

High Performance Detectors for X-ray Spectroscopy

R. Redus, A. Huber, H. Sipilä, P. Kostamo, J. Kostamo

Amptek Inc, 14 DeAngelo Dr, Bedford MA, USA

Amptek has developed a new generation of X-ray detectors, providing true state-of-the-art performance in X-ray spectroscopy. The design, performance, and typical applications will be presented. All these detectors share a common technology, which yields lower electronic noise, lower dark currents, and improved charge collection relative to the previous generation. Refinements to the signal processing electronics and to the packaging have led to further improvements, enabling higher count rates and lower detection limits.

The dark current of these units, averaging 50 pA/cm² at 20°C, enables operation at higher detector temperatures. Amptek's vacuum sealing technology, providing $\Delta T > 85^\circ\text{C}$ for both beryllium and C-series windows, yields good performance at ambient temperatures up to 50°C, reduced power dissipation under typical conditions, and improved temperature stability. These are very important for handheld applications and in vacuum.

Amptek's latest FAST SDD® family combines a new generation of SDDs with CMOS preamplifier technology, providing a resolution down to 122 eV FWHM and counts rates of several Mcps. Active areas of 25 mm² to 80 mm² are available, all in the standard TO-8 package. For XRF applications, the peak to background and peak to valley ratios are improved, and these combine with better internal shielding to provide detection limits of 0.1 ppm in key XRF applications.

Amptek's detectors provide unmatched performance at low energies. The C series windows (40 nm Si₃N₄) combine low attenuation at low energies with a robust, hermetic, vacuum package. The window can withstand heating to 150°C, well beyond the 100°C limit for the assembly. The improved charge collection and noise provide a resolution of 40 eV FWHM at the C K_α line and detection down to the Li K_α line. They are available in areas up to 80 mm². These are used in EDS, WDS, and low energy XRF.

Amptek's SDD family combines the same new SDD generation with a conventional JFET amplifier, providing a cost-effective detector which is the workhorse of portable XRF. The new detectors enable higher ambient temperatures and/or extended battery life, improved peak to background ratios, and improved energy resolution.

Amptek's SiPIN family remains widely used in XRF applications due to its simplicity and low cost. The new detectors have lower noise, with 6 mm² SiPIN units providing 139 eV FWHM at 5.9 keV, making them competitive with SDDs for low count rate applications. The improved peak to background ratio results in lower detection limits and the lower dark current enables operation at detector temperatures of 0°C, for extreme environments or the best battery life.