XRR INVESTIGATIONS OF II-VI AND III-NITRIDR BASED DBR STRUCTURES, MULTILAYERS AND SUPERLATTICES

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Surface and interfacial roughness is a major issue for many technologically relevant multilayer systems in magnetism, optics and semiconductor physics. In optoelectronic applications, interfacial roughness affects especially the electrical and optical properties of light emitting semiconductors such as vertical cavity surface emitting lasers (VCSELs). On one hand this leads to an enhanced non-radiative recombination of the carriers, on the other hand the emitted light will be partially scattered or absorbed at the interfaces of the distributed Bragg reflectors (DBRs), which are usually applied as high quality reflectors in VCSELs and waveguides. Thus the interface quality will not only affect the efficiency, but also the lifetime of light emitting devices.

Using x-ray reflectivity (XRR) we have investigated DBRs and related built-in super-lattices for the blue to violet (AlN/InGaN) [1] and blue to green (MgS/ZnCdSe) [2] spectral regions, respectively. For the XRR experiments a double crystal monochromator setup with symmetrically cut Si(111) crystals was used at the BW1 beamline at HASYLAB (DESY, Hamburg). The scans were recorded in conventional $\theta-2\theta$ geometry. All structures were grown by molecular beam epitaxy in our institute in Bremen.

As an example for the composition of DBRs with embedded superlattice a transmission electron micoroscopy (TEM) image of a II-VI mirror is shown in FiG. 1.

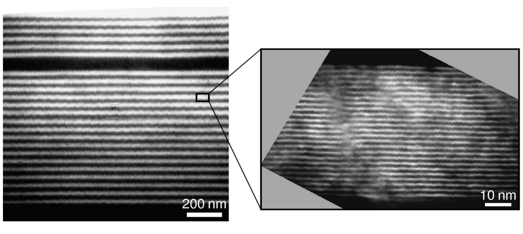

Figure 1. TEM of a similar II-VI 16 × DBR with embedded super-lattice in one of the two DBR-mirrorlayers.

The nitride samples consist a period of 30 double layers, and the zincselenide structures consist of 18 double layers. The aim of the study is to compare the established ZnSe-system with the nitrides.

The measurement shown the lowest reflec-tivity in III-V system in comparison with II-VI. The low reflectivity by the nitrides is caused due to the large lattice mismatch with respect to the sapphire (0001) substrate and due the significant surface mosaicity [3] of GaN, thus the enhanced roughness, which negatively influences the contrast in the measurements (Fig. 2). Roughness is an important parameter for the preparation and further reflectivity simulations from which we can obtain also information like electron density, and layer thickness [4].

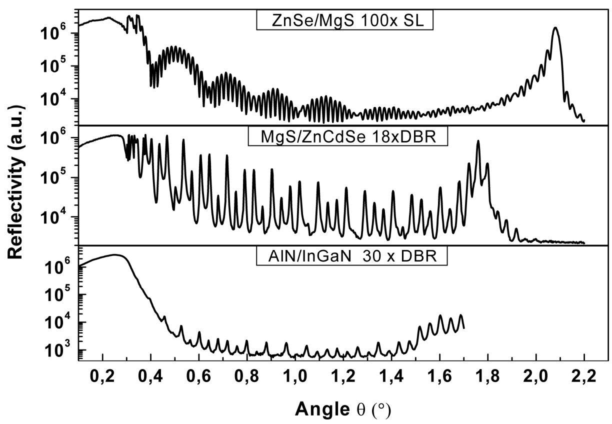

Figure 2. XRR - curves for ZnSe/MgS super-lattice, MgS/ZnCdSe 18 × DBR and AlN/InGaN 30 × DBR structures recorded up to the first order short-period superlattice Bragg peak.

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