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Improved SDD Detectors for Ultra-Fast, High-Resolution EDS in Microanalysis

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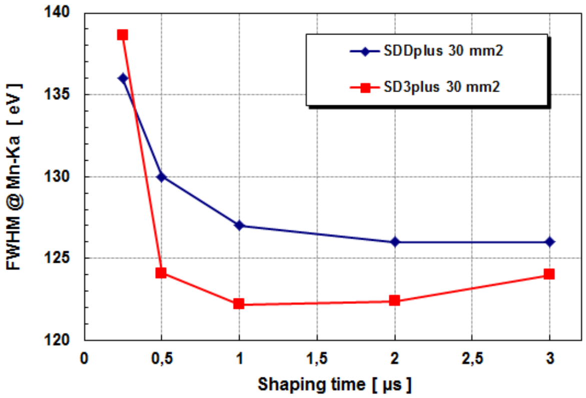
Recent advances in electron microscopy instrumentation with respect to electron beam brightness and spot size have continuously pushed for higher energy resolution and faster Energy Dispersive X-ray Spectroscopy (EDS) detectors. Silicon Drift Detectors manufactured by PNDetector and PNSensor in Munich with their unique feature of having the first FET monolithically integrated onto the sensor have asserted themselves as the standard detectors for microanalysis, meeting all the characteristics needed for accurate material composition measurements at high scan speeds in SEMs or TEMs.

High-resolution, ultra-fast EDS microanalysis applications require detectors with extremely low input capacitance, insuring optimum detector operation at very short shaping times. In the recent years a significant development work has been done in this direction at PNDetector by remodeling the geometry of the anode and of the integrated FET with the goal of reducing all the parasitic capacitances related to the detector anode. This led to a new generation of SDDs – the so-called SDD^{plus} series.

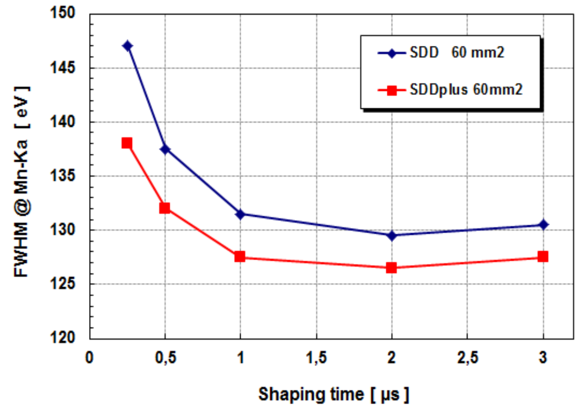
The low capacitance anode/FET can be adopted for all SDD types (round or droplet shape) and sizes (from 5 and 10mm^2 up to 100 mm^2 or multichannel devices). Fig.1 shows spectroscopic performances measured with the 30 mm^2 (a) and 60 mm^2 (b) SDD^{plus} detectors. Whereas energy resolution values of 126 eV are achieved with the round-shape SDD^{plus} devices, when applied to the droplet-shaped SD3 devices, the low capacitance FET drives the energy resolution below 122 eV at shaping times as short as 1 us. With the detector operated at 0.5 us shaping time (maximum input count rate of 400 kcps) the energy resolution is still below 125eV. Further measurements with SDD^{plus} devices of various sizes will follow.

When analyzing thin samples or biological probes with a low photon yield the measurement time is directly related to the detector collection angle. Another important development direction is moving toward smaller, more compact detector packages and therefore increasing the solid angle coverage of the detector with respect to the analyzed sample. An example here is the new large area 100 mm^2 SDD detector which has been mounted onto a very compact package of 18.5 mm diameter only (see Fig. 2a). The spectroscopic performance is similar to that obtained with smaller size detectors (Fig 3b) and this at moderate cooling temperature of -30°C. More detailed results, including the investigation of SDD^{plus} version of this detector will be presented.

For applications where boosting the x-ray photon intensity is of primary interest, but no compromises in terms of energy resolution are accepted, multi-channel SDD devices become the first choice. A 7-channel SDD with a total area of 70 mm^2, mounted in a very compact package and capable of dealing with huge count rates up to 7 Mcps will be introduced. Selected measurements with this multi-channel SDD device will be shown.



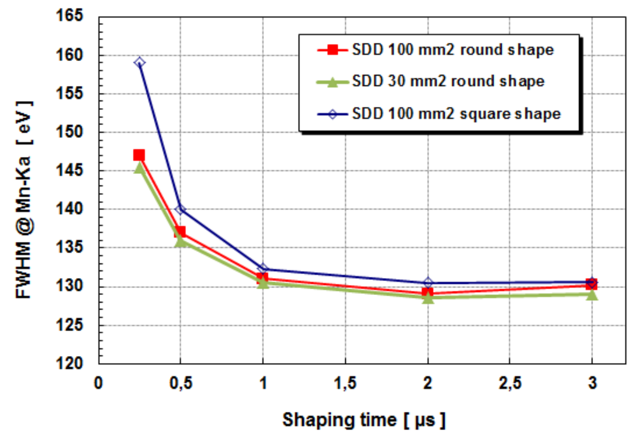
(a)



(b)

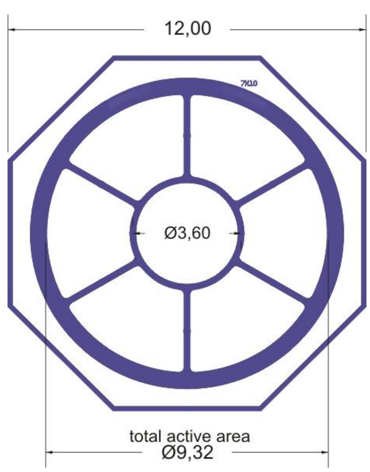
Fig1. Energy resolution vs. shaping time measured at -30°C with: (a) 30 mm^2 SDD^{plus}/SD3^{plus} detectors; (b) 60 mm^2 SDD^{plus}/SDD detector

(a)



(b)

Fig. 2 (a) SDD 100 mm^2 ultra-slim line package compared to 100 mm^2 standard package; (b) energy resolution vs. shaping time at -30°C for 100 mm^2 and 30 mm^2 SDDs



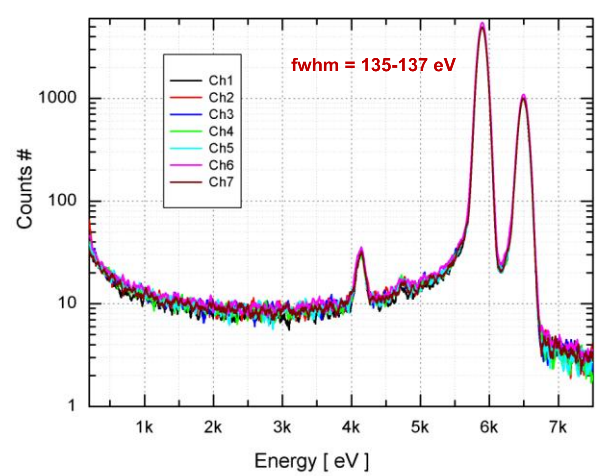


Fig. 3 Geometry and spectral performance of the 7-channel 7x10 mm^2 SDD. The Fe55 spectra were measured without detector collimator.