Halbleiter-Nanophotonik

SFB 787

Einladung

Es spricht: **Natalia Stolyarchuk und Stefan Mohn**
Leibniz Institute for Crystal Growth, Berlin

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Ort: Technische Universität Berlin
Institut für Festkörperphysik
Hardenbergstraße 36, 10623 Berlin
Raum EW 561

Thema: “Polarity control of III-nitrides on sapphire investigated by TEM"

Abstract:
Control of the polarity of III-Nitrides is the key to obtain layers with high structural perfection on sapphire substrates. The of deposition of a low temperature AlN buffer followed by high temperature epitaxy of GaN on nitrided sapphire substrates is the well known concept to get metal polar epitaxial layers. However, little is known on the atomic processes that govern the polarity.
In this work we are discussing the mechanism of polarity control that takes place during the initial stages of the MOCVD growth process, which includes:

- Nitridation of the sapphire surface in ammonia ambient at around 950 °C
- Growth of the low temperature AlN (650 °C) and GaN (580 °C) buffer layers
- High temperature epitaxy of AlN or GaN at around 1050 °C

With an aberration corrected transmission electron microscope we were able to resolve Al, O and N atomic positions for <1-100> and <11-20> lattice directions.

Our investigations show that already during nitridation the sapphire surface is chemically converted from Al_2O_3 to aluminum-oxynitride (AlON) by the substitution of O by N. It converts the initially N-polar interface structure to a metal polar surface. Growing AlN or GaN at low temperature preserves the AlON and metal-polarity is promoted for the ongoing process. AlON, however is unstable at high temperature epitaxial growth conditions, where it dissolves and N-polar growth results. Excessive nitridation of sapphire results in the formation of metal-polar islands aside of AlON. These islands, which are stable at high temperature growth conditions, introduce inversion domain boundaries inside the N-polar layers.
Our results thus show that careful calibration of the process is necessary to avoid mixed polarity.

Gäste sind herzlich willkommen!

Prof. M. Kneissl und Dr. T. Wernicke