Effects of Ultraviolet (UV) Light on NaI, CsI and BGO Crystals

Ultraviolet radiation in sunlight or fluorescent lighting can produce discoloration and phosphorescence in scintillation crystals. The coloration produced by UV radiation appears in the bulk of the crystal rather than the surface and is most noticeable in large crystals. For this reason, open window detectors or unpackaged crystals should be stored in darkness when not in use.

In NaI(Tl), the damage usually appears as a slightly muddy brown color and produces a loss of resolution. BGO is also very sensitive and its performance deteriorates quickly. BGO and NaI(Tl) should be protected from UV and should be stored in the dark. Counting efficiency is not generally impaired, though pulse height decreases and resolution deteriorates.

The sensitivity of scintillation crystals to UV light depends on the type of crystal and impurity content.

In general, the pure matrix (without presence of scintillation dopant) has better resistance to UV excitation.

Doped CsI crystals are also sensitive to UV light. The general order of resistance would be CsI(Pure), CsI(Tl), CsI(Na).

Although the effects of UV light to NaI have never been closely studied, the following may answer your questions.

1) How and why NaI(Tl) is damaged.

UV light damage to NaI appears as low energy noise in the spectrum. This noise is very similar to effects seen when a photomultiplier tube (PMT) is exposed to small amount of white light, such as a light leak.

With mild UV exposure, several pulses per second can be seen in the 6-10 keV region of a spectrum. If the crystal is stored in a dark area, this mild UV exposure will eventually disappear, although it may take from several hours to several days for the effects to stop.

Severe exposure to UV will appear as a severe light leak to the PMT with an overall loss in Pulse Height and Pulse Height Resolution. At this point no visible color centers can be seen, but effects to the NaI can be irreparable.

In extreme cases, the NaI crystal will take on a light to dark brown discoloration, these colorations are called color centers and permanently damage the NaI crystal. These color centers create light traps and reduce transmission through the NaI crystal.

2) The range of wavelength that effects NaI(Tl).

All Ultraviolet and shorter wavelengths.

3) The strength of light that affects NaI(Tl).

The affects of damage to the NaI crystal from UV light is a time intensity relationship.

Low intensity light such as unfiltered fluorescent light bulbs at a distance of 4 to 5 feet over a period of 1 to 2 hours will effect NaI, but may not cause permanent damage.

Exposure to higher intensity light such as sunlight can permanently damage a NaI crystal in a short period of time (less than 1 hour).

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Recommendations

All fluorescent lights should be covered with clear plastic filter tubes and have black end caps near the end of the bulbs where the UV intensity is the greatest. Two manufacturers of fluorescent light filter products are 3M™ (www.3m.com) and Vista® Window Films (www.vista-films.com). Their web sites can tell you who the distributors are in your area. For customers in Northeast Ohio (U.S.), Suntrol Co. (www.suntrol.com) is a knowledgeable distributor and installer.

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