We plan to install at the same beam-line a station for elemental composition analysis. PGNA is a non destructive nuclear method for performing both qualitative and quantitative multi-element analysis of major, minor, and trace elements in samples. It requires mainly a high-resolution gamma-ray spectrometer. It is essential to setup PGNA at a position with very low background of fast neutrons and gamma-rays. Such conditions are available at the exit of bent neutron guides. Different ways to extend PGNA to a full 3D technique were described in [1,2]. PGNA tomography is optimal in terms of beam-time and directly benefits from a large amount of gamma detectors surrounding the sample. Our proposition is therefore to add the instrument FIPPS proposed by the NPP group and its large detection power in our integrated platform to inspect large and complex objects.

SALSA provides already spatially resolved stress analysis with high resolution (down to 40 microns) and in large components (1m). However, it is optimized, and at the same time very much restricted to this application. In order to meet the more and more demanding requests of the materials community, the instrument must further develop.

Increasing data acquisition speed is a first concern. By replacing the relatively small 80mm high detector by a 240mm one, already provides a gain factor of 3 without deforming peak shape.

Changing the data acquisition mode, such that every neutron event is stored with time stamp and co-ordinate, allows continuous scanning. This brings many advantages for e.g. temperature dependent studies (finding phase transformations) and is even necessary for tensile testing, which must be performed at constant speed. For spatial resolved texture analysis or diffraction tomography a set of new collimators is required. The feasibility of using a straw-collimator has been demonstrated at T13C in 1999 [5]. A more efficient solution would be a collimator made of stacked cones, since it would accept larger divergences. Additional monochromators are required to increase the intensity for texture imaging (i.e. pyrolitic graphite) and extend the wavelength range (0.35nm) for new materials. The position of SALSA needs to be rethought. Being in line with VIVALDI inhibits wavelength changes and optimisation of the monochromator while experiments are running on VIVALDI. This is a huge drawback and limits SALSA's performance strongly.

The development of sample environment for large samples has already been mentioned above. The materials science laboratory (today: FaME38) can maintain, organise and provide the equipment to the various instruments. It is therefore an important part of "neutron-CSI".The required budget for "neutron-CSI" lies around 1.3 M€. This does not include neutron delivery and infrastructure.

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4. Refractive Analysis of Interfaces with Neutron Beams Optimised for a White Spectrum: RAINBOWS

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Abstract

A new technique of refractive encoding for specular reflectometry is described that uses the full white beam without the need for choppers. Depending on the resolution, gains of many orders of flux are possible opening a new area of sub-second kinetics in interface research or allowing very small sample areas to be studied.

Motivation

A gain in exploited flux of neutrons would be of immense benefit in a number of ways. At present routine measurements typically require 1 or a few μg of material at an interface or in solution and this is a challenge for studies that would exploit proteins isolated from natural sources or even synthetic peptides that can be more readily prepared in amounts of 10 ng. Reducing the amount of sample material will be key in opening new fields of research in natural products, biomedical science and related fields. A further obvious area that would benefit is in the study of time varying processes such as inter-diffusion and reaction kinetics. At present reactions at an interface can be studied with a time resolution of 1 second can be obtained on Figaro at the ILL. A gain of more than an order of magnitude in time resolution would allow new classes of experiments, for example with the higher concentrations of reagents that might be found in solutions rather than in a gas phase study.

Technique

The principle of refractive encoding has been outlined previously [1] and simply involves exploiting the dispersive power of refraction to measure the wavelength of neutrons. The technique has been recently demonstrated to work in low resolution on the AMOR reflectometer at PSI. The main reason for this was the longer sample to detector distance available there, as compared to ILL instruments. There is no need to have a complex prism shape. In this experiment, we used a very flat single surface of MgF_2. The layout of the technique is shown in Figure 1. First, in standard TOF mode, the main beam was measured through the prism and obtained a calibration of the deflection as a function of wavelength. Then we stopped the chopper open and measured the intensity again, this time with a gain of about 30x in intensity. The sample was positioned before the prism and the reflected beam was passed through the prism at the same angle.

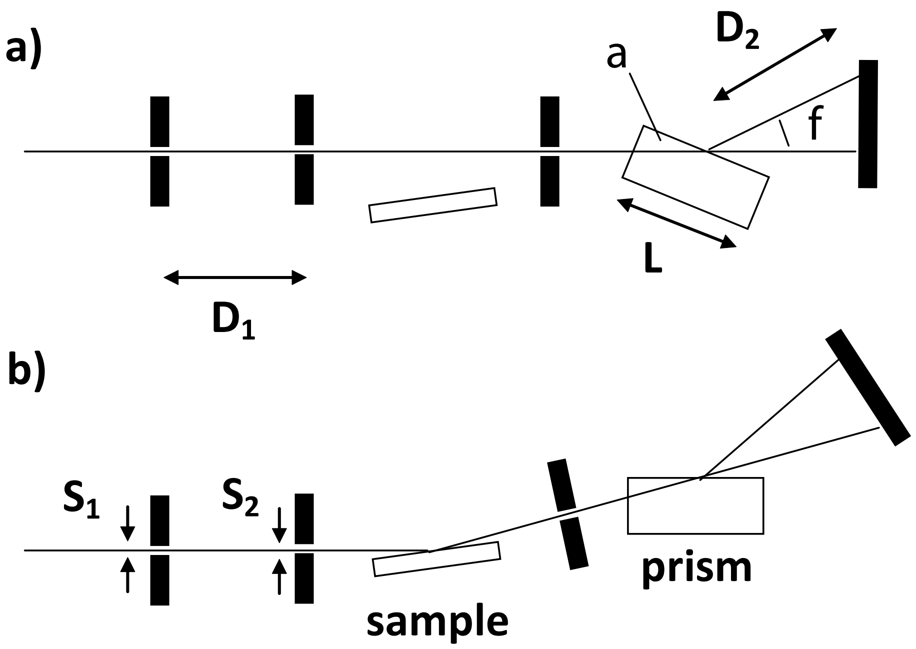

Figure 1*: The experimental layout. The upper panel a) shows the experimental conditions for measuring the direct beam. The slit in front of the prism does not collimate the beam but simply ensures that all reflected neutrons pass through the prism.*

Reflectivity was obtained by simply dividing the two data sets after the subtraction of the appropriate background (Figure 2). Figure 2 also shows for comparison a measurement at approximately the same resolution of 10 % obtained with the standard TOF method, where ten times the measurement time was required to produce data of the same quality.

For the experiment described here, the detector was 5 m away with 2.4 mm resolution. If a reflectometer was built at the ILL with a detector distance long enough (about 10 m) and a resolution less than 1 mm, it would be capable of measuring a factor of 15 in q and a reflectivity less than 10^{-4} in sub-second timescales, thus opening up a new area of fast kinetic studies. Such a machine would also be naturally used for GISANS measurements.

Given the machine requires such a thin source beam it could be considered as a parasitic instrument feeding off an unused edge of guide. In this case a deflecting super mirror would be required to bring the beam away from the exploited guide. The best geometry would be a horizontal reflection plane to remove the effects of gravitational dispersion on the prism angle.

In the AMOR experiment existing choppers were used to calibrate the dispersion but once Nb is known there is no need for this as the deflection has not been seen to divert from Snells' law.

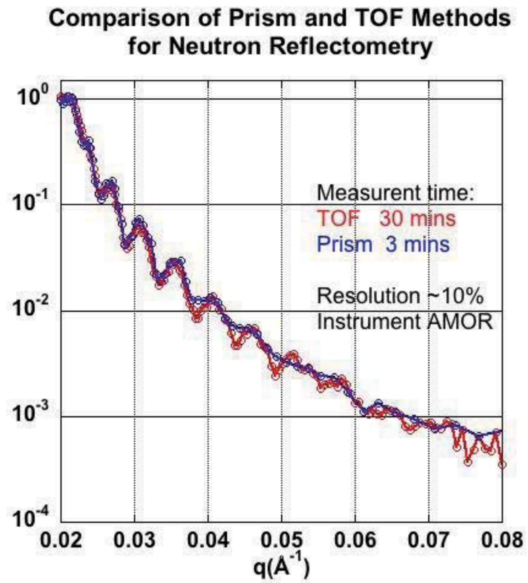

Figure 2*: Reflectivity measured by the prism (blue) and TOF (red) methods. It was not possible to have the same resolution as a function of wavelength as AMOR operates with a constant dλ/λ like D17 and FIGARO in this case set at 10%. The prism produces a resolution with constant dλ which varies from about 5% at 12Å (corresponding to the lowest q) to about 20% at 2Å (at the highest q).*

GISANS Option. Given the requirements for refractive encoding result in a long detector distance with a high resolution detector the machine is naturally adapted also for grazing incidence small angle neutrons scattering (GISANS). Here a beam is well collimated in both directions and scattering out of the reflection plane is studied. Refractive encoding is no use as the scattering itself is dispersive. However given the collimation constraints a prism could be used before the collimation to monochromate the beam removing the need for a selector. Thus the additional requirements would be another rotation axis before the collimation and detector resolution in both directions- a modest investment.

References

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