Indium segregation in high In content InAlN layers grown on GaN/sapphire templates was investigated by scanning transmission electron microscopy (STEM). The chemical nonuniformity of the layers was determined from energy dispersive X-ray analysis (EDX) and high-angle annular dark-field (HAADF) imaging. Low In content samples show no indication of a preferential incorporation of indium, proving that compositionally uniform layers and structures could be grown. For high content of indium, above 20 at % on average, the growth becomes unstable, leading to the preferential incorporation of In at some orientations [1,2]. The V-shaped In-rich structures were observed, resulting in the preferential indium segregation at the sides of the structures (Fig. 1). Indium atoms segregation was usually visible as a bending of lattice planes in InAlN structure. A detailed, structural model of strained defects, based on high-resolution TEM (HRTEM) observations was proposed. The model assumes coherent substitution of aluminum by indium in Al lattice sites which leads to the a-plane compressive stress accumulation. Such stress leads to the vertical strain by upward motion of the neighboring lattice sites and elongation of the c-lattice constant locally. Theoretical (simulated) HRTEM images, taking into account the In concentration variations were generated using JEEM software [3]. The changes of the contrast intensity between different atomic columns with variable In content were compared with the experimental data.


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Fig. 1: HAADF and TEM cross-section images of InAlN layers with indium content of 25% (a,c) and 28% (b,d), respectively.