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STRUCTURAL STUDIES OF WIDE-GAP QUANTUM DOTS BASED ON InGaN

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Keywords: quantum dots, InGaN, x-ray absorption, synchrotron radiation

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Processes of self-organization during epitaxial growth of semiconductor heterostructures represent methods for the fabrication of the very small nanostructures (quantum wires and dots) with electronic and optical properties very promising for their technological applications, like optical sensors, lasers or storage media [1]. The Stransky-Krastanov (S-K) growth mode is a well-known method to obtain such self-organized dots (QDs). Nevertheless, in case of InGaN the structures obtained in S-K mode are not stable during the overgrowth by GaN. A challenging task is to growth stable InGaN nanostructures. The structural properties play an important role in determining the performance of the light-emitting devices. Extended X-ray Absorption Fine Structure (EXAFS) refers to the oscillation caused by interference of the photoelectron wave of excited atoms scattered on the neighbors. Therefore from such an EXAFS analysis the local structure around a studied element can be derived, i.e. the radial distance (R) between the absorbing atom and its surrounding atoms, the number of atoms in the coordination shell and the mean-square deviation from ideal atomic position due to thermal vibrations and structural disorder (σ^2, Debye-Waller factor).

InGaN crystallizes in the wurtzite structure. Two kinds of In-N bonds can be distinguished: a longer single bond along the *c*-axis (*b*) and three shorter bonds with respect to the *c*-plane (*d*), as displayed in Fig. 1.

Due to the natural polarization of the synchrotron radiation information about anisotropy of bonds in the crystal and strain anisotropy can be extracted [2].

The InGaN quantum dots were grown by metal organic vapour phase epitaxy (MOVPE) on a sapphire (0001) substrate covered with 2 μm GaN layer deposited by MOVPE as well to ensure a superior growth start of the dots. Part of the samples were capped by a thin layer of GaN deposited at different growth temperatures. In case of high temperature capping the InGaN dots are dissolved forming a quantum well like layer [3]. The uncapped quantum dots were initially studied for the next determination of capping layer influence on the changes of the local structure (strain field) around In atoms.

The EXAFS spectra for investigation of InGaN self-assembled QDs at the K-edge of In were recorded at the beamline BM08 at the ESRF in Grenoble. Data were collected in fluorescence mode using a 13-elements high purity Ge detector. Indium L-edge XANES data were collected at the Advanced Light Source (ALS). The incident beam was monochromatized using double crystal the Si(111) monochromator. Fluorescence X-ray intensity from the sample were measured by a Hamamatsu (type S3584, 28 mm by 28 mm active area) Si photodiode. The measurements were done with taking into account polarization effect of synchrotron radiation.

The x-ray absorption spectroscopy was used to estimate the atomic ordering in QDs, the bond length between absorbing atoms and its surroundings as well as the anisotropy of the bonds. The result of the analysis will be discussed.

Acknowledgements: This work was supported in part by Polish State Committee for Scientific Research *(Grant No **N202 142 32/3888**)* and DFG Research Group "Physics of nitride-based, nanostructured light-emitting devices" in Bremen.

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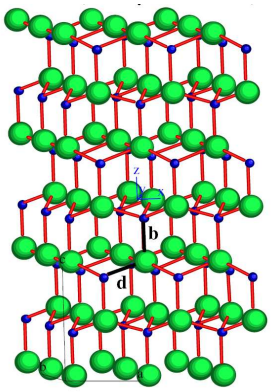

Figure 1. The wurtzite structure of GaN crystal and the bond length (*b*, *d*).