GISANS for ESS

Report from the Workshop in Garching, 19 & 20 February 2018

Sponsored by JCNS/MLZ and Uppsala University Centre for Neutron Scattering

The workshop was organised first to develop the science case for a dedicated grazing incidence small-angle neutron scattering (GISANS) instrument that could be built at the Maier-Leibnitz Centre in Garching and secondly to discuss a possible GISANS instrument to be built at ESS. A major point that was emphasised is the need for dedicated instruments: at present the effort required to set-up such experiments on other instruments makes the technique less-attractive for new user communities. The common interest in both instruments was recognised and the complementarity of capabilities would be important. The representation of about 20 user groups at a small workshop dedicated to instrumentation illustrates the depth of interest in provision of new capacity to enhance the technique. Several new groups want to become engaged with the technique. Existing GISANS experiments cover a broad range of science in areas of energy materials (e.g. solar cells, batteries), model membranes, biotechnology, coatings, magnetism, soft matter, tribology, etc. where interfaces are important.

The GISAXS community is growing rapidly and now benefits from dedicated beamlines as well as work flows that automatically optimise sample mounting, alignment, data collection, data reduction and analysis. Although the throughput in GISANS is less, there would be advantages in providing similar capabilities as far as possible for neutrons which could build on work done at synchrotron facilities. Particularly for buried interfaces, mixed materials at surfaces that can exploit isotopic labelling, and for magnetic structures, neutrons are crucial to make progress in understanding the three-dimensional organisation of thin layers.

Ideas about desirable resolution for a GISANS instrument were presented by Sebastian Jaksch. Several possible instrument concepts were shown by Artur Glavic and Stefan Mattauch that included HEKATE and Heritage. There are several aspects of design that will need further detailed study. It was recognised that appropriate detectors need to be evaluated, and their availability and performance would strongly influence instrument design. Various aspects of focussing and scattering signal enhancement with resonators were discussed.

The following desired features were identified:

- Ability to measure reflectivity on the same instrument: this is important data to combine with scattering.
- Variable resolution – a range from 7% to 1 or 2% could be useful. Resolution is important both for identification of scattering features and to provide identified depth ranges for the scattering. Optimising the choice of instrument length and guide design will be important.
- Ranges of momentum transfer in Q_z (normal to the interface) for reflectivity up to 0.35 $Å^{-1}$ are needed. It would be advantageous if the resolution in GISANS could provide information to allow matching of data with Q_x (in the plane of the interface) measured in off-specular scattering.
- Capability to investigate horizontal (liquid surfaces or liquid/liquid interfaces) from above and below. The feature could also be of importance for rheology experiments etc.
- Magnetic samples in magnetic fields.
- Low background – signals are often very weak.

- Sample environments should be planned from the start of the design to enable ease of precision angular and translational adjustments. It is expected that a wide range of in-situ studies will be wanted that include spin-coating, electrochemical cells, printing systems, magnets, rheometers etc.
- The provision of space for a wide-angle detector for GIWANS needs to be considered.
- The provision for spin-polarisers and analysers needs to be considered and where these could be located.
- Capacity is needed to use simple add-ons such as prisms to provide first-order refraction correction for a range of wavelengths and to exploit the provision of resonator substrates to enhance surface scattering.

There is willingness to co-operate amongst the various groups to pool ideas to provide the best instrument proposal. Communities exist in most European countries. It was noted that the Swedish community is very actively pushing for support for development of a full instrument proposal.

Actions

- Discuss with ESS the possible location of an instrument that might have an overall length of up to 65 m.
- Urgently seek support for the initial effort required to prepare a detailed instrument proposal to ESS.
- Encourage the BornAgain team to develop calculations of models for realistic samples that could be combined with McStas simulations of instruments. This would allow both better optimisation of instrument designs and would help with understanding experimental results.
- Continue the dialogue with the existing user community and new potential users to further develop the priorities for a detailed design. People should meet at the upcoming SXNS and GISAS conferences but also holding another Workshop in about a year would be useful.

Conclusions from the workshop as regards the potential new instrument for MLZ are documented separately.