lithium glass scintillators

properties of glass scintillators

	GS2	GS20	KG2
Density [g/cm³] (approximate)	2.64	2.5	2.42
Melting point	c.1200°C	c.1200°C	c.1200°C
Coefficient of linear expansion/C	7.0×10^{6}	9.23×10^{6}	
Light output relative to anthracene	22-34%*	20-30%*	20%
Decay times**, neutron excitation, ns	--	18,57&98	18,62&93
Decay times**, alpha excitation, ns	20,48&88	16,49&78	15,45&56
Decay times**, beta excitation, ns	19,57&103	20,58&105	17,51&96
Ratio of light output	0.23		
Wavelength of emission maximum [nm]	395	395	395
Refractive index at emission maximum	1.58	1.55	1.566
Resolution on the thermal neutron "peak" obtained with moderated Po/Be neutrons	13-22%	15-28%	20-30%
Peak/trough ratio of above "peak" (range)	15:1 to 40:1	10:1 to 40:1	10:1 to 20:1

* Determined by thickness, increasing with decreasing thickness down to approximately 2mm.

** Fast component, slow component and 90-10% respectively

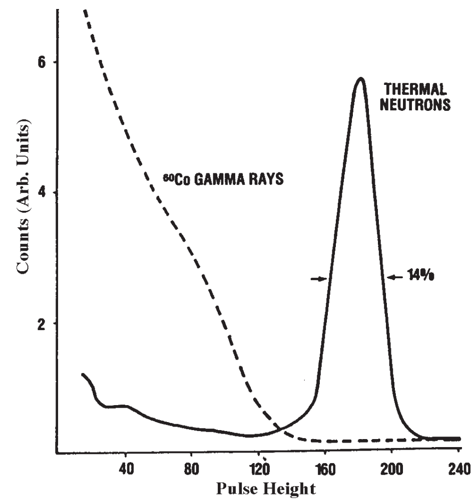

Figure 1. Pulse Height Spectra (1 mm thick GS20 ^{6}Li Glass)

introduction

Cerium activated lithium silicate glass scintillators have been used for a variety of radiation detection applications since their development in the late 1950's. Glass scintillators can be used for:

- neutron spectrometry
- neutron radiography
- oil and gas exploration
- alpha, beta and gamma detection in extreme environments

The most common application is neutron detection since the glasses are often enriched in Lithium-6.

These scintillators may be used in temperatures ranging from -200°C to +250°C. Their resistance to all organic and inorganic chemicals except hydrofluoric acid permits their use where conditions prohibit using other scintillating materials.

types available

Glass scintillators are divided into three types based on the percentage (by weight) of lithium content. In each type, the lithium is present in its natural isotopic ratio, enriched in ^{6}Li to 95%, or depleted in ^{6}Li (99.99% ^{7}Li). The properties of the different glasses within each type are similar except for neutron sensitivity. All of the glasses are formulated to have extremely low backgrounds (less than 20 dpm/100g) making it no longer necessary to order special types having this property.

Type	Isotopic Ratio	Total Lithium
GS1	Natural	2.4%
GS2	95% ^{6}Li	2.4%
GS3	99.99% ^{7}Li	2.4%
GS10	Natural	6.6%
GS20	95% ^{6}Li	6.6%
GS30	99.99% ^{7}Li	6.6%
KG1	Natural	7.5%
KG2	95% ^{6}Li	7.5%
KG3	99.99% ^{7}Li	7.5%

forms available

The most common forms supplied are discs or rectangles having one or both faces polished. The unpolished surfaces are usually coated with a highly reflective white paint. Also available are cylinders, fibers and powder. Standard flat dimensions range from 10 to 200 mm and thicknesses from 1 to 50 mm. These dimensions can be combined to produce cylinders, discs or rectangular plates having maximum weights of about 280 grams. Complete scintillation detector assemblies designed to your specifications can also be supplied.

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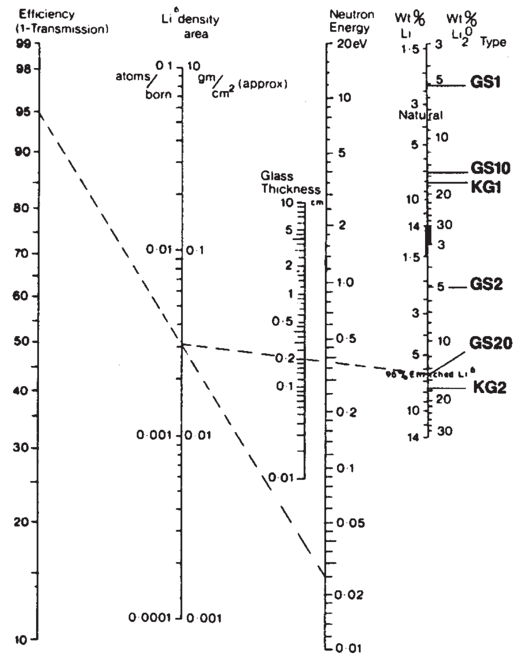
neutron detection

The nomogram to the right has been adapted from ref. 1 and may be used to obtain detection efficiencies for neutron energies below 20 eV. The efficiency is related to a given scintillator type and thickness. The example indicated by the broken line shows that a 2 mm thick GS20 scintillator would have an intrinsic efficiency of 95% for thermal (.025 eV) neutrons. **Table 1** lists some useful references dealing with the response of GS20 and KG2 glasses to other neutron energies.

Table 1. Specific Neutron Detection

Neutron Energy	Glass Type	Glass Thickness	Ref.
0.01-20 eV	All types	0.1-10 mm	1
Thermal	GS20(NE905)	1,3 mm	2
10eV-100 keV	GS20(NE905)	3.2 mm	3
100eV-1MeV	GS20	25.4 mm	4
1-600 keV	KG2, GS20	9.5 mm	5
1-6 MeV	GS20(NE905)	25 mm	6

Nomogram: detection efficiencies of glass scintillators for slow neutrons.



detection of other radiation

For detection of alpha, beta and gamma radiation, type GS1 scintillator is recommended. Crushed and sized powders of GS1 are used in flow cells for counting alpha particles, and C-14 and other beta emitters in biomedical research and process control functions. The scintillators depleted in ^{6}Li GS3, GS30 and KG3 (being sensitive to neutrons) may be used for high intensity gamma background measurements in conjunction with the enriched glasses.

In neutron detection applications with GS20 and KG2 glasses, excellent pulse height discrimination against gamma background is possible, particularly with thin scintillators. Data on gamma sensitivities are given in ref. 7.

Table 2. Gamma Sensitivities

Scintillators and thickness	Gamma photons to give same light output as 1 neutron ^{226}Ra	^{137}Cs	^{60}Co
(GS20) 1 mm	850	240	100
(GS20) 1.5 mm	550	160	74
(GS20) 3 mm	390	100	50
(KG2) 6.2 mm	310	81	57

References:

1. L.A. Wraight, *Nucl. Instr. & Meth.*, 33, 181-193 (1965).
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4. J. Camera et al, *Nucl. Instr. & Meth.*, 42, 277-282 (1966).
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