Spin-Echo SANS and Neutron reflection at the ISIS SecondTarget Station.

Neutrons and Food 2012

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Specular Neutron Reflection from a single interface

- Highly collimated beam incident on surface at <3°
- Probe structure perpendicular to the interface
- Measured signal is related to the difference in scattering length density at the interface and roughness
Monolayers at the Air/Water Interface

- Adding a surface layer yields interference fringes
- Isotopic substitution enables detailed studies
Off-Specular Reflectivity

- Scattering away from the specular beam reveals in plane structure.
- Frequently used to investigate polymer device structures.
- Complex Scattering theory.
- Overlaps strongly with GISANS.
Typical Science Areas

- Atmospheric chemistry
- Protein resistant surfaces
- Organic light emitting diodes
- Sustainable laundry detergents
- Lung surfactant
- Surfactant adsorption biosensors
- Gene delivery
- Inorganic templating
- Ionic liquids
- Neutron reflectivity
The ISIS Second Target Station

- 3 Reflectometers located on the Second Target Station
  - INTER, PolRef and OffSpec
- OffSpec for SESANS with Larmor to come.
- Dedicated Bio Lab
- 4 Chemistry Labs
- Materials Characterisation
INTER
• High flux reflectometer with large simultaneous Q range

2 Minute data acquisition from protein absorption at the air-liquid interface
Bovine Serum Albumin and Lysozyme

Measurement of BSA adsorption with different water contrasts. Inset: Single uniform layer fits to the reflectivity profile in D2O at pH 5.1 in the presence of 0.005 g.dm$^{-3}$ BSA.

J R Lu, T J Siu, B J Howlin (Surrey University), R K Thomas, Z F Cui (Oxford University), J Penfold, J R P Webster (ISIS)
Proteins at Interfaces

Surface arrangement of adsorbed lysozyme consistent with the observed structural parameters and minimizing the number of charge groups exposed to the air. The region of the protein estimated to have the lowest charge density is shaded.

Schematic diagram to illustrate the surface coverage and orientation of lysozyme molecules adsorbed at the silica-water interface. (a) 0.03 g.dm⁻³, (b) 1 g.dm⁻³.
Proteins at interfaces

Puroindoline-a adsorbed DPPG monolayer

Green, Clifton, Frazier et. al.
β-Purothionin adsorbed DPPG monolayer
Comparison of interfacial structures

OffSpec
Spin-Echo SANS at a pulsed Source

\[ \delta = \frac{c B L \lambda^2 \cot \theta_0}{\pi} \]

\[ \delta \rightarrow 20 \text{nm...} 20 \mu m \]

- 3 fixed fields (B), variable \( \theta_0 \)
- Fixed L, \( \lambda \) varied using time of flight
- Large simultaneous spin-echo length range.
  - Some Advantages
    - Longer wavelengths means thinner samples
    - Faster data collection 5-7 minutes limited by detector.
      - (Could drop to <30s)
  - Some Disadvantages
    - Broad wavelength range means no optimum sample thickness.
    - High peak flux makes detector design difficult
SESANS and SANS
4 Instrument settings combined
Time Resolved SESANS

Edler et. al.

![Graph showing spin echo lengths and corresponding ln(P/P_0)/\lambda^2 values for different time intervals.]
NIMROD is optimised for the investigation of molecular and mesoscale structure of disordered, or partially disordered, systems. A classic scientific application is the confinement of liquids in nanostructured materials such as MCM-41 silica. This material is formed from a hexagonal lattice of cylindrical pores (2.7nm diameter) within a glassy SiO$_2$ matrix.

Schematic picture of the pore structure of MCM-41 and an electron micrograph of the material

Kinetic measurements during pore filling were performed in 6 minute time slices on a 500mg sample of MCM-41
Larmor

New instrument for 2014/15

- Open blockhouse layout
- Workhorse SANS instrument with polarisation.
- Designed to allow the installation of Larmor precession instrumentation.
  - SESANS
  - Larmor Diffraction
Thanks

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