Spatially resolving the emission along the axis of (In,Ga)N/GaN nanowire heterostructures using cathodoluminescence spectroscopy

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Insertions of (In,Ga)N embedded into GaN nanowires (NWs) are considered for optoelectronic applications in the visible range. Spontaneously formed NWs exhibit a broad distribution of diameters and In content affecting the emission properties of individual NWs and thus leading to a broadening of the ensemble emission [1]. In this context, cathodoluminescence (CL) spectroscopy and imaging in a scanning electron microscope (SEM) is particularly suited to investigate the emission properties of single NWs and to spatially resolve different spectral contributions along the NW axis.

We investigate self-induced GaN NWs grown by molecular-beam epitaxy (MBE) with six axial (In,Ga)N insertions [2]. A representative CL spectral line scan recorded at 10 K along the axis of a NW with embedded (In,Ga)N insertions is shown in Fig. 1. The GaN base is dominated by the donor-acceptor-pair (DAP) transition in wurtzite (WZ) GaN, a result of a Mg memory effect in the used MBE chamber. At the lower growth temperature necessary for the incorporation of In, also segments of zincblende (ZB) GaN are formed, which manifest themselves by emission peaks in the range of 3.0–3.2 eV [3]. The (In,Ga)N emission around 2.2–2.4 eV is redshifted along the stack of insertions. This may be explained by the compositional pulling effect also observed by Tourbot et al. [4]. Finally, the (In,Ga)N emission can be distinguished from weak yellow defect luminescence in the base of the NW. The comparison of a set of single NW measurements shows that the peak energy of the (In,Ga)N emission does not correlate with the NW diameter. This finding is an indication that carrier localization by compositional fluctuations in the (In,Ga)N insertions plays a prominent role for the emission properties of these NW- based heterostructures.

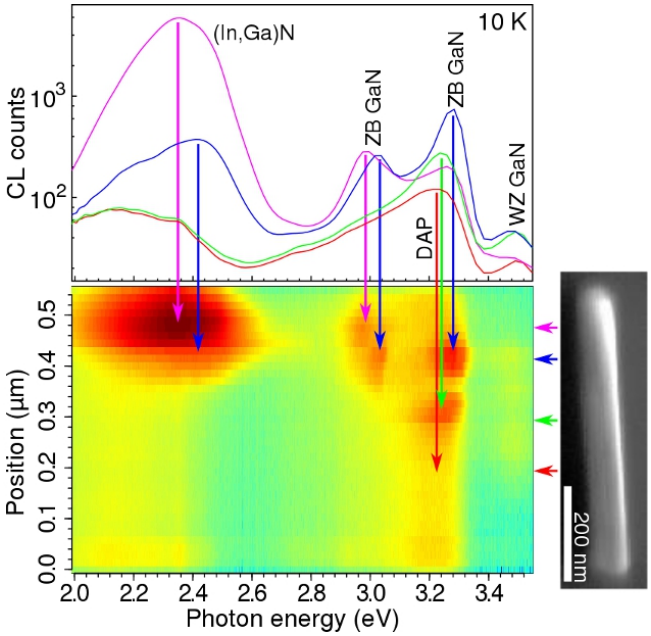

Fig. 1: CL spectral line scan along the axis of a NW. An SEM image of the NW is shown to the right, while several extracted spectra are displayed at the top.

[1] J. Lähnemann et al., *Phys. Rev. B,* **84**, 155303, (2011).

[2] M. Wölz et al., Nanotechnology, **23**, 455203, (2012).

[3] J. Lähnemann et al., *Phys. Rev. B,* **86**, 081302(R), (2012).

[4] G. Tourbot et al., *Nanotechnology,* **23**, 135703, (2012).