# *Transmission electron microscopy study of polarity control in III-Nitride films grown on sapphire substrate*


## Abstract:

Polarity is a critical issue for III-nitrides material system, that has an impact on the quality of epitaxial films and the performance of nitride-based devices, however there is still lack of understanding of the elementary mechanisms that are responsible for establishing metal or nitrogen polarity of the films on nonpolar substrate. The existing concepts are based on empirical observations and even contain ambiguous results. One of the main reasons for that is the lack of precise analytical tools, allowing localized determination of polarity and atomic structure of layers, at the time, when main concepts for polarity control were established.

In this work we develop a concept of polarity control in AlN and GaN layers grown by MOVPE on sapphire substrates, based on data obtained by rigorous analysis using various experimental methods. We investigate the polarity of the layers by aberration corrected HRTEM and high resolution high-angle annular dark field (HAADF) scanning TEM. The analysis of our experimental investigations yields the following principal results that concerns (i) mechanism that governs polarity selection during MOVPE growth of III-nitrides films; (ii) relation between initial sapphire surface nitridation and Al-polar inversion domains in N-polar AlN films; (iii) possibility of controlled switching the layers polarity from N to Al by oxygen annealing.

Our results explain the mechanism by which polarity is controlled in a MOVPE growth process that have been applied for the growth of group III-nitrides for three decades. Understanding of this mechanism opens up the possibilities for more controlled polarity engineering in nitride films and can as well give a clue to understanding polarity control in other material systems (e.g. oxides).