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Excellent Performance with 100 mm^2 Silicon Drift Detectors

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Energy dispersive X-ray detectors with large area are important in some dedicated applications of Scanning Electron Microscopes (SEM) or Transmission Electron Microscopes (TEM). The objective is to gain measurement speed - that means minimizing the measurement time or to detect extremely low doses as in trace element analysis. Silicon Drift Detectors (SDDs) are an ideal analysis tool if they combine the relevant specifications.

Very recently we have adapted the polysilicon technology to our 100 mm^2 SDDs making them the ideal large area detectors. The sensors combine a very low leakage current level of less than 200 pA/cm^2 with a large detection area allowing them to be operated at temperatures close to room temperature (-20°C to - 35^{o}C only). A small anode area in the center of the device in combination with the monolithically integrated first amplification FET leads to a minimum effective signal capacitance of about 120 fF.

Standard measurements are performed at small shaping times of 1 μs or less allowing high through put analysis with excellent energy resolution at the same time. Fig. 1 shows the energy resolution of a 100 mm^2 SDD Mn-K_α plotted against the shaping time at different operation temperatures. Energy resolution values better than 128 eV have been measured at operation temperature of -35°C. As a strong electrical field is applied in all regions of the detector the ballistic deficit is very small allowing operation at very short shaping times.

Moreover the adaption of the pnWindow technology to the radiation entrance window of the sensor allows excellent light element performance down to Boron and high quantum efficiency with 100 mm^2 active area. Detailed analysis results will be presented.

Being part of the SDD slim module line comprising 20, 30 and 60 mm^2 SDDs the module packaging of the 100 mm^2 detector has been optimized with regard to a minimum socket diameter (see Fig. 2a). As the detector is operated at reasonably warm temperatures, the spectrometer nozzle and the cold finger can be manufactured in a simple way, providing minimum dimensions for this part also. So a smaller distance between sample and detector is possible leading to a maximum solid angle.

The almost rectangular shape of the 100 mm^2 detector allows ideal combination in multi-element arrangements. In Fig. 2b a special design of a detector is demonstrated with 3 x 100 mm^2 active area which is now fabricated in poly-silicon technology. It has been used as energy dispersive detector in WDX applications to reduce background and enhance sensitivity significantly as well as for the detection of low energy protons as shown in Fig 3.

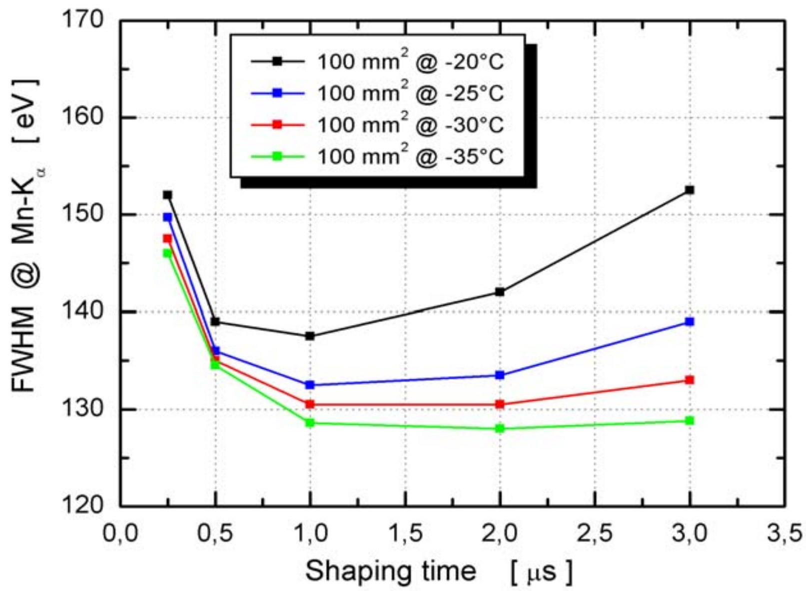

Fig 1. Energy resolution vs. shaping time at different operating temperatures. The 100 mm^2 SDD now fabricated in poly-silicon technology shows excellent resolution values at high temperature and short shaping times.

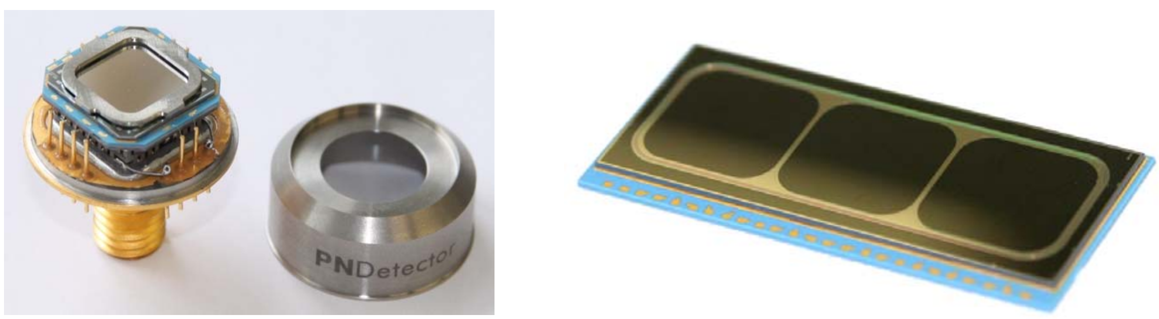

Fig 2. Different packaging configuration of single or multi-channel detectors based on the 100 mm^2 SDD element:

(a) 100 mm^2 Slim Line Module for SEM- or TEM-EDS systems with minimum diameter

(b) 3x100 mm^2 SDD module for WDX applications

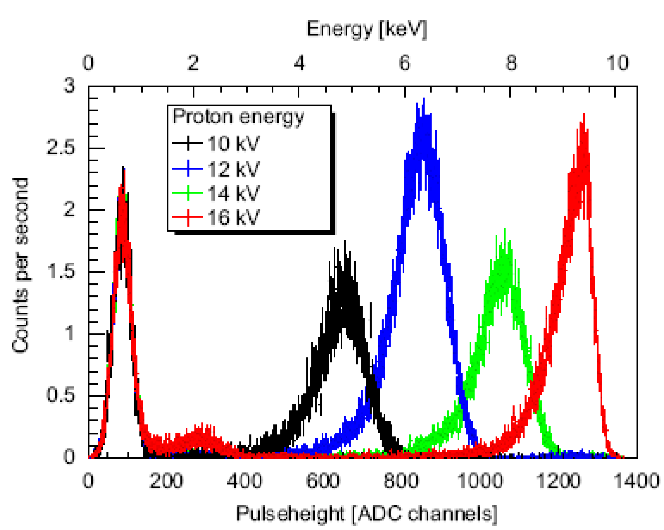

Fig 3. Low energy proton spectra measured with a 3x100 mm^2 SDD detector at room temperature.

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