ESRF	**Experiment title:** Freezing at solid liquid interfaces	**Experiment number:** S1296
Beamline: ID10	**Date of experiment:** from: 03-sept-97 to: 12-sept- 1997	**Date of report:** **18-9-98**
Shifts: 15	**Local contact(s):** D.L. Abernathy	*Received at ESRF:*

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Report:

We have performed an X-ray reflectivity study of the interface of liquid Ga in contact with a Si(l l l)-7x7 surface. We are interested in the ordering phenoma that have been predicted to occur(‘) at such a solid-liquid interface. Near the interface, the liquid is expected to exhibit atomic layering in the direction along the surface normal, as well as ordering parallel to the surface plane. X-ray reflectivity from such an interface is sensitive to a layering effect in the liquid, as we have demonstrated in a previous experiment on the Ga/diamond(111) system[(2)].

The scattering geometry and setup have been described in an earlier report of experiment S187. In brief: the interface is illuminated from the substrate side with a monochromatic X-ray beam. After scattering from the interfacial region the photons travel through the crystal on their way to the detector. This scattering geometry allows one to measure the change in density across the interface. The interface was prepared in a dedicated ultra-high vacuum (UHV) setup[(3)].

An accurately polished, low-miscut Si(111) sample was mounted in the scattering chamber that was pumped down and fixed onto a double tilt stage on the horizontal diffractometer of the TROIKA beamline. A clean (7x7) reconstructed Si(111) surface was prepared by flash-heating above 1100 °C. Subsequently, a drop of liquid Ga of nominal purity 5N was decanted from the centre of the melt and was deposited onto the clean surface[(4)]. The 3rd harmonic of the small gap undulator was set to give a maximum flux at a photon energy of 23.01 keV (0.54 Å wavelength). This allows for measurements along the rods for vertical momentum transfers in the range $0 < Q_{\perp} < 5$ Å^{-1}.

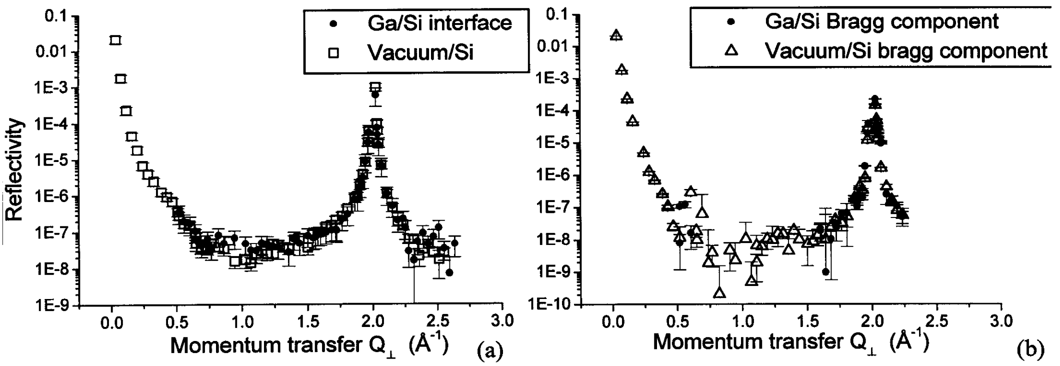

Fig. 1 Specular reflectivity of the clean and Ga covered Si(111)7x7, (a) shows the total reflectivity (b) the Bragg scattered reflectivity

The specularly reflected intensities in Fig. 1 were obtained by making transverse momentum scans. The intensity distribution in the transverse momentum scans can be decomposed in a sharp peak from Bragg scattering and a broad peak from diffuse scattering due to roughness. Fig. l(a) shows the total reflected intensities, Fig. 1 (b) the reflected intensities in the Bragg component of the intensity distribution. Because of the high background coming from the Ga bulk liquid and powder pattern from the Be window, the reflectivity could not be measured for $Q_\perp > 2.7$ Å^{-1}. Furthermore, due to an overhang of the Ga drop we could not measure below $Q_\perp = 0.5$ Å^{-1}. There appears to be no difference between the reflectivities observed for the Ga/Si and vacuum/Si interfaces. From the Bragg reflectivity we obtain the interfacial roughness. Assuming a Poisson-type roughness model we find for both interfaces an rms roughness of 3.1 Å.

For Ga/Si(111) we find no indication of a layering effect as for Ga/diamond(111). A layering effect for the Ga/Si system may become visible only at higher moment transfers. For example, Regan et al.[5] observed a layering effect at the free surface of liquid at Q=2.4 Å-1, which is at the limit of our range. On the other hand, the rather large rms interface roughness of 3.1 Å may well have prevented us from observing the layering of the liquid. Another explanation may be that, unlike for the Ga/diamond system, there is no epitaxial relation between α-Ga and Si(111).

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