

High Performance Silicon Drift Detectors with Integrated FET for XRF analysis

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Silicon Drift Detectors (SDDs) with integrated JFET transistor are fabricated by the Semiconductor Laboratory of Max-Planck-Institute in Munich in cooperation with PNSensor and are now widely used as high-resolution X-ray sensors in XRF and micro-beam analysis.

Minimization of the total detector capacitance due the small area readout node on one hand and to the integration of the front-end FET directly onto the detector on the other hand, combined with an ultra-low leakage current process makes the SDD with integrated FET an excellent energy resolving device for XRF spectroscopy.

With an energy resolution down to 132 eV at -20°C, the standard 10 mm² SDDs detectors with integrated FET have proven themselves for many years as very robust energy resolving sensors. A very interesting detector device for XRF and TXRF applications is the 30 mm² SDD which shows typical energy resolution of 136 eV for Mn-K_α at -20°C and 1 us shaping time. Operated in pulsed reset mode, the energy resolution remains almost unchanged over a large range of input count rates (e.g. 137 eV @ 100 kcps or higher with a dead time less than 0.2 %). The peak-to-background ratio measured with these devices varies from 5000 up to 8000. The integration of the collimator ring directly onto the SDD chip as well as the use of an additional bias ring surrounding the active area maintain the high peak-to-background ratio by reducing the losses at the detector edge caused by radiation entering the detector at large incident angles.

For special applications requiring ultimate energy resolution and peak-to-background ratio values, the SDD detector droplet combined with an optimized radiation entrance window at the silicon surface (pnWindow) is the ideal choice. With active areas varying from 5 to 20 mm², they show typical energy resolution between 123 and 128 eV at -20°C and peak-to-background ratio of up to 20.000. The pnWindow allows best detection of light elements starting from Boron or even Beryllium (e.g. energy resolution of 45 eV or better for B or C line).

We will report on the recent developments, present selected measurement results and analyze the performances of SDD detectors with integrated FET.