Known and new scintillation materials on a base of CsI:Tl crystal

A.M. Kudin, Yu.A. Borodenko, A.V. Kolesnikov, B.G. Zaslavsky, A.I. Mitichkin,

A.L. Shpilinskaya, L.N. Trefilova

Institute for Scintillation Materials, 60 Lenin ave., Kharkov, 61001, Ukraine

E-mail: kudin@isc.kharkov.com

Scintillation properties like light yield (LY), radiation hardness (RH) and afterglow (AG_{100}, after 100 ms) of known materials on a base of CsI:Tl crystal are reviewed. To characterize heat and mass transfer during the crystal growth we used additionally a GC term (growth conditions). GC means increasing "+" or decreasing "–" of control heater temperature during crystal growth. To obtain large ingots of 250 mm in diameter and 350 mm in height we used an automated pulling on a seed from the melt with feeding by melt. Only CsI:Tl,IO_3 crystals have been grown by Stockbarger technique to prevent formation of oxygen bubbles in ingot. Noted characteristics are listed in a table. Also we indicated a limit of Tl concentration (C_{Tl}) which corresponds to beginning of concentration quenching of LY at gamma excitation.

Material	GC	LY, ph/MeV	RH, Rad	AG_{100}, %	C_{Tl} limit, ppm
CsI:Tl	–	48 000	$\geq 10^4$	0.2-0.6	1600
CsI:Tl,BO_2	+	31 000	very bad	≤ 0.7	
CsI:Tl,Eu	–		$\sim 10^2$	≤ 0.7	1600
CsI:Tl,Na,CO_3	+	48 000	$\sim 10^4$	0.7-1.0	2050
CsI:Tl,IO_3		44 000	$\sim 10^4$	0.5-1.0	≥ 5000
CsI:Tl,Na,NO_2	+	45 000	$> 10^5$	≤ 0.7	???

As it seen from table only two materials (CsI:Tl,Na,CO_3 and new CsI:Tl,Na,NO_2) have a high LY and RH as well as provide good GC and can be grown like large-size ingots.

It is known that maximum LY for alpha particles is realized at C_{Tl} = 2100 ppm instead of C_{Tl} = 900 ppm for gamma rays (in case then Si photodiode is used as photoreceiver). So, the optimum of Tl concentration for light ions registration should be C_{Tl} > 2100 ppm. As it seen from results of table only CsI:Tl,IO_3 crystals satisfied this requirement. Nevertheless we believe that CsI:Tl,Na,NO_2 crystal can be a perspective candidate for particle identification in FAZIA project. To define the limit of C_{Tl} in this crystal additional investigations are required.