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The structure and strain relaxation in AlN/GaN superlattices revealed by X-ray diffraction and reflectivity

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AlN/GaN superlattices (SLs) are of interest for various applications in photonic devices operating in a wide optical range. Specifically, AlN/GaN SLs are used for LEDs emitting in the visible-ultraviolet spectral range. Also, AlN/GaN SLs find potential applications in the infrared spectrum [1,2].

Due to significant in-plane lattice mismatch between GaN and AlN (~2.4%), strain engineering is a critical issue for the active region design and has a major influence on the optical properties of the heterostructures. Therefore, a comprehensive structural characterization of the SLs is required to optimize their growth process and device performance.

We use the advantages of different X-ray and AFM methods to study the relaxation mechanism of the AlN/GaN superlattices in response to the induced lattice misfit. The geometrical parameters and micro-structural quality of AlN/GaN superlattices were determined by XRD measurements. The local structure of the SLs was estimated by TEM measurements. High density of cracks and dislocation pits were observed on the surface of all samples, which reveals two mechanisms of strain relaxation. The transition between the two mechanisms strongly depends on the barrier-to-well thickness ratio and the total thickness of the SL.

1. M. Beeler, E. Trichas, and E. Monroy. III-nitride semiconductors for intersubband optoelectronics: a review // Semicond. Sci. Technol.-2013.-**28.**-P. 74022.

2. M. Tchernycheva, L. Nevou, L. Doyennette, F. Julien, E. Warde, F. Guillot, E. Monroy, E. Systematic experimental and theoretical investigation of intersubband absorption in GaN/AlN quantum wells // Physical Review B.-2006.-**73.**-P. 125347