Surface processes during InGaN quantum well growth

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The active region of optoelectronic devices in the visible range based on group-III-nitrides is conventionally built from InGaN/GaN quantum well (QW) structures. For the performance of such devices control over the indium incorporation is mandatory. For long wavelengths emitters or solar cells layers with high indium concentrations ($x_{In} > 0.2$) are required. The more indium is to be incorporated the more such layers suffer from various effects such as high strain, defect formation and poor surface morphology as a consequence of the required low growth temperatures T_G. While at high T_G and lower values of $x_{In} < 0.2$ indium incorporation is limited by desorption, the growth process at lower temperatures is much more complex: Diffusion/cluster formation and desorption compete with indium incorporation. However, at least at low T_G indium incorporation takes place from a liquid-like adlayer [1,2]. The detailed structure of the adlayer and details of the interplay between indium incorporation - adlayer and adlayer formation - desorption are not yet understood.

To gain more insight into the indium incorporation process and the role as well as the properties of the adlayer we performed in-situ optical reflectivity experiments during MOCVD growth. Growth took place in a commercial Aixtron Aix200rf system with horizontal reactor using standard precursors. The system is equipped with a Laytec optical sensor which provides data on the curvature, the reflectivity at 633.2nm/950nm and the growth temperature by pyrometry.

We find evidence for indium on the surface during the time the precursor Trimethylindium (TMI) is supplied for low temperatures of about 970K (measured by a thermocouple). At these conditions the incoming flux is larger or equal to the desorption rate. The data reveal indium desorption and at least another loss mechanisms and possibly some reconfiguration of the surface (coverage). Furthermore, another source of indium is present delivering indium when TMI is already switched off.

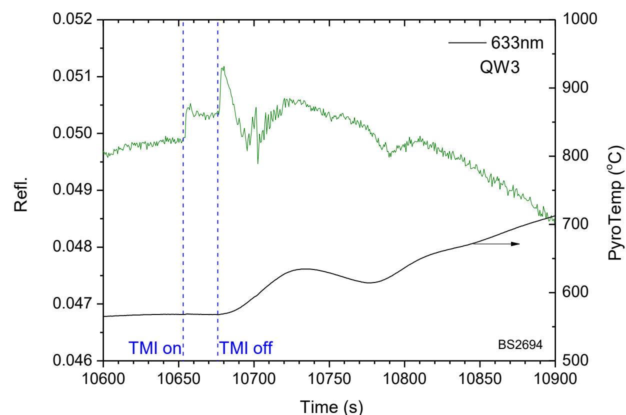

Fig. 1. Reflectivity transient taken during growth of the third QW in a 5xQW structure.

Keywords: Group-III-nitrides, reflectivity transient, adlayer

References

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