

Optical and Scintillation Properties of CsI(Tl,Eu) Crystals

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It is well known that Eu^{2+} ions in CsI lattice stimulate the 445 nm luminescence [1]. CsI(Tl) crystals codoped with of Eu^{2+} have a relatively low-level afterglow in millisecond range [2]. A possible explanation of the effect of afterglow suppression is an interaction between Eu^{2+} and oxygen containing impurities in the melt. Such process can results in purification of the crystal lattice from the impurity traps.

CsI(Tl,Eu) crystals have been grown by pulling on a seed from the melt with a feeding by melted row material in a conical crucible [3]. Obtained ingots have a good transparency in a visible range of spectrum but some of them include light-scattered particles. Absorption spectra in visible and IR range have been measured as well as emission and pulse height spectra. Level of afterglow is measured after 3 and 100 ms at excitation by 20 ns and 1 s X-rays pulse respectively. CsI(Tl) crystals codoped with Eu have an additional absorption band near 350 nm and emission band at 445 nm. According literature data these bands correspond to absorption and emission of Eu^{2+} ions. Light yield and energy resolution of CsI(Tl,Eu) crystals correspond to characteristics of CsI(Tl). Results of investigations on afterglow and IR absorption are presented in a table.

Material	Eu content, w. %	Afterglow, %		Position of IR absorption bands, cm^{-1}
		3 ms	100 ms	
CsI(Tl)	–	1.4	0.58	615; 1090; 1105; 1125 (SO_4^{2-}) 2144 (CNO^-)
CsI(Tl,Eu)	$1 \cdot 10^{-4}$	0.66	0.54	–
CsI(Tl,Eu)	$5 \cdot 10^{-4}$	0.61	0.42	–
CsI(Tl,Eu) with scattered particles	$4 \cdot 10^{-4}$	–	0.55	440; 540 (Eu_2O_3)
Eu_2O_3 in a CsI pill	–	–	–	440; 540

From the obtained data it can be concluded that Eu^{2+} ions interact with oxygen containing impurities in the melt. As a result the europium oxide is formed. White powder of Eu_2O_3 is concentrated on a bottom of crucible not in a crystal lattice if a convection flows are relatively low in the melt. In comparison with CsI or CsI(Tl), obtained CsI(Tl,Eu) crystals have a lower level of afterglow after 3 ms and excellent transparency in IR range of spectrum even in the region of CNO^- anions absorption at 2144 cm^{-1} .

- [1] H.J. Seo, W.S. Zhang, T. Tsuboi, et al. *Journal of Alloys and Compounds*, **344** (2002), 268
 [2] V.V. Nagarkar, E.E. Ovechkina, S.R. Miller, et al. *Functional Materials*, **12** (2005), 645
 [3] B. Zaslavsky. *Journal of Crystal Growth*, **200** (1999) 476