DUBBLE	**Experiment title:** Study of the polar surface of $DyScO_3$ (110)	**Experiment number:** 26-02-556
Beamline: BM26	**Date(s) of experiment:** From : 31-05-11 To : 06-06-11	**Date of report:** 01-07-11
Shifts: 18	**Local contact(s):** G. Portale	

Names and affiliations of applicants (* indicates experimentalists):

S. Harkema[1*], G. Koster[1], B. Kuiper[1*], J. Blok[1], J. Kleibeuker[1], P. Tinnemans[2*], V. Vonk[2], E.Vlieg[2]

[1] MESA+ Institute, University of Twente, Enschede, The Netherlands
[2] IMM, Radboud University, Nijmegen, The Netherlands

In this experiment the polar surface of $DyScO_3$ (110) was investigated using Surface X-Ray Diffraction (SXRD). Orthorhombic $DyScO_3$ (110) has a polar alternating layered structure of ScO_2^- and DyO^+ with a layer spacing of 0.195 nm. At the substrate surface this polar structure must be broken, resulting in an unknown reconstruction. For a bulk, single terminated surface the surface can either be scandium (ScO_2) or dysprosium (DyO) terminated. For well controlled growth of thin films it is necessary to know the surface crystal structure. A new surface preparation method was developed using different etching steps, to obtain atomically flat single terminated surface
The bare $DyScO_3$ (110) surface, without the chemical etch procedure, was already studied in previous experiments at BM26.

The first 3 shifts in this experiment were used to optimise the beam, start-up and align the diffractometer. A total of 5 samples were measured in the remaining 15 shifts. Samples were mounted on a heating stage obtained from the Sample Environment Lab and most measurements were performed at 250^{o}C. to remove all water on the surface.
Two samples prepared with the new surface treatment method of a double etching process were measured and were indeed atomically flat single terminated surfaces (Fig. 1). A reference sample prepared using the previously used sample treatment of only one etching step also yielded a single terminated surface, but the quality seems slightly less (data not shown).

On top of a scandium single terminated surface one atomic layer of DyO was deposited with interval pulsed laser deposition to again obtain a single terminated surface but with reversed termination, DyO instead of ScO_2. The SXRD measurements (Fig. 2) indicate that only about 65% of the surface after the deposition is covered with DyO, instead of the desired full layer. While it was difficult to calibrate the amount of DyO deposited, the AFM image after deposition (Fig. 2b) seemed to indicate a fully closed layer with few holes. A possible explanation between the discrepancy between the SXRD and AFM measurement is that not all the DyO deposited is in crystalline form and therefore would not show up in the SXRD measurement but would in the AFM image.

Some additional investigation and work will have to be done to be able to deposit exactly one atomic layer of DyO on ScO_2 terminated $DyScO_3$, but the first results are encouraging.
In conclusion we can look back on a successful experiment with no notable setbacks. All the desired data from all samples were measured, with the help of the DUBBLE staff.

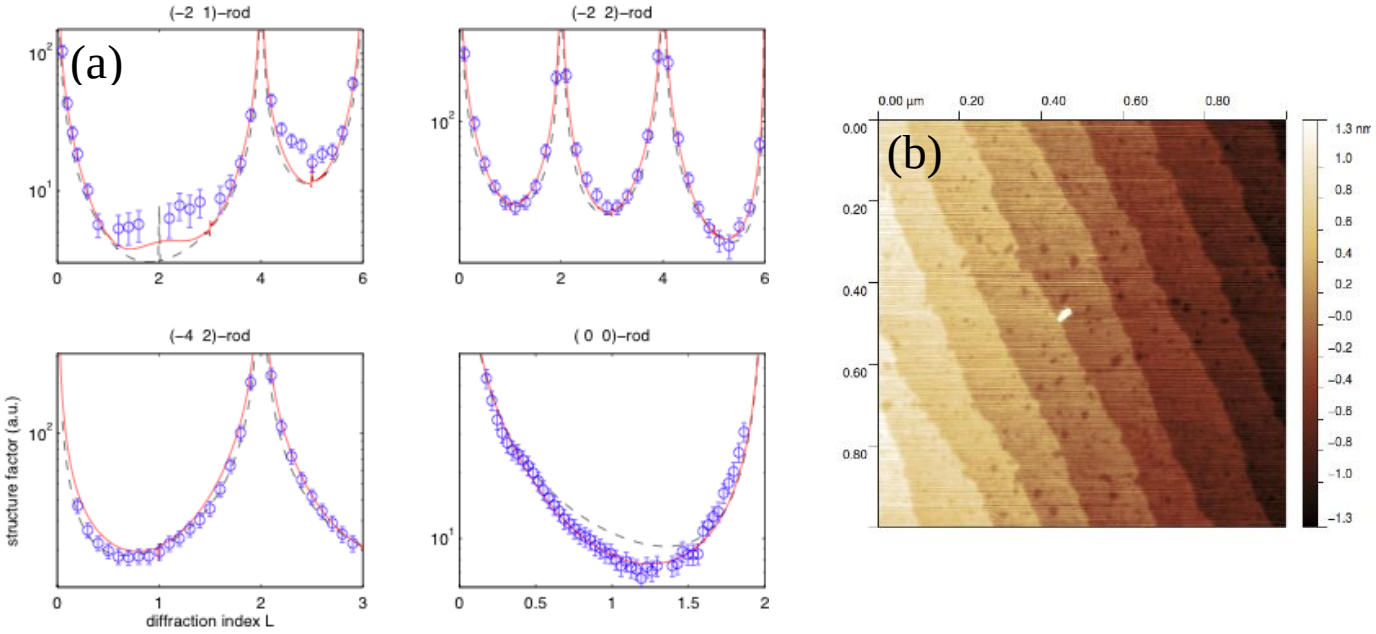

Fig 1.: a) SXRD measurements of a chemically etched polar $DyScO_3$(110) surface. A bulk scandium terminated surface model (black dashed line) is in reasonable agreement with the measured data (blue circles). Adapting the model slightly to have about 10% holes in the surface (red solid line) yields a good fit with the measured data. This model is in good agreement with the AFM image (b) also showing holes in the $DyScO_3$(110) surface. Etching of the surface is a probable cause for the holes.

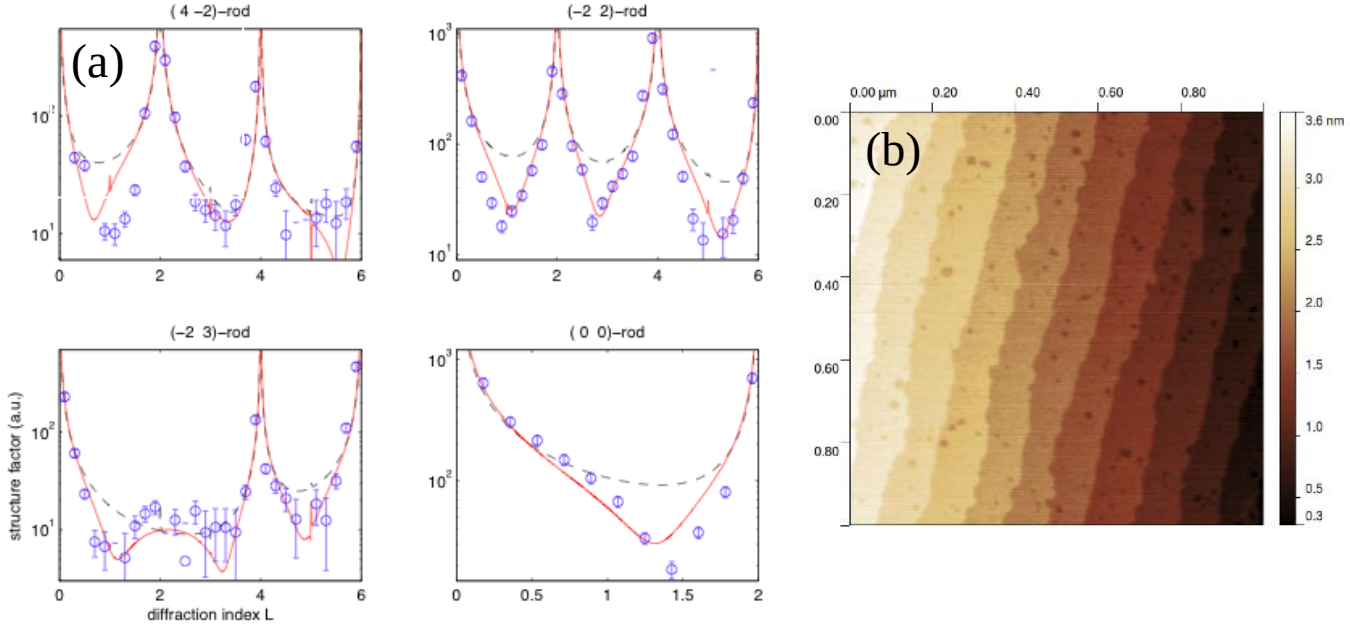

Fig 2.: Measurements on a dysprosium terminated $DyScO_3$(110) surface, produced by interval pulsed laser deposition of one atomic layer of DyO on top of a scandium terminated surface, reversing the termination.
a) SXRD data show that a DyO layer on top of a scandium terminated surface with a occupancy of about 65% (red solid line) is in reasonable agreement with the measured data (blue circles). A bulk terminated model is given for comparison (black dashed line).