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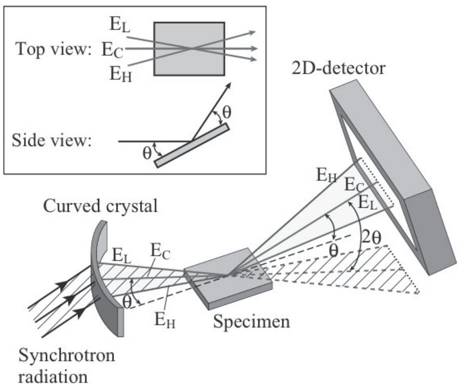
To observe structural dynamic behaviors at surfaces and interfaces, we developed a new method of simultaneously measuring X-ray crystal truncation rod (CTR) scattering profile without mechanical motion of the specimen, detector and X-ray optics during the measurement, using a geometry shown in the figure. A curved crystal polychromator produces a horizontally convergent X-ray beam having a one-to-one correlation between energy and direction. The convergent X-ray beam components of different energies are diffracted within corresponding vertical scattering planes by a specimen placed at the focus. In the specular geometry, although the glancing and exit angles, θ, are the same for all the directions, the momentum transfer continuously varies because the X-ray energy (wavelength) changes as a function of direction. The normalized horizontal intensity distribution behind the specimen represents the CTR scattering profile.

A convergent X-ray beam covering an energy range of 16 to 22 keV was produced by a curved crystal (Si 111 reflection). Scattering intensity was detected by a two-dimensional pixel array detector, PILATUS-100K. For 00L reflection (specular geometry) of a GaAs/AlAs superlattice on GaAs(001) substrate, reflected intensity was simultaneously measured in the range $1.6<L<2.4$ around the GaAs 002 Bragg reflection. The CTR profile down to reflectivity of 1×10^{-10} was measured with a sufficient data collection time 1000-7000 s. The CTR profile was well reproduced by that measured by the conventional step-by-step angle scan method with a monochromatic X-ray beam.

Its potential for time-resolved measurement was demonstrated by measuring CTR profile in short data collection time. With an exposure time of 10 ms, CTR profiles down to reflectivity of 1×10^{-7} could be measured. Changes in CTR profile during rotation of the specimen were successfully measured with time resolution of 1.0 and 0.1 s. The present method can be a powerful tool to study irreversible structural changes at surface and interface such as material growth and reactions.



The simultaneous multi-wavelength dispersive diffractometry.

Keywords: surface_x-ray_diffraction, synchrotron_radiation, time_resolved_measurement

MS21.P03

Acta Cryst. (2011) A**67,** C335

Ordering of pores in InP (001) subsurface multilayers: formation and structural characterization

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Porous single- and multilayed semiconductors are of significant interest both as an object with advanced physical properties and a material for different applications. Typically these layers with meso- and nanopores are formed by anodization technique. Etching under passing of electrical charge produces the confused morphology of pores and architecture of porous multilayers. The structural characterization of porous layers is a main task.

In the present study we show an application of high-resolution X-ray diffraction and scanning electron microscopy methods for determination of structural parameters and space configuration of pores. The porous structures (≈6mkm) with single- or four bilayers were formed by anodic oxidation of n-type InP(001) substrates in aqueous HCl solution. The structural parameters of the sublayers were varied by changing the electrochemical etching mode (potentiostatic/galvanostatic). The X-ray diffraction experiment was performed on the E2 Station of Hasylab with radiation energy of 10 keV. To collect data one dimensional MYTHEN detector was used. The reciprocal space intensity maps (RSM) near the InP 004 reflection were obtained at different azimuth angle (φ=0,90) (Fig). The map's features demonstrate two completely different types of pores in InP oriented particularly along <111>B and <001> directions. To extraction features of pore a model for scattering from such systems is proposed based on the statistical dynamical diffraction theory. Theoretical scattering maps have been fitted to the experimental ones. It is shown that a mathematical analysis of the scattering intensity maps makes it possible to determine the structural parameters of sublayers. The reconstructed parameters (thickness, strain, porosity of sublayers and the shape and space arrangement of pores) are in satisfactory agreement with the scanning electron microscopy data.

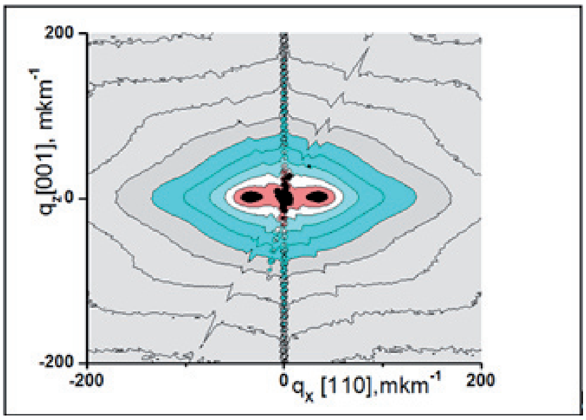

Figure. X-ray RSM from InP porous multilayers obtained in the vicinity of 004 reflection at φ=0. Two black sports demonstrate presence in the structure a middle ordering with correlation length 170nm.

Keywords: characterization, porous, multilayer

MS21.P04

Acta Cryst. (2011) A**67,** C335-C336

GISAXS study of interfaces in high-performance La/B_4C multilayer mirrors

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