_{0.30}\text{WO}_4$	580.4	333	613.0	615.5	2832	8.5	9.4
$\text{Ag}_{0.20}\text{Gd}_{0.28}\text{Sm}_{0.02}\text{Eu}_{0.30}\text{WO}_4$	580.4	300	613.0	615.5	2571	8.6	8.5
$\text{Ag}_{0.20}\text{Gd}_{0.27}\text{Sm}_{0.03}\text{Eu}_{0.30}\text{WO}_4$	580.3	262	613.0	615.5	2211	8.4	7.3
$\text{Ag}_{0.20}\text{Sm}_{0.30}\text{Eu}_{0.30}\text{WO}_4$	-	3	613	615.5	21	8.5	0.1

¹ The compositions determined by the crystal structure refinements are Ag_{0.238}Eu_{0.587}□_{0.175}WO₄ and Ag_{0.157}Eu_{0.614}□_{0.229}WO₄, respectively.

^a R/O is the $I_{\text{int}}(^5\text{D}_0 \rightarrow ^7\text{F}_2)/I_{\text{int}}(^5\text{D}_0 \rightarrow ^7\text{F}_1)$ ratio, often referred to as the asymmetry ratio.

^b I_{int} and I_0 are the integral intensity for the $^5\text{D}_0 \rightarrow ^7\text{F}_2$ transition on PL spectra of the studied phase and Ag_{0.50}Eu_{0.50}WO₄, respectively.