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AMOR – the versatile reflectometer at SINQ

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Abstract

We report on a new facility for neutron reflectometry situated at the end position of a cold neutron guide at the Swiss Spallation Neutron Source SINQ. The instrument is a flexible apparatus, adaptable to the needs of the user's individual experiment. Principally designed to operate in the time-of-flight mode it is also capable to exploit the fact that SINQ is a continuous source because PSI's developments in the field of thin film multilayers are fruitfully applied. By means of multilayer monochromators it can be converted into a constant wavelength reflectometer. Polarized neutron reflectometry on AMOR takes advantage of remanent FeCo/Ti:N supermirrors and multilayers which can be operated in a way that no spin flippers are needed. The time and angular contributions to the resolution in momentum transfer are separately determinable in TOF mode. The total length of the instrument is adjustable in order to optimize resolution together with the illumination of the sample's surface. Large sample environments can be placed on the sample table that is actively isolated against vibrations. Single detectors and an EMBL ^{3}He area detector can be chosen, alternatively. The instrument concept as well as parameters of its components are presented. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Reflectometer; Multilayers; Polarization analysis

1. Introduction

In the past two decades neutron reflectometry developed to a standard technique for nondestructive depth profiling and is now represented at every modern neutron scattering center. Since December 1996 SINQ is delivering a continuous flux of neutron to an increasing number of instruments. AMOR completes the once planned first series of experimental stations and is now open for users. The installation is placed on an end position of a supermirror-coated neutron guide with an output flux of 1.38×10^8 ns^{-1} cm^{-2} mA^{-1}. The guideline for this reflectometer is versatility, in order to allow for low as well as high-resolution experiments on large or small samples, be it that a polarized beam is needed of that the 'footprint' on the sample's surface has to be adapted [1].

2. Instrument description

Because of the advantages, that are inherent to the time-of-flight mode, the measurements are primarily performed according to this principle. Thus, the independent adjustment of the temporal and angular contributions to the resolution in q becomes possible. The distance between the two choppers, the velocity, as well as the relative phase with which the second follows the first together with the time channel width in the detector histogram define the temporal part. The usable wavelength band spans from 0.13 to 1.3 nm. Nevertheless, the user may see particular advantages in working at constant wavelength and therefore can switch AMOR to run in this mode. The development of multilayer monochromators has made the necessary progress to monochromate with these devices. The vertical scattering plane gives the opportunity of reflectometry on open liquid surfaces Fig. 1. Such investigations ask for the deflection of the incoming beam to impinge at a desired angle ϑ_i on the horizontal sample. For this purpose a supermirror will be mounted on the polarizer station. Vibration

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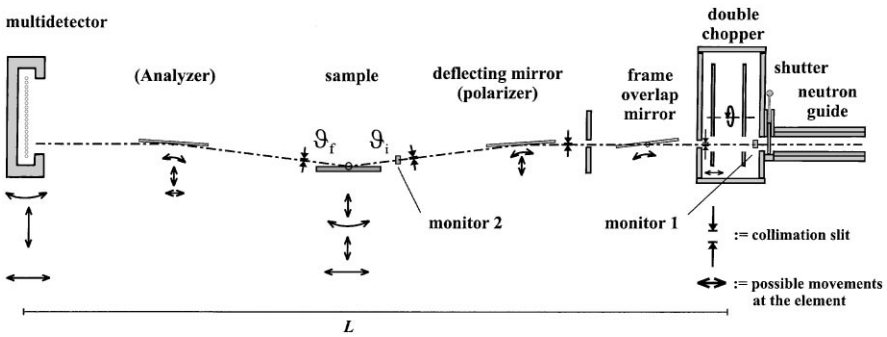

Fig. 1. Sketch of the overall instrumental layout of the PSI reflectometer. Components for the generation of magnetic fields, positioning aids, and single detectors are omitted.

isolation of the individual optical riders is maintained by an 8 m long optical bench made from granite and an active piezo damping table underneath the sample. As a novel approach AMOR's polarized reflectometry mode relies solely on remanent polarizer mirrors as spin determining devices [2]. Feasibility test at LANSCE have confirmed that remanent FeCoV/Ti : N supermirrors from our laboratory fulfil the practical needs for spin polarization to better than 90% [3]. For the spin analysis of the beam that is reflected from the sample we consider a mirror that provides an angular separation of the two spin states so that the spin-flip and the non-spin-flip signal can be measured simultaneously. The FeCo/Si-system deposited on silicon has proven to be suitable for this task [4]. An important element of any neutron diffractometer is certainly the detector. AMOR's detector station houses two systems on a motorized elevator. They move on a tangent along the 2ϑ-circle and can be tilted up to 10° to the horizontal plane. Two single ^{3}He-detector tubes can be aligned to the beam paths determined at the analyzer. Additionally, an area detector stands to the users disposition. Off specular reflection investigations will profit from this multi-wire ^{3}He chamber from EMBL with 20×20 cm^2 sensitive area and 2 mm spacial resolution (Fig. 1).

The high degree of flexibility and reproducibility on AMOR is supported by full computer control of the motorized and encoded stages for the mirror mounts, the sample, the diaphragms and the detectors.

3. Conclusion

With AMOR a new and flexible instrument is now available to the user community that covers most of the options in contemporary reflectometry. In close interchange with the local multilayer laboratory, state of the art multilayers and supermirrors are tailor-made to allow for the different options, mainly polarized reflectometry and constant wavelength mode.

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