1.4.36. GRAZING-INCIDENCE SMALL-ANGLE X-RAY SCATTERING (GISAXS) FOR STUDYING SUPERLATTICES IN OPTOELECTRONIC DEVICES

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As far as perfect crystal is an ideal model only, we deal with real crystal (natural and manufactured). **Nanotechnology** necessitates new level of non-destructive control of manufacture of new materials, and coverings.

It is possible to characterize the quality of real crystals in macro- and micro- scale with help of SASX and GISAXS. (SAS will be convenient if objective is the study of nanostructure crystalline diffraction patterns of 50 – 200 nm.)

In the first time small-angle scattering of X-Rays method was used for measuring random size of domains in the SiC and GaN crystals. Transmission electron microscope showed domain walls and stacking fault lines (5 – 10 microns on the photography). Such photograph picked up in fixed point of crystal. It is quality characterization. The same was with X-Ray topography.

It is quite another matter – quantitative methods S-AS gave a demonstration of model domains distribution, the three- dimensional size of domains and error of that size. Moreover, SAS is integral characterization, in large volume of crystal. The conjunction of transmission and reflection mode (grazing-incidence) SAS can to measure all three sizes of domain. GISAXS, reflection mode of SAS applied for surface structure, superficial fissuring, surface fracture, surface failure, blanket corrosion, surface deformation as for crystalline as amorphous matter.

In this work X-Rays measurements were used on thick films (0.2 – 0.3 mm) of the GaN deposited on (0001) plane of SiC substrate and thin (0.003 – 0.005 mm) films GaN deposited on sapphire (Al_2O_3). X-Ray rocking curves show difference in full width at half maximum (FWHM) of those structures.

We compare the shape of ordinary X-Ray diffractometry (XRD) rocking curves of crystals with SAS data. X-Ray rocking curves point out the difference in FWHM of those structures too. But results of measurement in bough case differ. It means that there was stress addition in widening of usual rocking curve of crystal films. Stress addition in widening of thin films was more than the same on thick films. It is explained by relaxation of stresses in thick films. Stresses in the film realize as domain segmentation. So on the size of natural superlattices in thin films were greater then in thick films. The model of the domain wall grids was proposed for GaN deposited on SiC and Al_2O_3.

SAS indicate difference in picture for those samples too. GaN films deposited on the SiC had the three dimensional 15 – 20 arc.sec disoriented domains (the second order of texture). GaN domains distribute in liquid cluster model. It was seen by presence of strong incident peak and weak size-peak. The grid of GaN domains looked like the network of 120 or 60 degrees 50 nm cell. GISAXS estimation the lengths (perpendicularly surface) of that rhombic-hexagonal prism were 200 – 300 nm. Interface GaN / SiC determined the texture of the second order in GaN layer.

Various optoelectronic devices were characterized by SAS. Coincidence of device commercial properties with domain characteristics were in good agreement.

Sputtered metals were studied by GISASX too. Studying of paint coating – inner checks, inner shelling – with GISAX is effective non-destructive control of surface covering. It would be published later.