Control of the morphology on selective area growth of GaN nanocolumns by rf-plasma-assisted MBE

A. Bengoechea-Encabo[1], S. Albert[1], F. Barbagini[1], P. Lefebvre[1],

M. A. Sanchez-Garcia[1], E. Calleja[1], E. Luna[2], A. Trampert[2]

1) ISOM and Dpt. Ing. Electronica, ETSIT, Universidad Politécnica de Madrid, 28040 Madrid, Spain.

2) Paul-Drude-Institut für Festköperelektronik, Hausvogteiplatz 5-7, 10117 Berlin, Germany.

Selective area growth (SAG) of GaN nanocolumns (NCs), making use of patterned or masked (nanoholes) substrates, yields a periodic, homogeneous distribution of nanostructures, that makes their processing much easier compared with self-assembled ones. In addition, the control on the diameter and density of NCs avoids dispersion in the electro-optical characteristics of the heterostructures based on this type of material (embedded InGaN/GaN quantum disks for example). Selective area growth using a mask with nanohole arrays has been demonstrated by rf-plasma-assisted MBE [1, 2]. Although some works have recently been published regarding SAG heterostructures [3], the control of the morphology of the NC is still an open question (i.e. lateral growth rate, topmost shape, geometry of the quantum disk, etc.). In the present work we report on the control of the topmost shape of the NC by adjusting the substrate temperature (and therefore the GaN decomposition and Ga desorption rates) leading to different types of geometries: from pyramidal islands (Figure 1.a), to nanocolumns with different topmost shapes (semi-polar planes, like those shown in Figures 1.b, or c-planes like the ones in Figures 1.c & 1.d). These different geometries will give quite different results when growing NCs with InGaN QDiscs embedded.

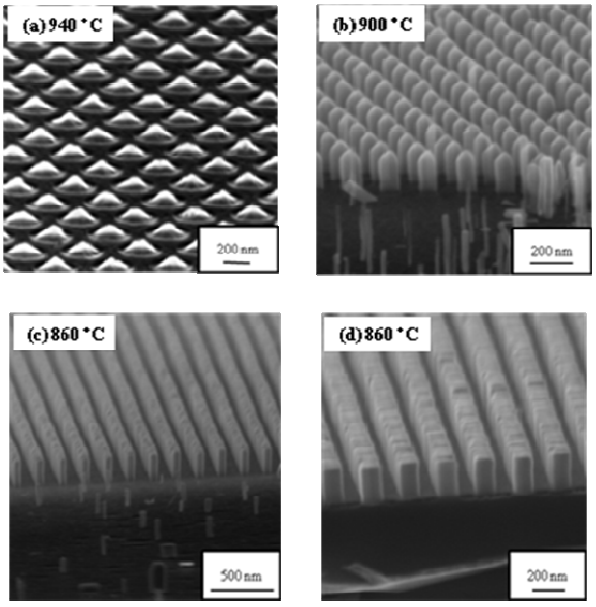

Figure 1. (a) Selective area growth of GaN pyramids, (b) GaN nanocolumns ending in pyramidal tip (b), and (c,d) two examples of GaN nanocolumns ending in flat c-planes.

[1] H. Sekiguchi, K. Kishino, A. Kikuchi, Appl. Phys. Express 1, 124002 (2008).
[2] K. Kishino, S. Sekiguchi, A. Kikuchi, J. Crys. Growth 311, 2063-2068 (2009).
[3] T. Kouno, K. Kishino, M. Sakai, Y. Inose, A. Kikuchi, K. Ema, Electron. Lett. vol 46, No 9 (2010).