BrilLanCe®380

It's what's Inside that Counts!

Scintillation Material

BrilLanCe®380 [$LaBr_3$(Ce)] is a transparent scintillator material that offers the best energy resolution, fast emission and excellent linearity. It has higher light output than NaI(Tl) and also better energy resolution.

The energy spectrum for 662 keV photons from ^{137}Cs has a FWHM (full width at half maximum) of 2.8% for the full energy peak in a 1" diameter by 1" long crystal, as shown in Figure 1. The material's superior energy resolution is most pronounced at energies above 100 keV when compared with NaI(Tl).

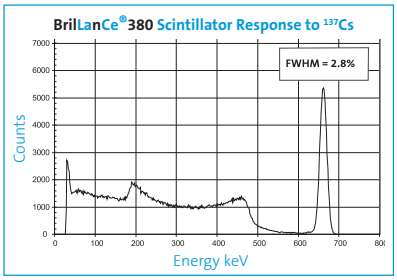

Figure 1. Pulse height spectrum

The emission of scintillation light (Figure 2) is well within the wavelength range of standard photomultiplier tubes (PMTs) with borosilicate glass face plates (Curve B), which makes these standard PMTs suitable.

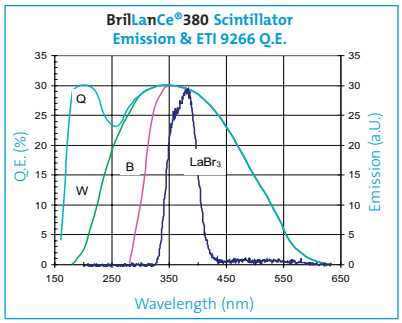

Figure 2. Scintillation emission spectrum of the BrilLanCe 380 crystal and Quantum Efficiency of a bialkali ETI9266 PMT with (B)Borosilicate, (W)UV glass, and (Q)Quartz face plates (Q.E. data courtesy of Electron Tubes, Inc.)

The light yield as a function of temperature was measured with ^{137}Cs excitation at two amplifier shaping times of 1µs and 12µs. The temperature of the PMT was maintained constant while the temperature of the scintillator was varied from -65°C to +175°C. Results are shown in Figure 3. This data indicates that around room temperature from 0°C to +55°C the light output of the BrilLanCe 380 crystal changes less than 1%, and the light output changes less than 5% in the range of -65°C to +140°C.

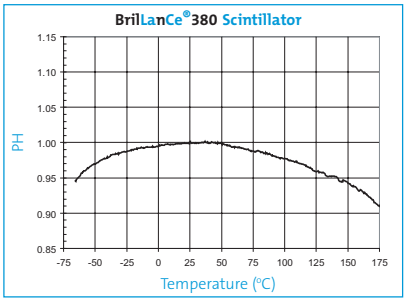

Figure 3. Temperature response. (The curve is for 12µs. The curve for 1µs is identical.)

Properties –

Density [g/cm³]	5.29
Melting point [K]	1116
Thermal expansion coefficient [10^{-6}/°C]	8 along C-axis
Cleavage plane	<100>
Hygroscopic	yes
Wavelength of emission max. [nm]	380
Refractive index @ emission max	~1.9
Primary decay time [µs]	0.016
Light yield [photons/keVγ]	63
Photoelectron yield [% of NaI(Tl)] (for γ-rays)	130

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CRYSTALS

Scintillation Products

BrilLanCe® 380
Scintillation Material

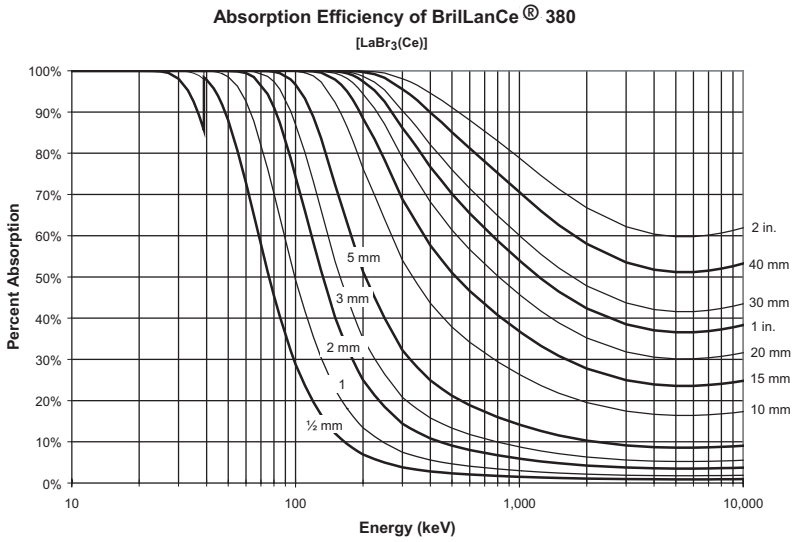

Figure 4. Gamma and X-ray absorption efficiency for various thicknesses of BrilLanCe 380 material. Data compiled by C. M. Rozsa (presented in Saint-Gobain Crystals' brochure "Efficiency for Selected Scintillators.")

The BrilLanCe®380 crystal emits light with a relatively short decay time of 16ns. This is about 7 times faster than NaI(Tl); and, if taken together with the high light output, excellent timing is possible. Defining the ratio of the decay time to the light output as an FOM*, it is clear from the table that the timing properties of a BrilLanCe crystal are expected to be very close to BaF_2. Indeed, sub-nanosecond coincidence resolving times of 250ps and lower have been measured.

The linearity of light generation of the BrilLanCe 380 scintillator with energy is excellent. It is well known that the amount of light produced per unit of energy by NaI(Tl) increases below 400keV and peaks at ~1.23 around 12keV. The light output of the BrilLanCe 380 crystal stays constant with energy, the maximum deviation at low energies being less than 5%.[1]

Table 1. Table comparing principle decay times of various scintillation materials

	Light Yield photons/keV	Decay Time tau (ns)	FOM* tau/(photons/keV)
BaF_2	1.8	0.8	0.44
BrilLanCe® 380	63	16	0.25
BrilLanCe®350	49	28	0.57
LSO	27	40	1.48
NaI(Tl)	38	250	6.58
GSO	8	60	7.50
BGO	9	300	33.3

* Figure of Merit

[1] E. V. D. van Loef, W. Mengesha, J. D. Valentine, P. Dorembos and C. W. E. van Eijk, *IEEE Transactions on Nuclear Science*, 50, 1 (2003).

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