

# Contents

Abstract (in Chinese).....	i
Abstract (in English) .....	iii
Acknowledgments.....	v
Contents.....	vi
List of Tables.....	viii
List of Figures.....	ix
<b>Chapter 1 Introduction.....</b>	<b>1</b>
1.1 Development and Application of III-Nitride Semiconductors.....	1
1.2 Status of Study on III-Nitrides.....	2
References.....	9
<b>Chapter 2 Theoretical Backgrounds.....</b>	<b>15</b>
2.1 MOVPE Technique.....	15
2.2 MOVPE Growth Process.....	16
References.....	20
<b>Chapter 3 Experimental Details.....</b>	<b>21</b>
3.1 Sample Preparations.....	21
3.2 Characterization Systems.....	23
<b>Chapter 4 Growth and Characteristics of In isoelectronic doping     GaN:Mg.....</b>	<b>32</b>
4.1 Isoelectronic In doped GaM:Mg.....	33
4.2 TMIn Flow Rate Effect.....	39
References.....	45
<b>Chapter 5 Conclusions.....</b>	<b>59</b>
5.1 Conclusions.....	59

5.2 In isoelectronic doping GaN:Mg.....59



## Tables List

Tab. 1-1	Properties of prospective nitride substrates.....	13
Tab. 3-1	The source equipment details of MOVPE system for group-III nitrides growth.....	22
Tab. 4-1	The growth condition of GaN:Mg and In-doped GaN:Mg samples.....	34
Tab. 4-2	The growth condition of In-doped GaN:Mg samples with various TMIn flow rate.....	39



## Figures List

Fig. 1-1	Energy band gap versus lattice constant for III-V semiconductor compounds and alloys.....	14
Fig. 3-1	Schematic of horizontal type GaN MOCVD system.....	27
Fig. 3-2	The schematic diagrams of (a) GaN sample structure and (b) the corresponding growth procedure.....	28
Fig. 3-3	Raman scattering system block diagram.....	29
Fig. 3-4	Photoluminescence and Photoluminescence excitation detection system block diagram.....	30
Fig. 3-5	The schematic diagrams of the Hall measurement system.....	31
Fig. 4-1	The schematic diagrams of GaN:Mg(+In) structure and the corresponding growth procedure.....	48
Fig. 4-2	SEM micrographs of (a) ~ (c) for GaN:Mg films grown with various Cp <sub>2</sub> Mg flow rates from 100 to 495 sccm, and (d) ~ (f) for GaN:Mg films co-doped with In atoms.....	49
Fig. 4-3	Hall properties of p-type GaN and In-Mg codoped GaN films as a function of Mg source flow rate.....	50
Fig. 4-4	Results of SIMS data for the solid Mg concentration for p-GaN and In-Mg codoped GaN films.....	51
Fig. 4-5	SIMS depth profile of Mg concentrations for both pure Mg-doped and In-Mg codoped GaN films.....	52
Fig. 4-6	I - V characteristics of as-deposited Mg-doped and In-Mg codoped GaN films without any dehydrogenation treatment.....	53
Fig. 4-7	Raman spectra of GaN:Mg and In-doped GaN:Mg films. Isoelectronic doping does not form alloy and clear carrier-induced plasmon since A <sub>1</sub> (LO) persists.....	54
Fig. 4-8	The PL spectra of GaN:Mg and In-doped GaN:Mg films obtained at room temperature under different TMIn flow rates.....	55
Fig. 4-9	PL intensity evolutions of GaN:Mg and In doped into GaN:Mg at different wavelengths.....	56
Fig. 4-10	The time constants of GaN:Mg and In-doped GaN:Mg films at various wavelengths for different TMIn flow rates.....	57
Fig. 4-11	PL intensity evolution at 400nm vs. temperature. The inset shows an Arrhenius plot that gives barrier energies of 69±8, 103±7 meV for GaN:Mg and In-doped GaN:Mg films, respectively.....	58