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X-ray measurements of type II InAs/GaSb superlattice in a wide angular range using the P08 beamline at PETRAIII

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The aim of this work was to characterize the type II InAs/GaSb superlattice (SL). In such structure several flat layers form a period which is then repeated tens or hundreds of times. The quality of the SL depends on the reproducibility of the layers parameters, such as composition, strain and thickness, in different periods during whole growth process. The quality of the grown superlattice can be judged by the contrast and full width at half maximum (FWHM) of satellite peaks observed in diffraction profile, especially for higher orders [1]. This is the reason why as many as possible higher order satellite peaks should be measured. In this paper we investigated InAs/GaSb superlattice formed by 30 periods, each consisted of four layers. The thicknesses of each layer were few nanometers and less. It is quite difficult to maintain a constant thickness of such thin layers in different periods during the growth process, therefore the quality control of the grown SL is crucial.

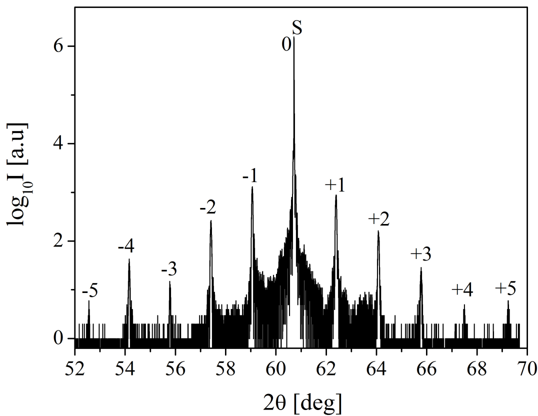

Figure 1. Experimental diffraction profile of the 004 reflection for a InAs/GaSb superlattice measured at a laboratory diffractometer.

Figure 1 shows the diffraction curve of the 004 reflection of investigated periodic structure measured in our laboratory by a high resolution diffractometer. The substrate S and satellite peaks are presented. As can be seen, the intensities of higher ordered peaks (±4; ±5) are very low. These peaks are important to measure the quality of periodic structure, but due to the fast drop of diffracted intensity far from a Bragg peak, the flux, produced by a laboratory source, is too low to achieve enough signal for higher order peaks. For this purpose the wide angle X-ray diffraction measurement on the beamline P08 at PETRAIII, DESY has been carried out. Numerous satellite peaks which are present on 2θ/ω in Fig. 2 confirm good reproducibility of the layers parameters in different periods. Furthermore, due to the big range of the scattering angles (2θ), two satellite groups belonging to the 002 and 004 reflections are observed. It can be seen from the Fig.2 that the SL peaks of these two groups do not coincide what may incorrectly suggest that the periodicity of the structure is not maintained.

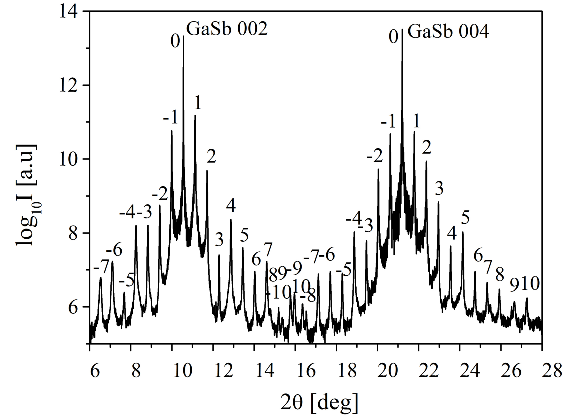

Figure 2. Synchrotron diffraction pattern of periodic InAs/GaSb structure measured around the 002 and 004 substrate reflections.

Calculations of the diffraction pattern of the investigated superlattice have been performed. X-ray diffraction curve was simulated by using a commercial software. As can be seen from Fig. 3, only one reflection 004 was calculated for the wide angle range. The conventional 2-wave diffraction theory cannot describe correctly the measured diffraction curve. Therefore, we will present the *N*-beam dynamical diffraction approach [2] which makes possible to simulate diffraction pattern in a broad angular range including several reflection (in this case three). Results of this calculation for a high quality superlattice will be presented.

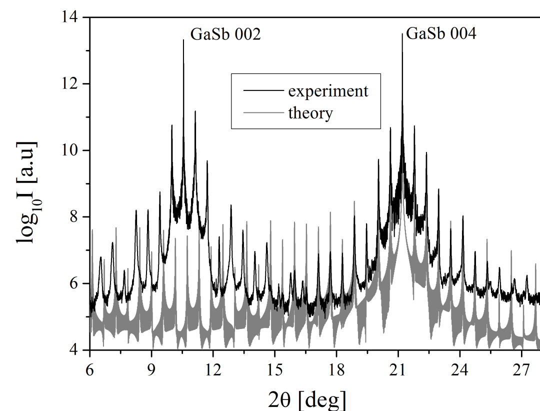

Figure 3. Comparison of experimental synchrotron profile (black line) with simulated one (gray line).

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