GaN/AlGaN Nanocavities with AlN/GaN Bragg Reflectors Grown in AlGaN Nanocolumns by Plasma-assisted MBE

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The growth of GaN multi quantum discs (MQDs), embedded in AlGaN Nanocolumns grown by MBE on Si(111) substrates, was recently reported [1,2]. The self-assembled Nanostructures grow under highly N-rich conditions, showing an outstanding crystal quality and very high luminescence efficiency, with no traces of extended defects, like dislocations or stacking faults. The AlGaN Nanocolumns, with diameters ranging from 30 to 150 nm, are strain free, whereas the GaN MQDs are fully strained, though the strain is inhomogeneously distributed. Photoluminescence and cathodoluminescence data revealed quantum confinement effects in a Nanostructure with 4 nm thick 5xGaN MQDs.

In this work we report on the growth of a wide variety of Nanostructures with GaN MQDs of different disc thicknesses (2nm to 8nm), and 8 to 10nm thick barriers of AlGaN (16% to 100% Al%). The Nanostructures were grown on Si(111) substrates starting with GaN and followed by the Al(Ga)N and the GaN MQDs. This new approach avoids the growth of mixed compact/columnar material when starting to grow AlGaN Nanocolumns, due to a much higher surface diffusion of the Al versus Ga adatoms. Photoluminescence measurements clearly show the emissions from the GaN MQDs that blue-shift as their thickness is reduced from 8 to 2nm.

AlN/GaN Bragg reflectors, with 10 (bottom) and 5 (upper) periods and nominal reflectivities at 345nm of 87% and 50% respectively, have been grown on the Nanostructures previously mentioned, to form a Nanocavity with an active region of 5xGaN MQDs in between. Results from photoluminescence measurements, transmission electron microscopy, and strain distribution calculations will be presented.

[1] E. Calleja, M.A. Sánchez-García, F.J. Sánchez, F. Calle, F.B. Naranjo, E. Muñoz, U. Jahn, and K.H. Ploog, Phys. Rev. B **62**, 16 826 (2000).

[2] J. Ristić, E. Calleja, M.A. Sánchez-García, J.M. Ulloa, J. Sánchez-Páramo, J. M. Calleja, U. Jahn, A. Trampert, and K.H. Ploog, Phys. Rev. B **68**, 125305 (2003).