Modulated ammonia flow-low temperature AlN buffer LP-MOVPE growth for high quality AlGaN layers

K.Moszak[1,2], D. Pucicki[1,3], W. Olszewski[1], J. Serafinczuk[1,3], D. Majchrzak[1,2] and D. Hommel[1,4]

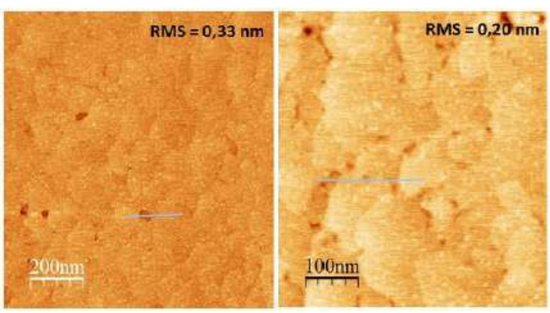
[1] PORT Polish Center for Technology Development, Stablowicka 147, Wroclaw, 54-066 Poland
[2] Institute of Low Temperature and Structure Research, Polish academy of Sciences W. Trzebiatowski Institute, Okolna 2, 50-422 Wroclaw, Poland
[3] Faculty of Microsystem Electronics and Photonics, Wrocław University of Science and Technology, Z. Janiszewskiego 11/17, 50-372 Wrocław, Poland
[4] Faculty of Physics, University of Wroclaw, plac Maxa Borna 9, 50-204 Wroclaw, Poland

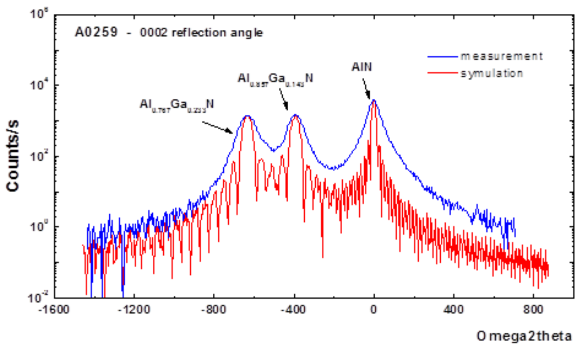
Keywords: AlGaN/AlN, low temperature AlN, LP-MOVPE, structural characterization

UV-LEDs offer many possibilities for novel applications due to radiation energy. Their advantages over conventional UV sources are nanosecond switching, long lifetime, compact, robust and environmentally low power consumption. LEDs emitting in the UVB (320-280 nm) and UVC (280-200 nm) spectral range can be used as gas sensing, water purification, disinfection of medical equipment and food [1]. The basics of these applications are focusing on AlGaN-based structures [2].

In the heteroepitaxy, the main difficulty is lattice mismatch between the substrate and subsequently grown layers of the structure. Growing low defect AlN by low pressure metalorganic vapour phase epitaxy (LP-MOVPE) method requires high temperature ~1250ºC in the reactor. An alternative method is to used amorphic AlN sputtered on sapphire by Radio Frequency Sputtering (RF) and then recrystallize such a layer in the furnace (1600-1700ºC/1h) in a nitrogen atmosphere [3].

In this study, we will present AlGaN/AlN on sapphire by using a linear change of NH_3 method in LP-MOVPE. This technique is convenient to obtain high quality AlN buffer using lower temperature (~1100ºC) in 3x2'' CSS reactor. For reference, we used AlGaN grown on high temperature (~1250ºC) AlN buffer by LP-MOVPE. HRXRD and AFM measurements confirm comparable results for both attempts. Estimation of threading dislocation density (TDD) by chemical etching will be discussed as well. The successful heteroepitaxial growth of high quality AlN buffer using low temperature is expected to decrease the fabrication cost of UV-LEDs.





[1] M. Kneissl, J. Rass III-Nitride Ultraviolet Emitters Technology and Applications, 2016
[2] Hideki Hirayama et al.,Appl. Phys. Lett. **91** (2007) 071901
[3] Hideto Miyake et al.,J. Cryst. Growth **456** (2016) 155–159