Transmission electron microscopy investigations of III-Nitride/Sapphire Interfaces at the atomic scale

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The important characteristic of the wurtzite structure of GaN grown along the [0001] direction is the polarity that essentially influences its physical properties. The most commonly used substrate for the growth of GaN is sapphire (Al_2O_3) which is nonpolar. Thus controlling the properties governing the selection of the polarity of the deposited films is the one of the main problems in growth GaN on c-sapphire.

The classical GaN growth process by metalorganic vapor phase epitaxy (MOVPE) constitutes of nitridation of the sapphire, low temperature nucleation layer growth and high temperature final growth stage. This process leads to films with a Ga polarity

Despite of a number of theoretical and experimental studies, little is known on the atomic structure of the III-nitride/Al_2O_3 interfaces and the processes that govern the polarity. This is mainly because conventional transmission electron microscopes were not capable to resolve single oxygen and nitrogen atoms with high spatial resolution.

In the present work we study the initial stages of MOVPE growth of GaN on sapphire by conventional (JEOL 2010F) and aberration corrected (FEI TITAN) transmission electron microscopes.

The cross-section analysis of nitridation layer reveals the presence of Al-polar domains together with a continuous N-polar (Al,O)N layer over so-called "voids" in Al_2O_3. The interface structure mostly fits well with the theoretical predictions of AlN grown under N-rich growth conditions.