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**1 – Introduction**

Title: The influence of Ga composition of GaInAsN QDs on N incorporation.

Author/s: R. Gargallo-Caballero[1], A. Guzmán[1], J. M. Ulloa[1], M. Hopkinson[2] and E. Muñoz[1].

Addresses and Email addresses:

[1] Instituto de Sistemas Optoelectrónicos y Microtecnología, Departamento de Ingeniería Electrónica, ETSI Telecomunicación, Universidad Politécnica de Madrid, Ciudad Universitaria s/n, Madrid, Spain (rgargallo@die.upm.es)

[2] Department of Electronic & Electrical Engineering, EPSRC National Centre for III-V Technologies, University of Sheffield, Sheffield S1 3JD, United Kingdom.

Currently, dilute nitride III-N-As semiconductors, such as InGaAsN/GaAs quantum well material system, allow to develop very competitive lasers at long wavelength emission (1.3 μm). However, longer wavelengths, such as 1.55 μm, are very difficult to achieve without making worse the performance of the device. Alternatively, as it is well known, great efforts are being devoted to the study of dilute nitride III-

N-As quantum dots (QDs) semiconductor [1]. Mainly, this is due to the attractive advantages that they show over other materials and structures: the strong reduction in the bandgap of the III-As semiconductor by adding even a few percent of nitrogen into them, and the interesting physical properties that the QDs offer to laser characteristics (e.g. low threshold current, etc).

**2 – Main Body of Text**

In this work, we have examined the impact of the Ga composition of the GaInAsN QDs on the nitrogen incorporation into these nanostructures grown on GaAs (100) substrates by molecular beam epitaxy (MBE) using a radiofrequency (RF) nitrogen plasma source. According to the literature, the nitrogen shows a maximum level than can be incorporated into the GaInNAs given a certain indium composition in the material, due to the presence of indium during the growth. Also, in GaInAsN has been found a clear degradation of the crystal quality compared to GaAsN [2]. In consequence, it is possible that there are some variations and limitations in the nitrogen incorporation into GaInAsN QDs depending on the composition of these nanostructures. Optical analysis and morphological characterization have been performed to study these effects using Photoluminescence (PL) measurements and Atomic Force Microscopy (AFM), respectively.

Firstly, several samples were grown under identical growth conditions with different Ga composition of the GaInAsN QDs and fixing the active nitrogen during the growth. In order to perform both a morphological and an optical characterization of these nanostructures, two layers of QDs were grown in each sample under the same growth conditions: one of them buried and the other one on the surface of the sample. Moreover, in order to deduce the real nitrogen composition of these nanostructures, the same samples without N were grown. The presence of N into the QDs reduces drastically the bandgap energy, so increases the peak wavelength of the PL emission. In this way, analyzing the PL measurements it has been possible to study the real incorporation of N into the QDs. Also, the dependence of the optical quality of these nanostructures on the Ga and N composition of the GaInAsN QDs have been studied.

Furthermore, we have grown a set of several samples of GaInAsN and InAsN QDs under the same growth conditions and only changing the active nitrogen generated by the N plasma source. With this experiment, we have tried to investigate the influence of the Ga presence on the surface N solubility into these nanostructures, and to observe if it exits in some case a maximum N level that can be incorporated into the GaInAsN and InAs QDs.

We also explore the possibility to improve the optical quality of the GaInAsN QDs by a post-growth rapid thermal annealing (RTA) treatment of the grown samples. As it is well known, thermal annealing improves the PL efficiency of InGaAsN materials due to several mechanisms (e.g. removing dislocations at interfaces related to the growth with N) [3]. Therefore, we have studied the effect that the post-growth thermal annealing as a function of the different Ga composition of these QDs has on the optical characteristics of these nanostructures. We carried out a RTA of the grown samples in the experiments mentioned above and latter an optical characterization of them by PL measurements.

**3 – Conclusion**

In conclusion, the growth of GaInAsN QDs on GaAs (100) by MBE using a RF plasma nitrogen source with different Ga and In composition and its influence on the nitrogen incorporation into GaInAsN QDs has been investigated and discussed in this work. Optical analysis and structural characterization of these samples have been performed by AFM and PL measurements, respectively. Also, an additional study was performed in order to investigate the influence of the RTA treatment as a function of the Ga composition of the GaInAsN QDs on the optical quality of these QDs.

References

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