X-ray Diffraction and Luminescence of $Y(TaNb)O_4$: Eu^{3+}, Tb^{3+} Phosphors

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Yttrium tantalate, yttrium niobium-tantalate and yttrium niobate doped by rare earth elements such as Europium (Eu) and/or Terbium (Tb), $Y(TaNb)O_4$: Eu^{3+}, Tb^{3+}, are of great interest to both scientific and application point of view. In these phosphors, the host lattice emission centers and the rare earth emission centers can both contribute to the overall luminescence. Due to their variable luminescence chromaticity, the rare earth activated yttrium tantalate type phosphors are promising materials for optoelectronics. $Y(TaNb)O_4$: Eu^{3+}, Tb^{3+} phosphors were prepared by solid state reaction from flux of homogeneous mixture consisting of Y_2O_3, Eu_2O_3, Tb_4O_7, Ta_2O_5 and Na_2SO_4.[1] X-ray diffraction (XRD) and X-ray excitation were used to investigate the structural and luminescent properties of $Y(TaNb)O_4$: Eu^{3+}, Tb^{3+} phosphors.

Under X-ray excitation (50 KeV, 100 mA), the blue-light emission of $Y(TaNb)O_4$ phosphors is associated with TaO_4^3 and NbO_4^3 groups from the host crystalline lattice.[2] When rare earth ions such as Eu^{3+} and Tb^{3+} are used simultaneously to partially substitute the yttrium ions from the host crystalline lattice, Eu^{3+} and Tb^{3+} emission centers are created. In this case, the luminescent emission could be red-shifted toward longer wavelengths, and both of them can contribute to the overall luminescence. In Fig. 1, the first 2 picks at 490 nm and 545 nm correspond to Tb^{3+}, and the picks at 590 nm, 612 nm and 705 nm are the Eu^{3+} contribution to the X-ray excited luminescence. The luminescence intensities of Tb^{3+} and especially of Eu^{3+} under X-ray excitation were much higher in comparison with UV or VUV excitation. Moreover, by means of X-ray diffraction we first calculated the crystallographic data for $YTaO_4$ and $YNbO_4$ with double activation by Eu^{3+} and Tb^{3+}. In Fig. 2, the fitting results by Rietveld analysis are shown for the phosphor $YTaO_4$: Eu^{3+}, Tb^{3+}. We also found that the addition of the rare earth ions doesn't improve the basic structure, but increase the unit cell volume according to Vegard's law. The unit cell volume increment was 0.53 % and 0.26% for Eu and Tb, respectively. The detailed crystallographic information from Rietveld analysis is listed in Table 1.

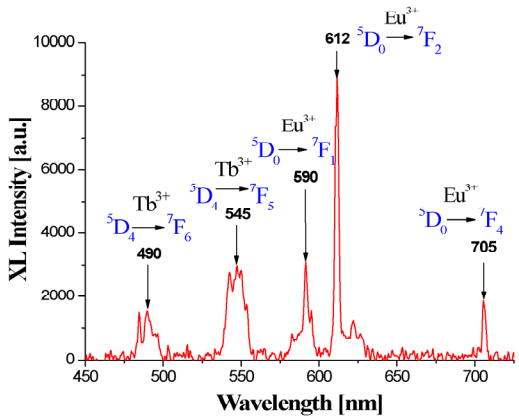

Fig. 1. X-ray Luminescence of $YTaO_4$: Eu^{3+},Tb^{3+}.

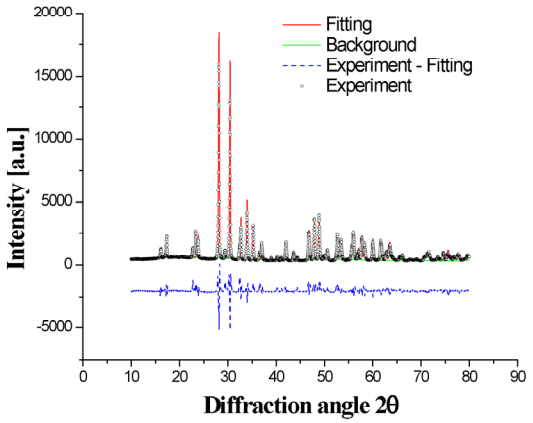

Fig. 2. XRD patterns of $YTaO_4$: Eu^{3+}, $Tb^{3+}$and Rietveld fitting.

Table 1. Crystallographic data for $YTaO_4$ doped by Eu^{3+} and/or Tb^{3+}.

Formula	a (Å)	b (Å)	c (Å)	B (Å)	V (Å^3)	R-factor	Atomic distances Y-O (Å)	Atomic distances Ta-O (Å)
$YTaO_4$	5.2937	5.4569	5.1082	96.36	146.653	0.144	O(1) 2.587 O(1) 2.632 O(2) 2.520 O(2) 2.424	O(1) 1.490 O(1) 2.480 O(2) 1.658
$Y_{0.95}Eu_{0.05}TaO_4$	5.2971	5.4605	5.1116	96.37	146.939	0.149	O(1) 2.601 O(1) 2.627 O(2) 2.526 O(2) 2.412	O(1) 1.486 O(1) 2.486 O(2) 1.666
$Y_{0.95}Eu_{0.025}Tb_{0.025}TaO_4$	5.2980	5.4610	5.1120	96.37	146.989	0.142	O(1) 2.602 O(1) 2.639 O(2) 2.536 O(2) 2.417	O(1) 1.489 O(1) 2.467 O(2) 1.646
$Y_{0.95}Tb_{0.05}TaO_4$	5.2973	5.4591	5.1109	96.38	146.884	0.150	O(1) 2.379 O(1) 2.328 O(2) 2.301 O(2) 2.247	O(1) 1.892 O(1) 2.557 O(2) 1.926

The doubly activated $Y(TaNb)O_4$: Eu^{3+}, Tb^{3+} phosphors could be applied to the X-ray intensifying screens for medical diagnosis with variable photoluminescence colors from blue- to- green- to- yellow-to-red.

1. A. Hristea, E. -J. Popovici, L. Muresan, R. Grecu, L. Silaghi-Dumitrescu, E. Indrea, and M. Vasilescu, "Yttrium-tantalate-based phosphors for x-ray intensifying screen," ROMOPTO 2003: Seventh Conference on Optics, SPIE 5581, 781 (2004).
2. G. Blasse and A. Bril "Photoluminescence Efficiency of Phosphors with Electronics Transitions in Localized Centers", J. Electrochem Soc. 115 (10), 1067 (1968).