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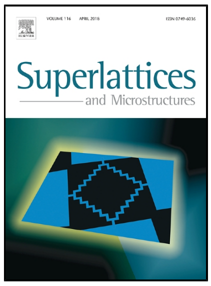

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Influence of high Mg doping on the microstructural and opto-electrical properties of AlGaN alloys

Qingjun Xu[a,b], Shiying Zhang[a,b], Bin Liu[a,*], Tao Tao[a], Zili Xie[a], Xiangqian Xiu[a], Dunjun Chen[a], Peng Chen[a], Ping Han[a], Youdou Zheng[a], Rong Zhang[a,*]

[a] *Key Laboratory of Advanced Photonic and Electronic Materials, School of Electronic Science and Engineering, Nanjing University, Nanjing 210093, China*

[b] *College of Optoelectronics Engineering, Zaozhuang University, Zaozhuang 277160, China*

Abstract

Mg-doped $Al_xGa_{1-x}N$ (x=0.23 and 0.35) alloys have been grown on GaN templates with high temperature AlN (HT-AlN) interlayer by metalorganic chemical vapor deposition (MOCVD). A combination of secondary ion mass spectrometry (SIMS) and transmission electron microscopy (TEM) indicates the formation of more inversion domains in the high Al mole fraction Mg-doped AlGaN alloys at Mg concentration~10^{20} cm^{-3}. For Mg-doped $Al_{0.23}Ga_{0.77}N$ epilayer, the analysis of cathodoluminescence (CL) spectra supports the existence of self-compensation effects due to the presence of intrinsic defects and Mg-related centers. The energy level of Mg is estimated to be around 193meV from the temperature dependence of the resistivity measured by Hall effect experiments. And hole concentration and mobility are measured to be 1.2×10^{18} cm^{-3} and 0.56 cm^2/V at room temperature, respectively. The reduction of acceptor activation energy and low hole mobility are attributed to inversion domains and self-compensation. Moreover, impurity band conduction is dominant in carrier transport up to a relatively higher temperature in high Al content Mg-doped AlGaN alloys.

Keywords: $Al_xGa_{1-x}N$; Mg doping; MOCVD; microstructural properties; optoelectronic properties.

1. Introduction

P-type doping Aluminium gallium nitride (AlGaN) is of critical importance for the realization of high-efficiency, deep ultraviolet (UV) optoelectronic devices including light emitting diodes, lasers, photodetectors, and bipolar transistors [1, 2]. For the most widely used p-type dopant of magnesium (Mg), its activation energy in $Al_xGa_{1-x}N$ increases monotonically with increasing Al content from 0.17 eV in GaN to 0.51 eV in AlN [3, 4]. Therefore, it is very challenge to achieve high p-type conductivity due to the large activation energy of the Mg

[*] Corresponding author.
*E-mail addresses:*bliu@nju.edu.cn; rzhang@nju.edu.cn