

## BaF<sub>2</sub> Barium Fluoride Scintillation Crystal

Barium fluoride (BaF<sub>2</sub>) is presently the fastest known scintillator. It has an emission component with subnanosecond decay time that yields very fast timing. Fast timing is required for positron lifetime studies, time of flight measurements, Positron Emission Tomography (PET) and certain high energy or nuclear physics applications. Using special electronics, time resolutions around 200 ps are possible for small detector geometries.

BaF<sub>2</sub> has several scintillation emission bands. The fast scintillation light is emitted in the UV in bands centered at 220 and 195nm. The decay time of the fast component varies between 600 and 800ps.

To detect the fast scintillation light, it is necessary to use a photomultiplier tube with a quartz entrance window. Furthermore, the optical coupling compound must have a good transparency for UV light. Usually silicon oils or compounds are used.

The self-absorption of the material is very low so that the use of large scintillation crystals is possible. Next to the fast emission components, BaF<sub>2</sub> also emits a relatively slow scintillation component in a band centered at 310nm. The decay time of this component has an average value of 630ns.

Using quartz photomultiplier tubes for the detection of the scintillation light, about 15% of photoelectrons are produced by the fast component whereas 85% originates from the slow component ( $\gamma$ -rays). The total number of photons emitted from a BaF<sub>2</sub> crystal is about 12 per keV of photon energy.

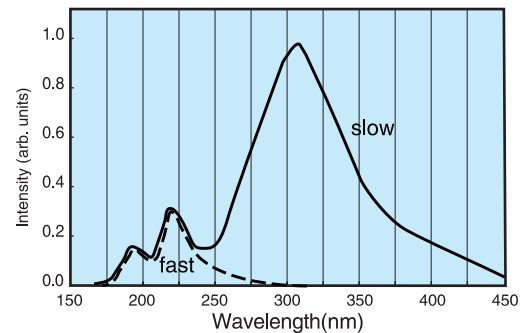


Figure 1. Scintillation emission spectrum of BaF<sub>2</sub>

### PROPERTIES

Parameter	Description/Value	Unit
Density	4.88	g/cm <sup>3</sup>
Melting point	1627	K
Thermal expansion coefficient	18.4 × 10 <sup>-6</sup>	C <sup>-1</sup>
Cleavage plane	<111>	—
Hardness (Mho)	3	—
Hygroscopic	slightly	—
Wavelength of emission max	310 220(195)	nm
Lower wavelength cutoff	135	nm
Refractive index @ emission max.	1.50 (310nm) 1.54 (220nm)	—
Primary decay time	630 (slow) 0.6 – 0.8 (fast)	ns
Light yield	10 (slow) 1.8 (fast)	photons/keV $\gamma$
Photoelectron yield	(for $\gamma$ -rays) 16 (slow) 3 (fast)	% of NaI(Tl)

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The ratio between the intensity of the fast and the slow scintillation components of BaF<sub>2</sub> depends on the ionizing power of the absorbed particle. This feature allows gamma discrimination and particle identification by pulse shape discrimination techniques. (References below.\*)

The response of BaF<sub>2</sub> to neutrons up to 22MeV has been investigated. (Reference below\*\*.)

The scintillation intensity of the fast component is independent of temperature between -40°C and 25°C. The slow component varies gradually with temperature, attaining its maximum at -10°C. (V.Nanal et al., Nuclear Instruments and Methods in Physics Research, A389, 1997, 430-436).

BaF<sub>2</sub> is not hygroscopic, but condensing moisture can pit its surface. It is relatively radiation hard. Radiation doses of 105 Gray (107 rad) do not cause any severe damage to its scintillation characteristics.

### References:

\* NIM A376 (1996) 108-212  
NIM A312 (1992) 515-520  
NIM A269 (1988) 595-598

\*\* NIM A274 (1989) 501-506

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

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