D3 spectrometer demonstration

Contrast Matching experiment with H2O/D2O mixture in contact with a film

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The scattering length density of hydrogen containing materials can be varied by isotopic substitution of hydrogen with deuterium. Accordingly, the index of refraction for a H2O/D2O mixture can be tuned to the index of refraction of almost any other material. In this so-called "contrast matching" method, the index of refraction of the liquid is matched to the one of the thin layer, i.e. according to Fresnel no enhanced reflectivity occurs at this interface. In Figure 1, the simulated reflectivity curves for a Si/SiO2 sample in D2O and contrast-matched water (CMW) are shown. In CMW the Kiessig fringes disappear indicating that there is no reflection from the interface.

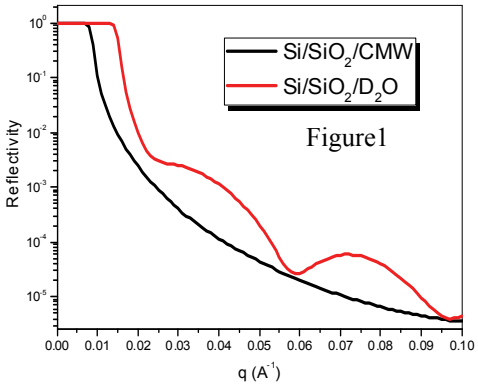

Figure1

In this demonstration we will:

1. Introduce the components of the D3 reflectometer: slit S0 and monochromator, directional defining slits (S1, S2, S3 and S4), neutron spin polarizers and flippers, and the signal detectors. The importance of the beam and sample alignments will also be discussed.

2. Discuss how neutron reflectometry can be used to determine the physical, chemical, and magnetic properties of thin films and interfaces. We will show how to prepare CMW with the same SLD as the SiO_2 film. The sample set-up (Figure 2) will be discussed and two NR measurements will be performed in pure D_2O and CMW and the raw NR data will be compared.

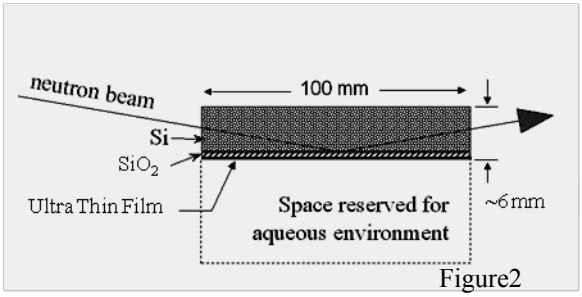

Figure2

3. Explain how to use the least-squares fitting program, Parratt32, to find the best model and the SLD profile of the system.

Figure 3 shows the components of the D3 reflectometer in the unpolarized mode. D3 operates with a fixed wavelength (2.37 Å) and in the horizontal scattering plane. The 300 mm tall vertically focused pyrolytic graphite monochromator creates an intense image of the source 45 mm high at the sample. A vertically limiting slit S0 allows reducing the monochromator height if a particular experiment requires a small vertical beam divergence. All other slits (S1 to S4) are driven by high-precision translation stages with 2 micron accuracy. Neurons reflected off the sample are captured by a 300 mm tall ^3He detector consisting of individually recorded 32 signal wires. An area detector is also available for 2-dimensional off-specular studies. (Components for polarized neutron mode not shown).

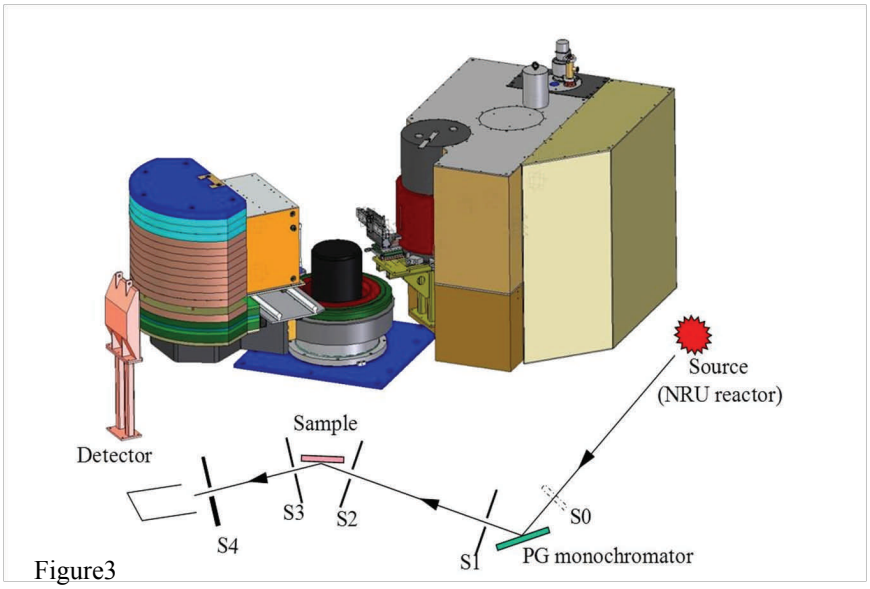

Figure3