PROTECTIVE FUNCTION OF THE COATING ON THE SURFACE OF CsI SCINTILLATOR

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Introduction

CsI pure and activated CsI:Tl and CsI:Na crystals are widely used in high energy physics. It is well known that near the surface in CsI:Na a so called dead layer [1] exists. In CsI the 305 nm luminescence do not excited by photons with 5.9 eV energy because absorption take place immediately near surface [2]. According to paper [3] 21% of ready CsI:Tl crystals need an additional tuning after transportation. To protect the surface the varnish coating is used [4] sometimes.

The goal

The factors which cause instability of scintillation parameters of CsI and CsI(Tl) crystals during their operation are considered. We have tried to show that protective coating on the CsI surface allow to ensures the stability of the main scintillation parameters in the process of long-term storage and after irradiation. Additional functions of the coating are considered recently in paper [5].

Results

To illustrate the protective possibilities of coating we used CsI:Na crystal. Fig.1 shows the changing of light output for alpha particles then crystal are stored at a different relative humidity. It is seen that curve 3 (H = 70%) for crystal with organosilicon coating (15 ± 5 μm) coincides with data for crystal without coating for H = 5%.

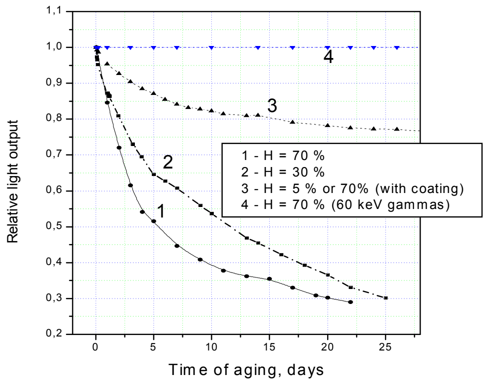

Fig.1. Relative light output as a function of time at different relative humidity (H). CsI:Na crystal is excited by alpha particles (1, 2, 3) or gamma rays (4).

It has been revealed that degradation of scintillator surface results in gradual worsening of energy resolution. It is shown that the surface degradation is caused by the presence of a deformed and distorted layer near surface. Degradation is conditioned by two processes: firstly, decomposition of supersaturated solid solution of vacancies [6] and, secondly, relaxation of elastic stresses near the surface.

The first process is connected with diffusion of vacancies outside the crystal. The flow of impurity ions absorbed on the surface directs opposite to the vacancy flow. The duration of this process is approximately two weeks at the room temperature. As a result the layer arises with increased concentration of hydroxide ions. After irradiation in this layer the induced absorption of U-centers occurs which disappears after additional polishing [7- 9]. Fig.2 shows the result for CsI crystal with protective coating after irradiation. It is seen that in this case additional absorption is absent. So, coating prevents formation of such colored layer. The temporary protection of surface by using coatings, which interact with hydroxide, gives the same result.

The second process leads to recrystallization and formation of mosaic. As a result of this process specially formed for equalization of light yield the surface relief is spontaneously changed. Recrystallization do not depends on humidity. It should be noted that storage of the crystal leads to destruction of matting surface if H = 70%. Any way the uniformity of light output along the CsI:Tl pyramids is subject to unpredictable changes. We conclude that matting of surface should be excluded from the tuning of crystals. Other way we described in ref. [5]. Coating applied to all surface scintillator excluding output window can successfully combine three function: *(i)* protective covering from atmospheric effects; *(ii)* scintillation light convertor of luminescence; *(iii)* ancillary surface for performance of operations on changing the light collection coefficient.

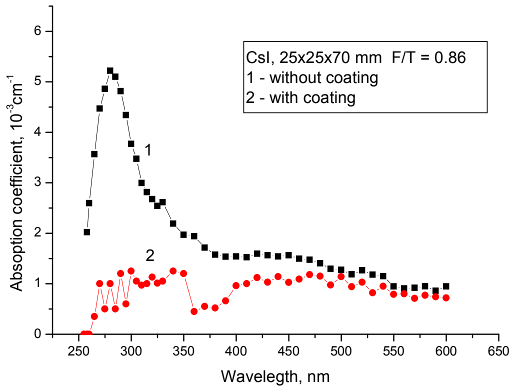

Fig. 3. Additional absorption in CsI crystal after irradiation by the dose of 10^5 Rad.

Conclusion

Necessity and the perspective of coating application are shown: for protection of surface on the stage of detector manufacturing and for wavelength shifting coatings during their operation. In correct technology of coating taking into account temporary character of surface layer relaxation, the protective function ensures stability of the main scintillation parameters in the process of long-term storage and operation. We drawn the conclusion that such coating applied to all surface of CsI and CsI(Tl) scintillators excluding output window can successfully combine three function: *(i)* protective covering from atmospheric effects; *(ii)* scintillation light convertor of luminescence towards the region of higher spectral sensitivity of the photoreceiver; *(iii)* ancillary surface for performance of operations on changing the light collection coefficient without the risk to exceed limited size tolerations and *(iv)* protective coating increase the radiation hardness of CsI pure crystal.

Acknowledgements

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