Understanding the selective area nucleation and growth of GaN nanocolumns by MBE using Ti Nanomasks

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III-nitride nanocolumns (NCs) have attracted much interest in the last years [1,2] being strain- and dislocation-free when grown spontaneously [3]. III-nitride nanocolumnar complex heterostructures have been grown by Molecular Beam Epitaxy, like Light Emitting Diodes [4-6]. Unfortunately, the random nature of self-assembled growth, with limited control on density and diameter is a drawback to achieve actual devices. Density and diameter fluctuations yield strong electrical and optical properties dispersions leading to low emission efficiency (localized current injection). When InGaN quantum disks (QDisc) are embedded in GaN NCs, diameter fluctuations may lead to variations of QDisc thickness and composition, strongly affecting the optical properties. Selective area growth (SAG) [7-9] is an efficient way to overcome this problem. In this work, the influence of the substrate temperature, III/V flux ratio and mask geometry on the selective area nucleation and growth of GaN NCs is investigated. For a given set of growth conditions, the mask design (diameter and pitch) is crucial to achieve SAG. Local III/V flux ratio within nanoholes is a key factor that is tuned, either varying growth conditions, or the mask geometry. In addition, some conditions may allow selective nucleation but not a subsequent vertical growth. With optimized conditions ordered GaN NCs can be grown with a wide variety of diameters. In this work, ordered GaN NCs with diameter as small as 40 nm are shown.

Figure 1: Ordered NCs on a nanohole Ti-mask array with 150 nm diameter and 275 nm pitch