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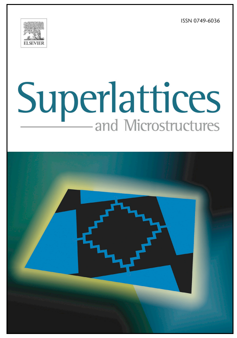


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# Photoluminescence properties of (Al,Ga)N nanostructures grown on $Al_{0.5}Ga_{0.5}N$ (0001)

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## Abstract

The optical properties of $Al_{0.1}Ga_{0.9}N$ nanostructures grown by molecular beam epitaxy on $Al_{0.5}Ga_{0.5}N$ (0001) templates are investigated. By combining morphological and photoluminescence (PL) characterizations, we have performed an in-depth analysis of the nanostructures properties as a function of the deposited amount. It is shown that: 1) the nanostructures present an asymmetrical height distribution, and a variation in their shape (i.e. both symmetric and elongated nanostructures are observed); 2) the main PL emission is found in the UV range (above 3.6 eV); and 3) a broad emission in the near UV-blue range is observed. These results allowed to attribute the main PL peak to nanostructures with properties in close agreement to the nominal $Al_{0.1}Ga_{0.9}N$ concentration and deposited amount. Concerning the broad PL band at lower energy, it has been correlated to the formation of an additional type of nanostructures with larger size and lower Al composition compared to the $Al_{0.1}Ga_{0.9}N$ ones.

**Keywords** Quantum dots, AlGaN, ultraviolet, molecular beam epitaxy

## 1. Introduction

(Al,Ga)N materials are currently of great interest for optoelectronic devices, especially for ultraviolet light emitting diodes (UV-LEDs). This alloy is a good candidate for UV emission as it is possible to tune the band gap from 3.4 eV (GaN) to 6.0 eV (AlN), by adjusting the Al composition.

The UV-LED research domain is motivated by a wide range of applications such as water and air sterilization, biological analysis, epoxy curing, high-density optical storage and medical therapy. They have advantages compared to traditional mercury lamps which suffer from environmental problems and technical limitations [1]. Contrary to blue LEDs, which have already shown very high efficiencies, UV LEDs suffer from a significant decrease with wavelength of the external quantum efficiency (EQE) [2]. One of the main reasons of this droop is the high threading dislocations (TDs) densities, in the $10^9$-$10^{10}$ $cm^{-2}$ range, in (Al,Ga)N alloys. TDs are structural defects that act as non-radiative recombination centers and are mainly due to the large lattice mismatch between the substrate, i.e. sapphire, and the epitaxial layer. To overcome this intrinsic problem many research works are in progress to improve the (Al,Ga)N crystalline quality [1, 3, 4]. On the other hand, another approach can be used by growing three