BEIJING ENERGY

NaI(Tl)
Scintillation Crystal

NaI(Tl) and Polyscin® NaI(Tl)
Sodium Iodide
Scintillation Crystal

Of all available scintillators, NaI(Tl) is the most extensively used material. NaI(Tl) has a very high luminescence (scintillation) efficiency and is available in single crystal or polycrystalline forms in a wide variety of sizes and geometries. The material exhibits no significant self–absorption of the scintillation light.

Single Crystal NaI(Tl)

Figure 1 shows the emission spectrum of NaI(Tl). The emission maximum is well matched to the sensitivity curve of photomultiplier tubes (PMTs) with bialkali photocathodes.

NaI(Tl) produces one of the highest signals in a PMT per amount of radiation absorbed. It is second only to our BrilLanCe®380 scintillator. Under optimum conditions, an average of 1x104 photoelectrons are produced per MeV γ –rays.

The relation between the scintillation intensity and the temperature is shown in Figure 2 for two main amplifier shaping times. For most applications, a 1 μs shaping time is used for temperatures around room temperature and above. The small difference in PH between the 1 μs and 12 μs shaping times does not affect energy resolution for these temperatures.

NaI(Tl) exhibits several decay time constant components. The primary single exponential decay constant is 250ns at room temperature. As the temperature increases, the longer time constant components decrease in intensity and the 1 μs and 12 μs response curves become identical (Figure 2). The relation between the effective decay time and the temperature is presented in Figure 3. [IEEE NSS NS–30, 380 (1983)]. NaI(Tl) is susceptible to radiation damage, i.e. prolonged exposure to intense radiation degrades the scintillation performance. Radiation damage has been observed above levels of 1 Gray (102 rad). The crystal should not be exposed to ultraviolet radiation from fluorescent lamps or sunlight.

Scintillation crystals of NaI(Tl) are routinely grown with a potassium content of less than 0.5 ppm, and are appropriate for low background applications.

NaI(Tl) crystals are widely used for radiation detection: in nuclear medicine, for environmental monitoring, in nuclear physics, aerial survey, well logging and in many other applications.

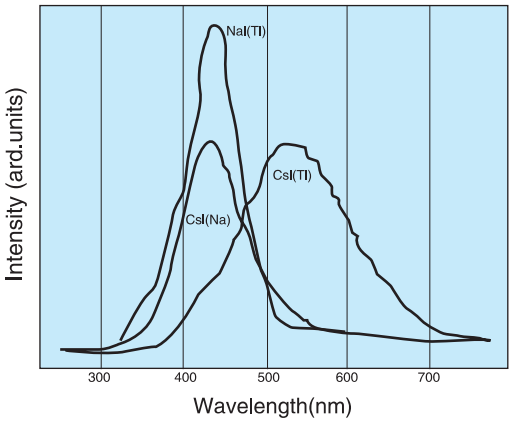

Figure 1. Scintillation emission spectrum of NaI(Tl) and other scintillation materials(1990)

PROPERTIES

Parameter	Description/Value	Unit
Density	3.67	g/cm³
Melting point	924	K
Thermal expansion coefficient	47.4×10^{-6}	C^{-1}
Cleavage plane	<100>	—
Hardness (Mho)	2	—
Hygroscopic	yes	—
Wavelength of emission max	415	nm
Refractive index @ emission max.	1.85	—
Primary decay time	250	ns
Light yield	38	photons/keV γ
Temperature coefficient of light yield	$-0.3\%C^{-1}$	—

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NaI(Tl)
Sodium Iodide
Scintillation Crystal

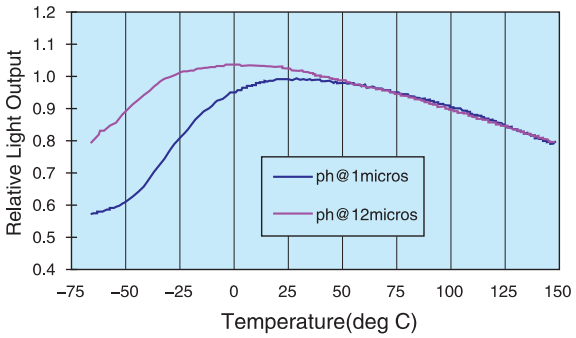

Figure 2. Temperature response of NaI(Tl)

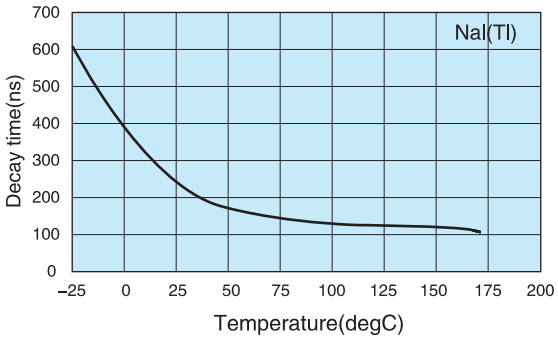

Figure 3. Temperature dependence of the decay time of NaI(Tl)

Polyscin®NaI(Tl)

Polyscin® NaI(Tl) crystals are widely recognized as suitable alternatives to single crystal scintillators in many applications where thermal and mechanical shock are encountered. This crystal offers ruggedness combined with a scintillation performance identical to single crystal NaI(Tl). Current applications include aerospace research, oil well logging, geophysical survey and radiation environmental monitoring.

The polycrystalline structure of Polyscin® NaI(Tl) is derived from a unique manufacturing process in which single crystal ingots are recrystallized under heat and pressure. The resulting material may be characterized as a polycrystalline material with randomly oriented crystal grains in a mosaic structure. The density of NaI is not changed in the process. The characteristic improves mechanical strength but has no effect on the scintillation performance since the material is optically equivalent to single crystal NaI(Tl).

Any fractures produced by thermal or mechanical shock in Polyscin® NaI(Tl) are normally blocked or confined to the small local volumes called grains. Because the cleavage planes of the grains are randomly oriented, it is unlikely that a small fracture would propagate across the grain boundaries. This makes Polyscin® NaI(Tl) the material of choice where ruggedness is important, such as well logging, MWD and aerospace applications.

In contrast, single crystals can cleave along <100> planes under similar shock conditions. In a detector assembly fabricated from single crystal material, even a small crack may propagate along the entire crystal, interfering with the light collection and degrading the pulse height resolution.

Another feature of Polyscin® NaI(Tl) is the possibility to manufacture complicated detector geometries directly without extensive machining. Special geometries currently offered include hexagonal, square and rectangular detector assemblies and large diameter slabs.

Polyscin® NaI(Tl) has been used to construct long crystals of 10 x 10 x 100cm3 (4” x 4” x 40”) and large flat crystals of 60cm x 90cm area (24” x 36”). The use of long continuous bars eliminates the discontinuity encountered by interfacing two or more shorter crystals, improving the scintillation characteristics. Long crystals may be used as position sensitive detectors while at the same time providing spectroscopic data. Detectors of this kind have been fabricated in steel and low background aluminum housings.

NOTICE: We can customize various sizes of crystals according to the demand of the customers.

BEIJING ENERGY WEB SITE www.beijing–energy.com
Beijing Energy Science & Technology Co., Ltd.
ADD: 3F，Building C，BeiQiJia Industry Base, Changping District, Beijing，China，102209
TEL:+86–10–6975 1218 / +8613911739991
FAX:+86–10–6975 1261
E–mail:Beijing_Energy@163.com