Nanoscale physics

Effect of structural strains on phonon spectra in AlN/GaN heterostructures with multiple quantum wells

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In this work we studied the effect of structural strains on the optical phonon spectra in AlN/GaN heterostructures with multiple quantum wells (MQW). Test samples were grown by plasma-assisted molecular beam epitaxy on *n*-GaN / *c*-plane sapphire substrates and consisted of periodic AlN / GaN layers repeated by 5, 10, 20 periods. Besides, three sets of samples had a predefined QW / barrier thickness of 5/3, 3/3, 1/3 nm. Using high resolution X-ray diffractometry and transmission electron microscopy [1], we determined the deformation state, strain relaxation and thickness of MQW layers in the samples. Using Raman spectroscopy, we measured the red and blue spectral shifts of E_2^{high} phonon modes for AlN and GaN layers, caused by the tensile stress in AlN barrier and by the compressive stress in GaN QW layers accordingly. Fig. 1 shows the dependence of Raman shifts vs. stress in MQW AlN/GaN plotted with our experiments and literature data. We defined the stress-shift coefficient as 4.3 cm^{-1}/ GPa for AlN and 3.6 cm^{-1}/GPa for GaN. The obtained results are useful for physics and engineering of MQW heterostructures in III-nitride based nano- and optoelectronics. Research was supported by NASU projects #1.2.1 and #9/17-N.

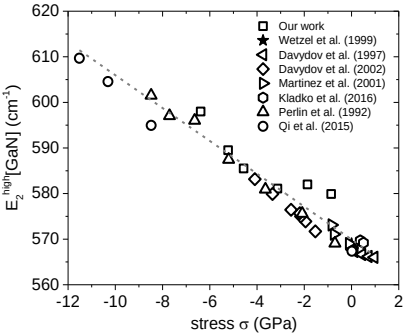

Fig. 1. Raman frequency shift of E_2^{high} mode vs. stress in MQW AlN/GaN.

1. *Kladko V. et al.* Substrate effects on the strain relaxation in GaN/AlN short-period superlattices // Nanoscale Res Lett.-2012.-7.-P.289.