FA5-MS39-P05

Electric Field Induced Structure and Resistance Modifications in Metal/$SrTiO_3$ Junctions.

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In oxides with perovskite-type of structure, oxygen can be a sufficiently mobile defect even at room temperature when an electric field of sufficient strength (~1000 V/mm) is applied. Our in-situ investigations of metal/$SrTiO_3$ junctions revealed reversible structural changes and the formation of non-stoichiometric regions during the application of external electric fields. This might be caused by a field-induced redistribution of oxygen vacancies. The investigations were carried out using wide-angle X-ray scattering, X-ray absorption spectroscopy, nanoindentation and time-dependent electric measurements.
Motivated by the successful use of $SrTiO_3$ with different doping metals for memory cells on the basis of resistive switching in combination with the findings on the major importance of oxygen vacancy redistribution, we want to show the possibility of realizing a resistance change memory based on vacancy-doped $SrTiO_3$. The formation of corresponding metal/$SrTiO_3$ junctions in an electric field will be discussed as well as the switching between ohmic and Schottky-type resistive properties. A notable hysteresis in the current-voltage characteristics can be used to carry out Write, Read and Erase operations to test the memory cell properties of such junctions. But whereas the electric field-induced formation of Schottky-type junctions may be explained by oxygen vacancy redistribution, the resistive switching is preferably discussed in terms of vacancies serving as electron trap states at the metal/oxide interface.

Keywords: structure-properties relationships, electrical properties of solids, perovskite oxides

FA5-MS39-P06

An AFM-study of the surface topography of anatase single crystals.

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Grazing Incidence X-ray diffraction (GIXRD) is a surface X-ray diffraction method for the analysis of mineral surfaces and interfaces on atomic scale [1,2]. This method requires very flat and large single crystal surfaces with a rms-roughness well below 10 nm. Therefore crystal surfaces used in GIXRD-experiments are analyzed for surface topography and roughness. Atomic force microscopy (AFM) provides a simple, inexpensive and fast technique to investigate the macroscopic surface structure and measure the surface roughness. TiO_2 is the most widely used photocatalytic material for heterogeneous photocatalytic oxidation (PCO) processes [3]. Photocatalytic thin films consist of a mixture of rutile and anatase nanocrystals, where the anatase surfaces are the most active part in the PCO process [4]. The structure and properties of the most abundant (101) and (001) anatase crystal faces are studied with a wide range of experimental and simulation techniques, however, to the best of our knowledge, exclusively in vacuum conditions. GIXRD experiments on anatase surfaces in environmental conditions will provide information about the surface and interface structure of natural anatase crystals, allowing to analyse the surface properties in more "real" conditions compared to UHV experiments. In preparation of these GIXRD experiments here the (101) and (001) surfaces of anatase single crystals from Hardangervidda, Norway, were characterized with atomic force microscopy (AFM). Four bipyramidally shaped crystals with (101) and (101) surfaces about 3 x 5 mm in size were scanned, whereas not all surfaces could be used, because of scratches or impurities. The surface topography consist mostly of wide terraces, with overall widths > 50 µm, sometimes spotted with small impurities. The roughness criteria for GIXRD experiments was met only by three out of the 22 faces analysed. The surface roughness of the samples is very high, with rms-roughnesses between 4 - 69 nm for the (101) faces and 14 – 59 nm for the (001) faces, respectively. The roughness could not be decreased by repeated tempering of the crystals at different temperatures between 300 – 700 °C during 1 and 7 days, alternately. The AFM analysis showed that no (001) face is suitable for GIXRD and only one (101) face of the antase crystals met the roughness criteria required for surface diffraction. This demonstrates that one of the major difficulties in performing surface X-ray diffraction experiments, especially with the GIXRD method, is finding suitable single crystal specimens.

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Keywords: atomic force microscopy, surface roughness, surface X-ray scattering

FA5-MS39-P07

Neutron radiography study of the dehydration kinetics of smectites in moulding sands.

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Natural bentonites are an important material in the casting industry. The bentonites plasticize and stabilize quartz sand moulds for cast metals. Depending on the time-temperature history during casting, the initially moist smectites become partially or completely dehydrated. Although rehydration of the smectites should be a reversible process per se, the industrially dehydrated smectites lose their capability to reabsorb water. This limits the number of possible process cycles of the mould material. An open question in the casting process is the detailed behavior of the pore water within the moulding sand as well as the interlayer-water within the