Molecular Beam Epitaxy of Group III Nitrides: Basics and new challenges

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This tutorial will at first give an introduction into the fundamental growth mechanisms of gallium nitride by molecular beam epitaxy (MBE). The basic growth diagram describing the different regimes of growth (group V-rich, group III-rich, regime of Ga droplets) will be presented and correlated to the surface morphology and electrical properties of the grown material. Next, the growth of ternary nitrides such as InGaN and AlGaN will be described, taking into account the desorption of group III elements during growth.

In order to study the surface coverage of GaN with Ga under various conditions and to compare this with ab-initio calculations, we have devised a new in-situ control technique utilising mass spectrometry in direct line-of-sight to the substrate surface. This allows us to quantitatively detect the desorbing gallium atoms during growth. Since the impinging material fluxes are also quantitatively calibrated, this technique can be used to evaluate the growth rate in-situ. Using this technique, we present a study of the nucleation of GaN for several cases of homo- and hetero-epitaxy.
Adsorption and desorption experiments facilitate to determine the gallium coverage for different points of the growth diagram, which is essential to for a theoretical understanding of GaN growth.
Finally it will be shown how the transition from 2-dimensional to 3-dimensional growth of GaN on aluminium nitride can be controlled by varying the gallium surface coverage.

In the end, a brief motivation for the growth of semiconducting nanowires and some first results obtained by MBE growth of GaN will be presented (for more details see presentation of C. Cheze).