



Experiment title:  
Structural study of the low temperature  $c(4 \times 2)$  clean  
Si(001) reconstruction

Experiment  
number:  
SI-126

Beamline:  
BL7/ID3

Date of experiment:  
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Shifts:  
12

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## Report:

The main goal of this experiment was to determine the structure of the low temperature  $c(4 \times 2)$  reconstruction of the clean Si(001) surface.

Concerning this main goal we should say that the experiment has not been successful, in fact we have not been able to observe any peak corresponding to this reconstruction.

However we were successful in:

- prove that the intensity ratio between the  $2 \times 1$  and  $c(4 \times 2)$  peaks is much larger than the value reported in the germanium case;
- at the lowest temperature we reached ( $\sim 120$  K as calculated by measuring the lattice parameter) a  $2 \times 2$  superstructure is formed.

With the present experimental setup we do not think we could achieve a better result. In fig 1. we report an hscan along the  $[h, 0.5, 0.03]$  direction. In the picture two peaks clearly appear, the  $(1, 0.5, 0.03)$  from the  $2 \times 1$  reconstruction and a  $(1.5, 0.5, 0.03)$  coming from the  $2 \times 2$  one.

We spent quite a lot of time in order to optimize the diffractometer setup and we have to emphasize the very good signal to noise ratio that we obtained for the 2x1 reconstruction. This was measured by using grazing incidence and exit angles and by having an incident beam width of 0.04 mm to illuminate only the surface.

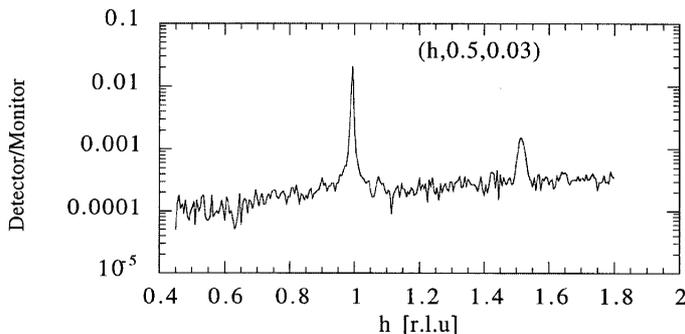


Fig. 1) Scan along the  $[h, 0.5, 0.03]$  direction. Two peaks corresponding to the 2x1 and 2x2 reconstructions are clearly visible. Please note the logarithmic scale.

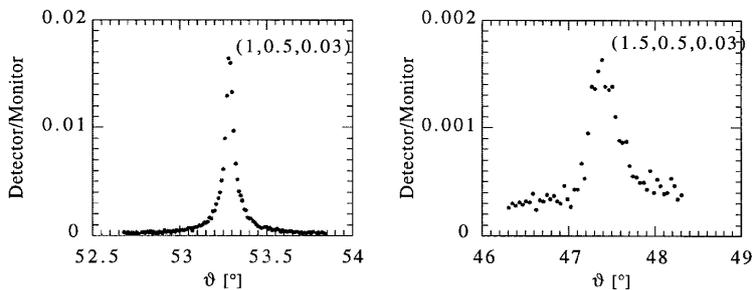


Fig.2) Theta scans of the  $(1,0.5,0.03)$  and of the  $(1.5,0.5,0.03)$  peaks. In the first case the FWHM is  $0.08^\circ$  confirming the presence of large domains. The intensity of the 2x2 peak is about 30% of the 2x1 implying that a large part of the surface has this reconstruction.

In fig.2 we report theta scans of the  $(1,0.5,0.03)$  and  $(1.5,0.5,0.03)$  peaks.

We looked for other peaks corresponding to the 2x2 reconstruction but we could not observe any others. We have to point out that a large part of the reciprocal space was not visible because of shadowing by the clips.

Even if we think that this measurement is the maximum possible in the present situation, we can affirm that a better study of this system can be performed when a more appropriate sample holder, designed for thin samples, will be available. We are ready to develop this new tool and to provide it at ESRF for general use.