Comparison of localization effects in AlGaN layers and GaN/AlN multi-quantum-wells

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A series of $Al_xGa_{1-x}N$ layers with $0.12 \leq x \leq 0.24$ and GaN/AlN multi-quantum-wells (MQWs) with QWs thicknesses between 1 and 6 nm was grown by molecular beam epitaxy. The samples were characterised by X-ray diffraction and transmission electron microscopy techniques.

Continuous wave spectra of the photoluminescence (PL) of these structures were measured at temperatures ranging from 15 to 300 K, and temperature behaviour of PL peak emission energies was analysed. It exhibited in general an S-shape behaviour characteristic for disordered systems, however some differences were observed between AlGaN layers and GaN/AlN QWs. In the AlGaN layers typical S-shape dependence was observed, reported also in other alloy systems including InGaN, which can be analysed within a model of potential fluctuations caused by alloy disorder [1]. In GaN/AlN MQWs systems the quantum well width fluctuations seem to constitute the main contribution to potential fluctuations, however the creation of AlGaN on GaN QWs and AlN quantum barriers interfaces has to be taken also into account. Additionally, the Quantum Confined Stark Effect (QCSE) influences emission properties of QWs. As a result the much more varied temperature behaviour of QWs PL peaks is observed. These conclusions are confirmed by theoretical analysis of the experimental data.

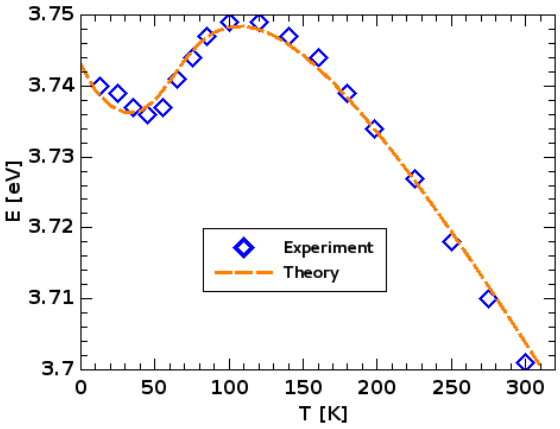

Fig. 1. PL energy dependence of $Al_{0.12}Ga_{0.88}N$ layer on temperature. Experimental data are marked with blue diamonds, whereas dashed line represents theoretical model of potential fluctuations.

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[1] P. A. Dróżdż, K. P. Korona, M. Sarzyński, T. Suski, R. Czernecki, and D. Wasik, *Phys. Status Solidi B*, **253**, 284–291 (2016).