ESRF	**Experiment title:** Atomic structure of SrTiO3/LaAlO3 multilayer systems	**Experiment number**: HS3456
Beamline: ID03	**Date of experiment**: from: 20/02/2008 to: 23/02/2008	**Date of report**: 14/05/2008
Shifts: 9	**Local contact(s)**: Dr. Didier WERMEILLE	*Received at ESRF:*

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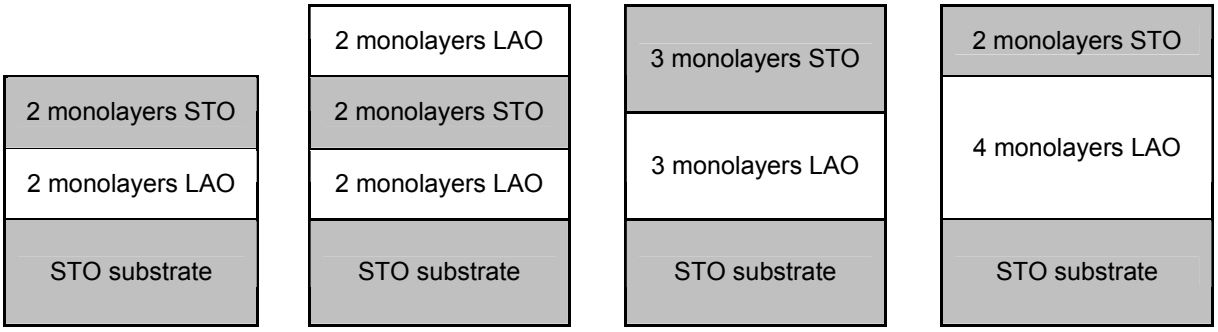
Report:

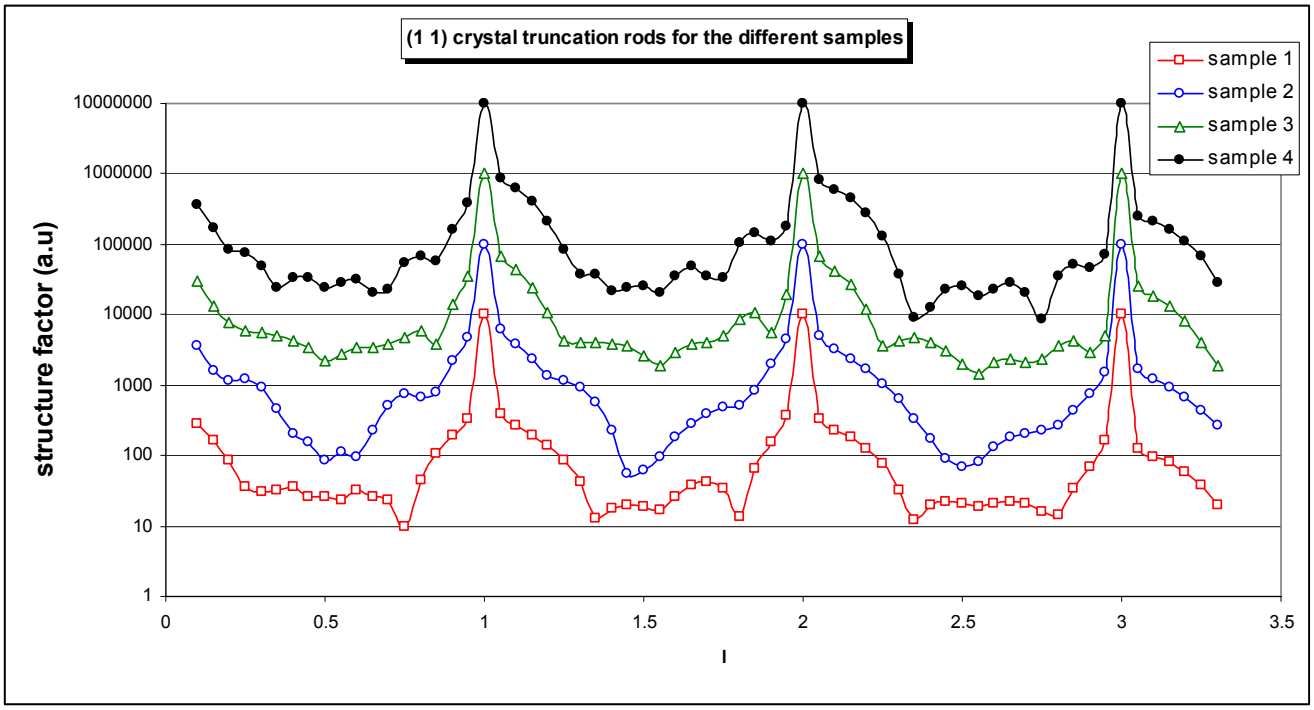
One of the main research topic of the Condensed Matter Physics & Devices Group at Twente University is the study of electric and magnetic properties of (devices of) thin layers, mostly consisting of rather simple oxidic materials. One of the methods used to deposit these compounds is Pulsed Laser Deposition (PLD). With the PLD method, it is possible to deposit oxidic materials layer by layer in a controlled way. One of the interesting developments of the method is the possibility of producing multilayers. As an example: on an atomically flat single crystal substrate ($SrTiO_3$ (001), cubic) alternating layers of n unit cells of $LaAlO_3$ and m unit cells of $SrTiO_3$ can be deposited. This ensemble is repeated l times, producing a 'superlattice single crystal' with a tetragonal unit cell of approximately $n*a_{LaAlO3} + m*a_{SrTiO3}$ in the direction perpendicular to the surface. The cell constants in the plane are equal to those of the $SrTiO_3$ substrate. Reciprocal lattice scans prove that there is no twinning and that the layer is perfectly epitaxial.

The multilayer systems produced this way, show interesting electric properties: while $LaAlO_3$ and $SrTiO_3$ are both insulators, the multilayer systems, however, show interface conductivity [1,2]. This intriguing phenomenon of conductivity at the interface between two insulating materials has become known as "electronic reconstruction". It is well known that the atomic structure of surfaces and interfaces differs in general from the bulk. In order to better understand and model the exotic properties of the aforementioned heterointerfaces, it is important to determine the atomic structure of these systems accurately. The goal of this experiment was to determine the atomic structure of a number of LAO/STO multilayer systems.

In this experiment four samples were measured of the following compositions



For each of these samples a number of Crystal Truncation Rods (CTR's) have been measured, with good reproducibility. First results are presented in the following figure, where the (11) CTR's of the different samples are shown..



From the figure it is evident that the CTR's for the various samples are clearly different and furthermore that they contain enough detail, to make the determination of the atomic positions in the interface feasible.
A detailed evaluation of the data is presently in progress.

References

[1] M.Huijben, *PhD thesis, University of Twente, april 2006*
M. Huijben *et al, Nature Mater.* ***5,*** *556 (2006)*
W. Siemons *et al. PRL* ***98****, 196802 (2007)*

[2] A. Ohtomo & H.Y. Hwang, *Nature* ***427****, 423 (2004)*
A. Ohtomo & H.Y. Hwang, *Nature* ***441****, 120 (2006)*
A.S. Kalabukhov *et al. Phys Rev* ***B 75****, 121404 (2007)*