MS37 P03

Growth evolution of superlattice morphology O. Caha[a], V. Holý[b], K. E. Bassler[c], [a]Department of condensed matter physics, Masaryk University, Brno, Czech republic. [b]Department of condensed matter physics, Charles University, Prague, Czech republic. [c]Department of physics, University of Houston, USA.
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Keywords: superalattices, grazing-incidence diffraction, diffuse scattering

During growth of short-period superlattices, spontaneous lateral composition modulation can occur leading to a quasiperiodic modulation of the thicknesses of individual layers; resulting one-dimensional nanostructures (quantum wires) have potential applications in optoelectronics. Theoretical description of the modulation process is based on two different models. If there is a high density of monolayer steps on the vicinal surface a step-bunching instability occurs [1], but if the density of the the monolayer steps is low, a self-organized growth of two-dimensional or three-dimensional islands takes place. The latter process occurs, if the reduction of the strain energy due to an elastic relaxation of internal stresses in the islands outweighs the corresponding increase of the surface energy (morphological Asaro-Tiller-Grinfeld (ATG) instability [2]).
The dependence of the lateral composition modulation on the number of layers was investigated using grazing incidence x-ray diffraction. The series of four samples of InAs/AlAs superlattices grown by molecular beam epitaxy (MBE) on an InP(001) substrate was studied; the substrate was prepared without any nominal miscut. The samples have 2, 5, 10 and 20 superlattice periods; the InAs and AlAs thicknesses were nominally 1.9 monolayers in all samples. For all samples, we have measured the intensity distribution of the grazing-incidence 400 and 040 diffraction in the plane parallel to the sample surface. The x-ray measurements have been carried out at the beamline ID01 of the European Synchrotron Radiation Facility (ESRF, Grenoble).
From the experiment follows that the modulation amplitude increases with the number of layers, the lateral modulation period L=(267 ± 15) Å remains constant during the growth, while the width of the lateral satellites decreases [3].
From this behavior it follows that the first stages of the spontaneous modulation of the average chemical composition of a short-period superlattice cannot be explained as a result of the bunching of monolayer steps at the interfaces. Most likely, this behavior can be ascribed to the ATG instability, in which the critical wavelength of the surface corrugation, L_{crit} depends on the stress in the growing layer, elastic constants and its surface energy. The evolution of the surface morphology of multilayers has been studied only in a linearized approach so far [4]. We have simulated a full nonlinear time evolution equation of the spontaneous lateral modulation and we have obtained the critical wavelength L_{crit}=300 Å. The particular values of diffusion rate have only weak influence on the resulting interface morphology. We have also found that the nonlinear dependence of the strain energy on the layer thickness (wetting effect) has a crucial influence on the resulting interface morphology [5].

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MS37 P04

Metallic films on polymer foils characterized by in-situ WAXS coupled with mechanical tests J. Keckes[a], G. Maier[a], P. Kotnik[b], Ch. Resch[b], Ph. Schwarzl[b], *[a]Erich Schmid Institute, University of Leoben. [b]Anton Paar GmbH.* E-mail: keckes@unileoben.ac.at

Keywords: thin film analysis, stress analysis, mechanics

The new tensile stage TS600 from Anton Paar GmbH was used for in-situ synchrotron X-ray scattering investigations on Cu and Ag thin films with the thickness in the range of 50-1000 nm. The films were deposited on uniaxial oriented PET foils of 50 µm thickness. The metal/polymer structures were cyclically strained in the tensile stage and the structural response of the metal film as well as of the polymer were simultaneously monitored using a 2D detector. The experiments were performed at synchrotron sources HASYLAB (beamline A2) and ELETTRA (SAXS beamline).
By performing in-situ SAXS and WAXS experiments on the metal/polymer composites it was possible to determine a variety of structural parameters. In the case of metallic films elastic strains and stresses, flow stresses and the size of coherently diffracting domains were evaluated. For the polymer material, orientation factors and internal strain of crystals and amorphous phase were evaluated from the scattering signal. The parameters were correlated with the actual state of the cyclic tensile experiments. Since the plastic deformation in the metal film occurs at smaller strains then in the polymer, the setup allowed to test the film also in compression. The characterization of the metallic films demonstrated a strong dependence of the flow stresses on the film thickness. For the films below 400 nm thickness, the flow stresses increase dramatically up to few hundreds MPa.
The polymer material was fully elastic in the tested regime. The strain in the amorphous and in the crystalline phase was approximately in the same order of magnitude. No dependence of the metallic film thickness on the mechanical response of the polymer could be assessed.
A part of this work was supported by the Austrian NANO Initiative within the projects "StressDesign - Development of Fundamentals for Residual Stress Design in Coated Surfaces".

MS37 P05

X-Ray Diffraction by the One-dimensional Superlattice with a Stacking Fault H.M.Manukyan, *Department of Physics, Yerevan State University. Yerevan, Armenia*
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Keywords: X-ray diffraction, multilayers, defects

Superlattices (SL) are multilayered crystalline structures, in which electrons are affected by, besides the periodic lattice potential, an additional periodic potential with period considerably exceeding the lattice parameter.

Owing to a number of unique properties, the SL has good prospects of being widely applicable to microelectronics and computer engineering. Being important in applications, the SL perfection has been investigated by various methods of X-ray and electron microscopy analysis. One of the possible defects in artificial SL is the stacking fault. In the present paper the dynamic theory of X-ray diffraction on the one-dimensional SL with a stacking fault between layers is developed.
A formula for the dependence of reflectivity on the phase of the stacking fault and its depth is obtained. For comparison with ideal superlattice, the relative modification of reflectivity is calculated. It is shown, that presence of stacking fault reduces intensity of satellites. Thus, the closer defect to the surface of the SL, the less its action on the diffraction pattern.
As is known, the interference absorption factor of a multilayered crystalline system has oscillating character. In the present paper it is shown, that presence of stacking fault reduces the interference absorption factor, maintaining its oscillations. The formula for the relative modification of the interference absorption factor is obtained.

MS 37 P06

Synchrotron station "Langmuir" at Kurchatov Center of Synchrotron Radiation and Nanotechnology E.Yu. Tereschenko, V.V. Lider, V.A. Shishkov, Yu.N. Shilin, S.I. Zheludeva, M.V. Kovalchuk *Shubnikov Institute of crystallography Russian Academy of Science, Moscow, Russia*.
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Keywords: Langmuir monolayer, X-ray fluorescence, synchrotron X-ray instrumentation

Project of SR station "Langmuir" – the first Russian SR facility which is dedicated to study interfaces (liquid/air, liquid/liquid, liquid/solid and solid/solid); inorganic, organic and bioorganic nanolayers on water surface as well as on solid substrate; lipid-protein systems on liquid subphase, ets.
Structural configuration of station includes: *double-crystal monochromator with slits* which prepare fixed position X-ray beam over energy range 2 – 38 keV; *double-element setup* for beam deflection at grazing incidence; *sample unit* – Langmuir trough or multicircle goniometer for solid samples; *detector unit* – X-ray detectors (scintillation counter or linear position-sensitive) and fluorescent SSD.
Double-element setup was specially designed for X-ray beam deflection on the fixed Langmuir trough: first element deflects the beam from horizontal plane, the second one – directs the beam on liquid surface. Application of different couples of reflecting elements: two total reflection mirrors; multilayer structure – gradient multilayer structure; total reflection mirror – gradient multilayer structure, allows to change working range from 0 up to $Q_z^{max} \sim 0.12 \div 0.35$ Å^{-1}.
Optical scheme of the station makes it possible to realize different X-ray surface-sensitive techniques such as: total reflection X-ray fluorescence analysis; X-ray standing wave at total reflection conditions; high resolution X-ray reflectivity; grazing-incidence diffraction.
The station is planed to be in operation at the end of 2007.

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MS37 P07

Structure and dielectric properties of $Ba_{1-x}Sr_xTiO_3$ ceramics A. Aoujgal[a,b], A. Bouifoulen[a], A. Tachafine[b], J. C. Carru[b], H. Ahamdane[c] and A. Outzourhit[a], [a]*Laboratoire de Physique du solide et des couches minces (LPSCM), Faculté des sciences Semlalia, Université Cadi Ayyad, BP 2390.Marrakech, Morocco.* [b]*Laboratoire d'Etude des Matériaux et des Composants pour l'électronique (LEMCEL), Université du Littoral - Cote d'Opale, BP 689, 62-228 Calais, FRANCE.* [c]*Laboratoire des Sciences des Matériaux (LSM), Faculté des sciences Semlalia, Université Cadi Ayyad. BP 2390 Marrakech, Morocco.* E-mail : aaoujgal@ucam.ac.ma

Keywords: Ferroelectric, perovskite, X ray diffraction.

Ceramics of barium strontium titanate are widely used in the electronics industry, in particular because of their high constant dielectric and its remarkable ferroelectric properties. Different compositions of this ceramic (x=0.8, 0.4, 0.35 and 0.2) with perovskite structure were synthesized by the conventional solid state reaction. Stoichiometric amounts of BaCO3, SrCO3 and TiO2 of high purity where thoroughly mixed using. The mixture is calcined at 1225 °C for 5 h. The calcined powders were ground and pelletized at a pressure of 2 tons. The pellets were subsequently sintered at 1400 °C for 1 h.The obtained pellets were characterized by X ray diffraction and scanning electron microscopy. The dielectric properties of the various samples were analyzed. Measurements of the capacity and conductance as a function of temperature were taken in the temperature range 10K to 300 K at various frequencies (1KHz, 10KH and 20KHz). Measurements were taken in a helium gas closed cycle cryostat which was recently installed in our laboratory (a).
The x-ray diffraction measurements revealed that the formation of the pervoskite phase for all the compositions studied with no detectable secondary phases. The lattices parameter and the transition temperature evolved with the composition x of strontium. The results of the structural, microstructure and dielectric studies will be presented and discussed.

MS37 P08

Structure studies of a titanium oxide nanoporous matrix A. Bouifoulen[a], M. Elyaagoubi[a], A. Aoujgal[a], D. Abouelaoualim[a], M. Khadiri[b], A. Oueriagli[a] and A. Outzourhit[a] [a] *State Physics and thin films Laboratory, Physics department, Faculty of Sciences Semlalia, Marrakech, Cadi Ayyad University, POB 2390, Marrakech Morocco.* [b] *Centre of blood transfusion, Ministry of health, Marrakech Morocco.*
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Keywords: nanoporous, titanium oxide, XRD.

Nanoporous titanium oxide matrices were obtained by anodization of highly purity of titanium (99.97%) sheets in a mixture of HF, H_2SO4 and H_3PO_4 acid baths. The voltage was maintained by an ELC Al 781 N power supply. The titanium sheet was the anode and a sheet of platinum was the cathode. The anodization voltage was