

## Experimental manifestations of CsI:Na crystal hygroscopicity

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It is known that many scintillation materials are hygroscopic, first of all this concern the most effective of it. This circumstance significantly impairs the performance characteristics of scintillator. In practice the hygroscopic crystals are used after packing to housing that limits their application, for instance, impedes the detection of weakly penetrating radiation.

Hygroscopicity of materials is defined as: "the property of materials to absorb moisture from the air". Hygroscopicity is characteristic to substances which are well soluble in water especially for chemical compounds which form a crystal hydrate with water. CsI-based scintillator do not correspond this definition. The quantitative characteristic of hygroscopicity is an increase in the mass of the sample when stored under normal conditions. It is known that such changes are negligible for CsI-pure material as well as for CsI:Tl, CsI:CO<sub>3</sub> and even for CsI:Na. Nevertheless, the CsI:Na material is considered to be slightly hygroscopic, information on this is given in all reference publications. It seems that this term in scintillation technique implies the deterioration of the spectrometric properties of the surface layers of crystal. It is well known that CsI:Na crystals are not used for detection, for example,  $\alpha$ -particles. This feature is associated with the formation of a dead layer (DL).

The nature of DL is somehow or other associated with the hygroscopicity of crystals. It was shown [1, 2], however, that DL is formed upon aging of CsI:Na crystals in a dry atmosphere or deep vacuum. The mechanism of DL formation is diffusive and consists of two stages. The DL itself as a full loss of detection efficiency is formed at second stage after sodium diffusion to the free surface, approximately after 6 months of aging.

Manifestation of hygroscopicity is associated with the second stage of DL formation. Adsorption of water from air by crystal surface can be observed visually. If the aged scintillator is removed from the housing and placed in a humid atmosphere, its surface very quickly, literally before our eyes, will be covered with droplets of dew. Figuratively

speaking, the sample "perspire", in fact, the water on the surface is not a droplet, but a pool of saturated NaI solution. Such picture can be observed after CsI:Na aged sample removing from dry atmosphere. It turned out that all samples became wet, despite the fact that they were placed in plastic bags for temporary storage. The explanation for such focal hygroscopicity is precisely the formation of the NaI phase on the surface of the CsI crystal. It should be noted that when the crystals are stored under normal conditions, the sweating effect is not observed.

So, the hygroscopicity of CsI:Na crystal has a focal nature and can be observed visually but at specific conditions. Formation of liquid puddles on the boundary crystal–air course a negative change in surface relief. Further transformation of NaI to  $\text{NaHCO}_3$  and water puddles to a loose coating course a change in reflectivity, its uniformity and in energy resolution. To prevent these negative changes it is sufficient to wipe the crystal surface dry before removing of scintillator from dry room. Another way [3] is consisted in application of hydrophobic protective coating on the crystal surfaces.

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