MIRION TECHNOLOGIES

Silicon Lithium, Si(Li), Detectors for X-ray Spectroscopy

Features/Benefits

- 2-5 mm thick detectors providing better stopping power for high-energy X-rays compared to SDD's
- Escape to full energy peak ratio 2-3 orders of magnitude higher compared to HPGe detectors

Applications

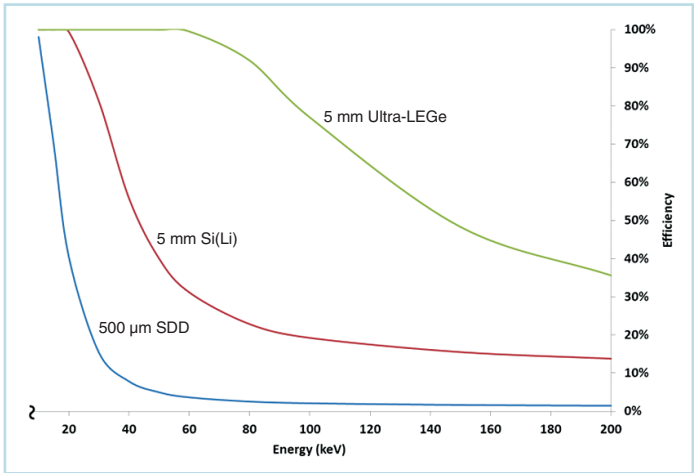
- XRF, XRD
- Synchrotron applications (EXAFS, XANES,…)
- X-ray spectroscopy (e.g. EDS)
- PIXE
- Mossbauer spectroscopy

Description

Silicon Lithium X-Ray Detectors are the heart of solid state x-ray spectroscopy systems. These detectors, which are p-i-n devices formed by lithium compensation or drifting of p-type silicon, are the result of some of the most carefully controlled manufacturing processes in existence. These detectors are fabricated to exacting quality standards, which is essential in ensuring a product of high performance and excellent long term reliability.

The Si(Li) x-ray detector is an integral part of a detector system which includes a liquid nitrogen cryostat and a low noise Integrated Transistor Reset Preamplifier (I-TRP).

These detectors certainly have a place in the market for x-ray applications next to Silicon Drifted Detectors (SDD's), such as our X-PIPS™, and low-energy germanium detectors (LEGe's and Ultra-LEGe's). Si(Li) detectors can be made with thicknesses up to 5 mm, which means they have a much higher stopping power than SDD's (max. 500 µm) and can be used up to higher energy x-rays (see graph below). Compared to germanium, however, silicon has a lower stopping power for the same detector thickness. But the big advantage of silicon is that it has characteristic x-rays at much lower energies (around 1.7 keV) compared to germanium (10-11 keV). Therefore the generated x-rays are less likely to escape the detector volume, which makes the escape peak less prominent. This means the ratio of the full energy peak to the escape peak is 2-3 orders of magnitude higher for a Si(Li) detector compared to a HPGe detector. Additionally the germanium x-rays lie around 10-11 keV, which is right in the region of interest for some experiments or applications. The absorption edges of germanium in the region of interest complicate the spectrum and the analysis.



Comparison of high-energy efficiency Germanium vs. Silicon

Silicon Lithium, Si(Li), Detectors for X-ray Spectroscopy

Si(Li) detectors cover an energy range from a few hundred eV to above 50 keV and are used in a wide variety of applications including x-ray fluorescence, x-ray microanalysis, PIXE, EXAFS, x-ray diffraction, and Mössbauer spectroscopy.

The finest in semiconductor technology and cryogenics, combined with advanced signal processing electronics give CANBERRA Si(Li) detectors solid performance and reliability. Unlike early Si(Li) detectors and unlike those manufactured by some companies today, CANBERRA Si(Li) detectors are stable at room temperature so they can be shipped and stored without LN_2.

CANBERRA Si(Li) detectors are available in two versions. The standard detector uses conventional geometry and a gold surface barrier entrance window. The Super Si(Li) uses a proprietary geometry and entrance window. This, along with a special shaping amplifier, improves resolution by at least 10 eV (FWHM) and increases the peak/background by about ten-fold to greater than 10 000:1.

GENERAL SPECIFICATIONS AND INFORMATION

Standard Configuration:

- Cryostat with 1 in. diameter and 4 in. long stainless steel endcap and 25 µm thick Be window
- Integrated Transistor Reset Preamplifier with 3 meter bias, signal and power cables
- Resolution (FWTM) less than or equal to twice the FWHM resolution

Si(Li) DETECTOR MODEL LIST

Model Number	Active Area (mm^2)	Nominal Thickness (mm)	Resolution (eV) FWHM @ 5.9 keV
SL12145	12.5	2	145
SL12160	12.5	2	160
SL30155	30	3	155
SL30170	30	3	170
SL80165	80	5	165
SL80180	80	5	180

Super Si(Li) DETECTOR MODEL LIST

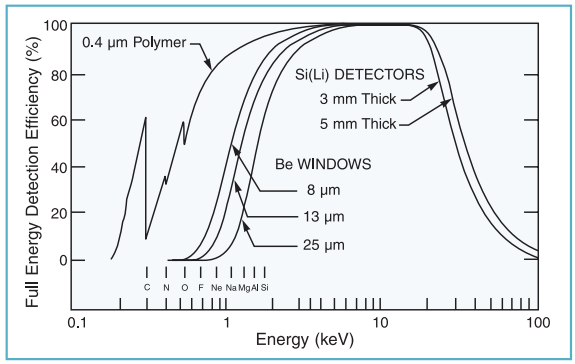
Model Number	Active Area (mm^2)	Nominal Thickness (mm)	Resolution (eV) FWHM @ 5.9 keV
SSL12135	12.5	2	135
SSL30145	30	3	145
SSL80155	80	5	155

ENDCAPS AND CRYOSTATS

Si(Li) detectors are built in a 1 in. diameter by 4 in. long stainless steel endcap on a flanged-style or retractable cryostat. The Dewar or electric cooler can be chosen from our wide range of available options.

To take full advantage of the low energy response of the Si(Li) and Super Si(Li), CANBERRA offers the option of a thinner window or even a windowless cryostat. A 1/3 mil thick Be window is available on the 12.5 and 30 mm^2 models. The polymer window, available on all models, is a multilayer film which is supported by a ribbed silicon support structure. The film spans silicon ribs that are about 100 µm apart and 0.3 mm thick and act as a collimator accordingly. On horizontal cryostats, the support rib orientation can be chosen by designating the appropriate window model-number suffix: V for vertical ribs and H for horizontal ribs. The support structure is 75% open. The total film thickness is about 340 nm, 40 nm of which is an aluminum layer which reduces sensitivity to ambient light. Note that the curves do not show the effect of the support structure but of the window film itself. More information on windowless cryostats can be found under the 'Cryostats and Cryostat Options' section.

Note that Polymer windows are not light tight. Detectors equipped with this window should be used in a darkened environment. Be and Polymer windows are not warranted against damage caused by, among others, abuse or harsh environments.



Transmission curves for various types and thickness of windows. The polymer window curve does not show the effect of the support grid on overall efficiency.

Windowless retractable cryostats are available for applications in which no window can be tolerated. Exposure of such detectors to light, moisture, chemical or oil vapors, or high pressure can cause irrevocable damage so extreme care is necessary in operating them. They are not warrantied against such conditions.

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