3.4 Scintillation Properties of Pure CsI and CsI Doped with CsBr

by Ł.Świderski, M.Moszyński, A.Nassalski, A.Syntfeld-Każuch W.Czarnacki, W.Klamra[1)], V.A.Kozlov[2)]

[VI.1]

Scintillation techniques are still of interest in many fields of nuclear physics, medicine and recently also astrophysics. There is a demand to develop crystals with a high light output, a good energy resolution and a short decay time. CsI(Tl) is one of the most widely used scintillators because of its high light yield (~65000 ph/MeV). However, because of a long decay time with two main decay modes of ~0.7 µs and ~3.4 µs, it is used rather for low count rate measurements. In contrast, pure CsI has a much shorter decay time (~20 ns), but its scintillation efficiency is also largely reduced (~2000 ph/MeV), which also degrades the energy resolution. CsI doped with Cesium Bromide was proposed as a scintillator that combines advantages of both above crystals. Recently, the increase of CsI(Br) scintillation yield in comparison to pure CsI was ascribed to a rise of the luminescence emission band around 450 nm, although previous work shows that it may also be caused by impurities in the crystal lattice like I^- vacancies or oxygen-containing compounds. The aim of the present study was to compare the main characteristics of the pure CsI with the bromine doped one.

The measurements of the light yield, its non-proportionality and energy resolution were done using a Photonis XP5500B photomultiplier (PMT). High blue sensitivity of the PMT of 13.7 µA/lmF, which corresponds to quantum efficiency of about 35%, was an important advantage because of a poor scintillation efficiency of the tested crystals. Before each set of measurements, the samples were mechanically polished, wrapped with several layers of Teflon tape and then coupled to the photocathode by means of silicon grease.

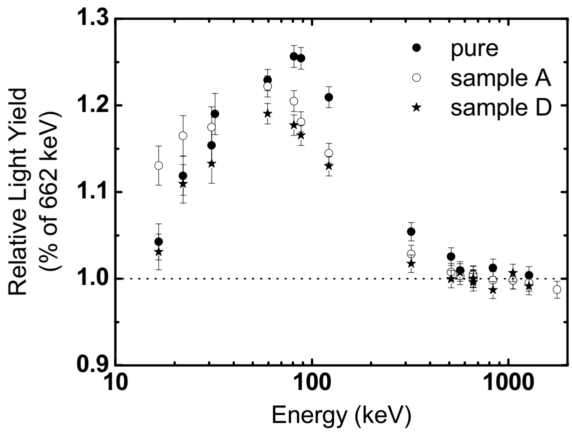

Fig. 1 Non-proportionality of photoelectron yield measured for pure CsI and doped crystals with relative bromine concentration 1÷2.8.

A correlation of the intrinsic resolution versus non-proportionality characteristics of the tested samples was studied. It turned out that pure CsI exhibits the most non-proportional response of light yield, which is clearly seen at energies below 300 keV (see Fig. 1).

As it has been suggested in the literature [1], [2], also in this case the non-proportionality of light yield is correlated with the intrinsic resolution of the crystals. As one can notice from Fig. 2, the intrinsic resolution of the pure CsI is much worse than that of the bromine doped crystals. Comparing two samples of CsI(Br), one can see that the non-proportionality behaviour of sample A is slightly larger than that of sample D. This is reflected in its intrinsic resolution, which is also slightly larger for sample A than that for sample D.

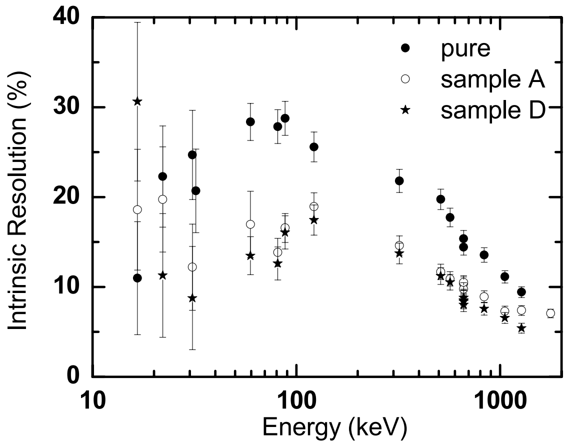

Fig. 2 The intrinsic resolution measured for pure CsI and doped crystals with relative bromine concentration 1 ÷ 2.8.

Presented at the IEEE SCINT Conference, Winston-Salem, USA, June 2007, submitted to IEEE Trans. Nucl. Sci.

[1] M.Moszyński, "Energy resolution of scintillation detectors", SPIE Proceedings, vol. 5922, 592205-1

[2] J.D.Valentine, B.D.Rooney, J.Li, "The light yield non-proportionality component of scintillator energy resolution", IEEE Trans. Nucl. Sci., vol. 45, 1998, pp. 512-517

1) The Royal Institute of Technology, Alba Nova, 106 91 Stockholm, Sweden

2) Lebedev Physical Institute, 117924 Moscow, Russia