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Multiple beam SANS instrument for kinetic studies on low sample volumes

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Abstract
Tracking of kinetics and dynamical processes on extremely low sample volumes is one of the most promising fields for new applications of neutron scattering complementing synchrotron X-ray research. The proposed SANS instrument using multiple beams focussed on the sample is designed for investigations of nanoscaled fluctuations and sub-millisecond dynamics in new materials obtained only in small quantities. It allows kinetics of chemical processes to be studied in a large dynamic range in one shot when fast changes of external parameters has to be applied on small sample volumes. The instrument can be optimized for continuous or long pulse neutron sources [1].
We present the design of a prototype of an innovative SANS instrument which consists of a multichannel guide [2] combined with monochromating mirrors which produce 6 individual beams with different wavelengths focussed on the sample of 2 mm in size [3]. The multichannel guide can compress the intensity at the end of conventional (cold neutron) guide by more than a factor 5-10 leading to a spot size of only a few mm. At the end of this device neutrons are extracted in 6 individual beams with cross sections 5 mm. It is expected that the wavelength distribution in these two beams will be very different when a white spectrum is offered to the device. Mean wavelengths (between 4 and 20 Å), bandwidths (and also neutron polarisation) can be chosen individually for each beam by proper multi-layer coating. E.g. neutron beams of 11 A , 8A and 5A are obtained with a d-spacing of 30 A multi-layers reflecting at 11° , 8° and 5°, respectively with more than 60% reflectivity. All beams are then focussed on the sample with a cross-section of 2×2 mm2. Scattering cross sections are measured simultaneously for each individual beam in separate detectors with pixel sizes of mm resolution covering the entire Q-range defined by the three wavelengths. The standard SANS collimator is replaced by movable apertures which allow a flexible choice of the collimation. In the final design TISANE and MIEZE techniques should be implemented which allow periodic processes in sub-millisecond time range to be studied by means of SANS.They consist of measuring the response to a periodicperturbation applied to the sample (e.g. magnetic or electric fields, T, P, pH etc) by using a pulsed neutron beam. Both techniques are based on time signals produced by lock-in techniques. In the TISANE technique [4] a pulsed polychromatic beam is produced by a multi-slit double chopper which deserves individual beams simultaneously. All neutrons from different chopper pulses elastically scattered by the sample in a given oscillation state are collected in the same time frame of the detector, irrespective of their wavelengths.. Considerable gains in intensity are obtained by large frame overlap.

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