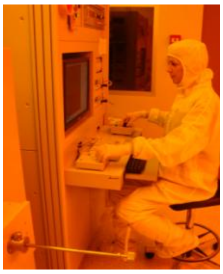

Substrate nanopatterning by e-beam lithography to growth ordered arrays of III-nitride nanodetectors, white light emitters, and solar cells

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III-nitride nanorods have attracted much scientific interest during the last decade because of their unique optical and electrical properties [1,2]. The high crystal quality and the absence of extended defects make them ideal candidates for the fabrication of high efficiency opto-electronic devices such as nano-photodetectors, light-emitting diodes, and solar cells [1-3]. Nitride nanorods are commonly grown in the self-assembled mode by plasma-assisted molecular beam epitaxy (MBE) [4]. However, self-assembled nanorods are characterized by inhomogeneous heights and diameters, which render the device processing very difficult and negatively affect the electronic transport properties of the final device. For this reason, the selective area growth (SAG) mode has been proposed, where the nanorods preferentially grow with high order on pre-defined sites on a pre-patterned substrate [5].

Once the ordered growth of nanorods is mastered, we envisage its application to demonstrate novel opto-electronic devices, which go well beyond the state-of-the-art. These devices are interband and intersubband nanophotodetectors based on GaN/AlGaN and InGaN/AlGaN nanorods containing quantum size heterostructures, light emitting diodes, and very efficient solar cells. The spectral range of interest extends from near infrared (near-IR) to visible and UV. The objective is to take profit of the excellent transport and optical properties which can be expected from defect-free nitride nanorods for fabricating efficient nanodevices in the form of single wire detectors or ordered arrays of nanodetectors. Another two objectives of the project are the development of efficient white light emitters for general lighting, and arrays of InGaN/GaN/ Si solar cells.

In this work, which was carried out within the first 6 months of a two-year IEF, results of substrate hole-patterning using e-beam lithography are presented (Figure 1). This technique was selected because of its versatility, resolution, and reproducibility. I will present results of GaN/InGaN nanorods selective growth by MBE on pre-patterned masks. When the mask fabrication process and the growth parameters are optimized, high crystal quality nanorods are achieved that exhibit perfect hexagonal cross section, constant size and distribution, and extreme ordering over large areas of several micron (Figure 2). This is the first important achievement that allows proceeding with the fabrication of nanodevices.

This fellowship allows me to get acquainted on new technologies in the field of material science and devices, contributing to my career development, either academic or linked to the industry. This is possible by means of scientific skills, professional maturity, independence for managing, and by establishing personal relations with other groups and researchers all over the world.

To keep Europe's industry on the leading edge in the field of new high-performance semiconductors, it is crucial that fundamental research breakthroughs are transmitted to younger generations who will lead the emerging technology. Therefore it is essential to guarantee an efficient connection between production and innovative research. There is an urgent need in Europe to train young scientists in the field of III-V nitrides materials and devices and to be ready for the numerous applications that will flow from this technology.

Figure 1

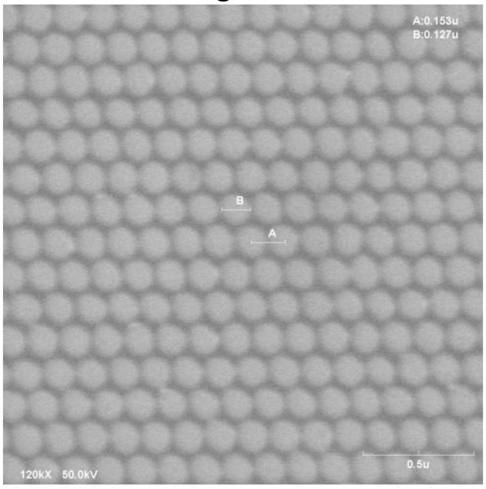
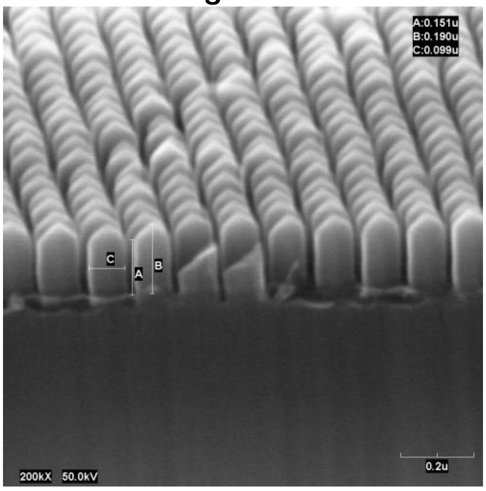


Figure 2



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