

Sulphur-induced reconstruction of the SrTiO₃(001) surface

Mark J. Haastrup¹, Igor Beinik¹, Jeppe V. Lauritsen¹

¹*Interdisciplinary Nanoscience Center, Gustav Wieds Vej 14, Aarhus C, Denmark*
mjh@inano.au.dk

The physical and chemical properties of a material is greatly affected by the atomic arrangement and electronic structure on the surface. This opens up for chemical functionalization of the surface as an additional parameter in material synthesis. Perovskites such as SrTiO₃ (STO) single crystals are widely used substrates in oxide research. Recent discoveries in 2D material synthesis using STO as a substrate includes high-T_c superconductivity with one unit cell FeSe film[1] and high mobility two-dimensional electron gas at the interface of the LaAlO₃/SrTiO₃ heterojunction[2]. Here, we focus on functionalization of the surface with sulphur compound as part of growth of transition metal sulphides on this surface.

Atomically flat and clean STO (001) single crystals are characterised by scanning tunnelling microscopy (STM), non-contact atomic force microscopy (nc-AFM), and X-ray photoelectron microscopy (XPS). The samples are prepared by first ex situ etching in deionised water followed by a high temperature annealing of commercial samples. The samples are then sputtered with Ar⁺ ions and annealed in situ with and without the presence of oxygen in a UHV chamber.

Exposing the surface to a sulphur compound is seen to have a dramatic effect on the surface properties. Annealing the sufficiently cleaned STO substrate in a background pressure of dimethyl disulfide (DMDS) results in a large scale (~100 nm) striped surface reconstruction patches along with disordered cubic reconstruction with a lattice constant of 1 nm covering the sample. We tentatively associate the observed reorganization into patches to preferential sulfidation of one of the cations in SrTiO₃ and formation of a monometallic sulphide phase.

References:

- [1] Ziqiao Wang et al, J. Phys.: Condens. Matter **29**, 153001 (2017).
- [2] Sang W. Lee, J Nanomater **2016**, 1671390 (2016).