

## EJ-254 BORON-LOADED PLASTIC SCINTILLATOR

This is blue-emitting plastic scintillator contains natural boron at concentrations up to 5% by weight. It is a clear, stable plastic with physical properties similar to those of the standard Eljen plastic scintillators. Its principal applications are fast neutron spectrometry and thermal neutron detection. The primary function of the boron is to provide a unique scintillation signal for low energy neutrons. The standard formulation contains 5% boron, and practical boron concentrations down to 1% are available.

The isotopic fraction of  $^{10}\text{B}$  in natural boron is 19.9%, and hence, the 5% loaded plastic contains nearly 1% of  $^{10}\text{B}$ . The neutron capture reaction on the boron  $^{10}\text{B}(n,\alpha\gamma)^7\text{Li}$  has a Q value of 2.78 MeV of which 2.34 MeV is shared by the alpha and lithium particles. This energy is fully captured in the plastic to produce a scintillation signal approximately equivalent in amplitude to that of a 76 keV electron. For delayed coincidence timing of the capture of fast neutrons, the time delay from the prompt recoil-proton pulse is typically 2.7 $\mu\text{s}$  for 5% B-nat plastics. This delay is inversely proportional to the boron loading.

<u>Physical and Scintillation Constants</u>	<u>5% B</u>	<u>2.5%B</u>	<u>1%B</u>
Light Output, % Anthracene .....	48	56	60
Scintillation Efficiency, photons/1 MeV e <sup>-</sup> .....	7,500	8,600	9,200
Wavelength of Max. Emission, nm .....	425	425	425
Decay Time, ns .....	2.2	2.2	2.2
No. of C Atoms per cm <sup>3</sup> , x 10 <sup>22</sup> .....	4.44	4.55	4.62
No. of H Atoms per cm <sup>3</sup> , x 10 <sup>22</sup> .....	5.18	5.17	5.16
No. of $^{10}\text{B}$ Atoms per cm <sup>3</sup> , x10 <sup>20</sup> .....	5.68	2.83	1.14
No. of Electrons per cm <sup>3</sup> , x 10 <sup>23</sup> .....	3.33	3.33	3.33
Density at 20°C, g/cc: .....	1.026	1.023	1.021

**Polymer Base:** ..... Polyvinyltoluene  
**Refractive Index:** .....1.58  
**Vapor Pressure:** ..... Is vacuum-compatible  
**Coefficient of Linear Expansion:** ..... 7.8 x 10<sup>-5</sup> below +67°C

**Light Output vs. Temperature:**  
 At +60°C, L.O. = 95% of that at +20°C  
 No change from +20°C to -60°C

**Chemical Compatibility:** Is attacked by aromatic solvents, chlorinated solvents, ketones, solvent bonding cements, etc. It is stable in water, dilute acids and alkalis, lower alcohols and silicone greases. It is safe to use most epoxies with EJ-254.

### Comparison of Capture Mechanisms for $^{10}\text{B}$ and $^1\text{H}$ for Thermal Neutrons in EJ-254

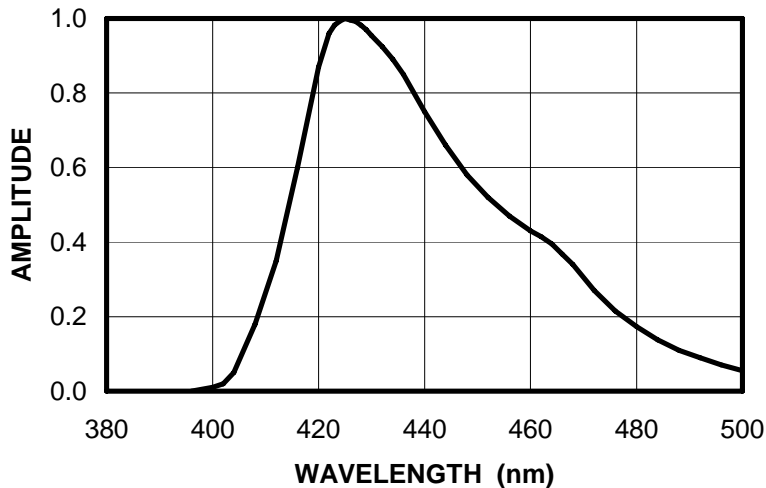
Competing capture reactions:  $^{10}\text{B}(n,\alpha)$   $\sigma=3840\text{b}$        $^1\text{H}(n,\gamma)$   $\sigma=0.332\text{b}$

<u>Natural B Loading</u>	<u>Ratio: <math>\Sigma(^{10}\text{B})\div\Sigma(^1\text{H})</math></u>
5%	127.6
2.5%	62.4
1%	25.6

## Linear Attenuation Coefficients for Neutron Capture by $^{10}\text{B}$ in EJ-254

Neutron Energy	Cross Section Barns/Atom	Linear Attenuation Coefficient, $\Sigma$ ( $\text{cm}^{-1}$ )		
		5% B	2.5% B	1% B
0.025 eV	3836.00	2.15	1.07	0.43
0.1 eV	1929.00	1.08	0.54	0.22
1 eV	610.00	0.34	0.17	0.068
10 eV	193.00	0.11	0.054	0.022
100 eV	60.60	0.034	0.017	0.0068
1 keV	19.00	0.011	0.0053	0.0021
10 keV	5.89	0.0033	0.0016	0.00066
20 keV	4.17	0.0023	0.0017	0.00047
30 keV	3.41	0.0019	0.00095	0.00038
40 keV	2.98	0.0017	0.00083	0.00033
50 keV	2.68	0.0015	0.00075	0.00030
100 keV	1.96	0.0011	0.00055	0.00022
120 keV	1.80	0.0010	0.00050	0.00020
150 keV	1.61	0.00090	0.00045	0.00018
200 keV	1.36	0.00076	0.00038	0.00015
225 keV	1.28	0.00072	0.00036	0.00014
250 keV	1.19	0.00067	0.00033	0.00013

**EJ-254 EMISSION SPECTRUM**



### References

1. L.R. Greenwood and N.R. Chellew, *Rev. Sci. Instrum.*, 50 (4) 466-471 (April, 1979)
2. D.M. Drake, et al, *Nucl. Instr. & Methods in Physics Res.*, A274, 576-482 (1986)



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