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Report:

In order to better evaluate the needs concerning the quality of silicon sensor and the characteristics of read-out electronics to be used in position sensitive microstrip detectors, we have recently performed test measurements under real conditions of synchrotron powder diffraction experiments, using a solid state detector with microstrip technology. The measurements were performed at 25 keV radiation energy on the Swiss Norwegian Beamline (SNBL) at the ESRF in Grenoble. Prior to microstrip detector measurements, data were collected on the same samples using a NaI scintillator detector with either a receiving slit or an analyzer crystal inserted between the sample and the detector. The double-sided silicon microstrip detector was a Bioscope system provided by IDE AS and already described elsewhere [1]. It consists of 640 x 640 channels with a strip pitch of 50 μm, corresponding to a detection area of 3.2 x 3.2 cm^2. Note that the IDE Bioscope used during our measurements was not optimized for this type of experiment, in particular to the high flux provided by synchrotron radiation. Therefore data were collected in single bunch mode. During data collection, the effective detection area was reduced to 0.4-0.7 x 3.2 cm^2, depending on the measured sample (the 3.2 cm being along the 2θ-axis). The microstrip detector was mounted on the 2θ arm of the SNBL diffractometer at a distance of 1 m from the sample, resulting in an overall angular range of 1.82° and a spatial resolution of 0.003°. The transformation of the strip-coordinates into 2θ-space was performed using data measured with the conventional detection setups. Our comparative measurements, including all three detection configurations (microstrip, NaI scintillator with receiving slits and analyzer crystal), were performed on two previously characterized samples : the intermetallic alloy $Yb_{12}Fe_{64}Ga_{24}$ and the zeolite system ZSM-5. Here, we only present results on the intermetallic system.

The crystallographic structure of $Yb_{12}Fe_{64}Ga_{24}$ was previously determined [2] to consist of two coexisting phases, one hexagonal and one rhombohedral, with space groups $P6_3/mmc$ a=8.5693 Å, b=8.3574 Å) and R-3m a =8.5906 Å, c=12.5644 Å), respectively. Because of the slight differences in d-spacings for both structures, this alloy appears well suited for evaluating the angular resolution provided by all three detection setups. Measurements performed on $Yb_{12}Fe_{64}Ga_{24}$ in all three detecting configurations are represented in Fig.1. For the 2θ line widths (FWHM), we obtained 0.028°, 0.034° and 0.040° for the analyzer, the microstrip and the receiving slits detection setup, respectively. In terms of angular resolution, the performance of the microstrip detector competes well with the conventional detection setups. Another important aspect for structural refinement from powder diffraction patterns is the accuracy of detected intensities. Form comparison of integrated intensities calculated for all the reflections, it appears that results obtained with the microstrip detector do not deviate systematically from the conventional detector data.[3] Finally, consideration should be made of the reduction in data acquisition time when using a position sensitive detector such as the IDE Bioscope system. Indeed 640 points covering 1.82° angular range were registered in 5 min whereas similar data with equivalent statistics would be collected in ~65 min and ~11 min with the analyzer crystal and receiving slits detection setups, respectively. The gain in time can be of course more pronounced if we increase the effective angular range in setting several position sensitive detectors in parallel.

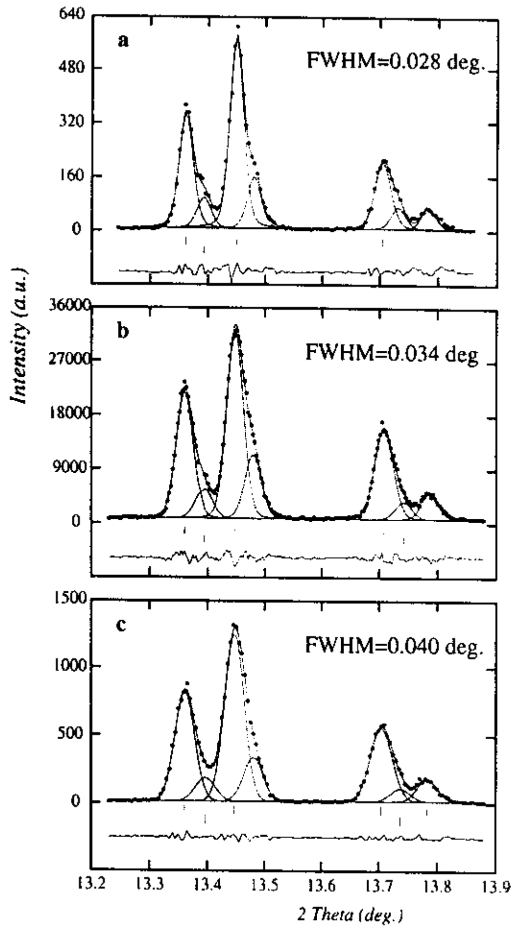

Fig. 1 Diffraction patterns of $Yb_{12}Fe_{64}Ga_{24}$ recorded at 25 keV with a) the analyzer crystal, b) the microstrip detector, c) receiving slits. The solid lines are fits to the data. Top and bottom ticks indicate reflections of the R-3m and $P6_3/mmc$ phases, respectively.

The test measurements we have performed under real experimental conditions will serve as a basis to design a dedicated system for the future powder diffraction station at the Swiss Light Source. Based on the experimental results obtained with the IDE Si microstrip prototype, we are confident in the promising potential offered by this technology for designing position sensitive detectors for powder diffraction. Application of the latest developments in read-out electronics makes them particularly interesting for time-resolved powder diffraction experiments.

[1] M. Overdick *et. al.*, Nucl. Instr. and Meth. A392 (1997) 173--177
[2] V. Pacheco, PhD Thesis, University of Geneva 1999
[3] Fauth *et. al.*, accepted for publication in Nucl. Instr. and Meth. A