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

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 Lanthanum bromide scintillator. Under optimum conditions, an average of 1x 10^4 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 (10^2 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.

Properties	
Density [g/cm^3]	3.67
Melting point [K]	924
Thermal expansion coefficient [C^{-1}]	47.4 x 10^{-6}
Cleavage plane	<100>
Hardness (Mho)	2
Hygroscopic	yes
Wavelength of emission max [nm]	415
Refractive index @ emission max.	1.85
Primary decay time [ns]	250
Light yield [photons/keVγ]	38
Temperature coefficient of light yield	-0.3%C^{-1}

NaI(Tl) is available in varying sizes and geometries:

- Cylindrical: 1” diameter x 1” thick, 2” diameter x 2” thick, 3” diameter x 3” thick, 5” diameter X 5” thick
- Rectangular: 2”x4”x16”, 4”x4”x16
- Camera plates: 24” x 18” x 0.375” thick
- Pixellated arrays for use with PMTs or PSPMTs

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NaI(Tl)
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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.

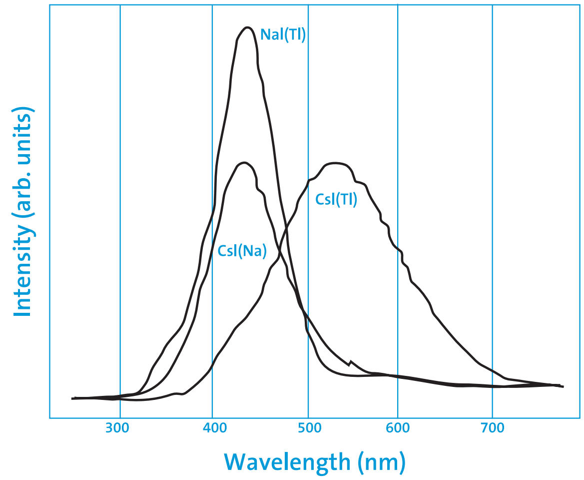

Figure 1. Scintillation emission spectrum of NaI(Tl) and other scintillation materials (1990)

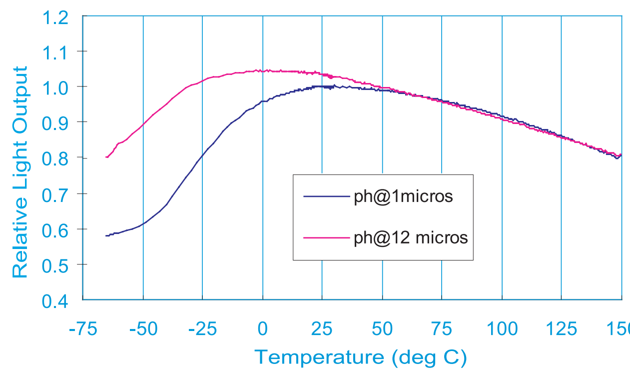

Figure 2. Temperature response of NaI(Tl)

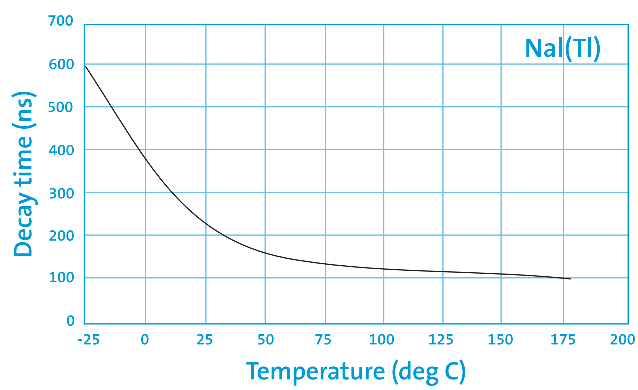

Figure 3. Temperature dependence of the decay time of NaI(Tl)

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Manufacturer reserves the right to alter specifications.

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