A STUDY OF CHARACTERISTIC INFLUENCE ON THE N-GAN IN DRY ETCHING PROCESS.

陳進財、陳勝利,陳勛祥

E-mail: 9125606@mail.dyu.edu.tw

ABSTRACT

THE GAN COMPOUND GENERATES SIGNIFICANT INTERESTING IN THE OPTOELECTRONIC SEMICONDUCTOR INDUSTRY BECAUSE IT CAN BE USED FOR BLUE AND GREEN LIGHT EMITTER DIODES (LED). DUE TO THE CHEMICAL INERTNESS AND BOND STRENGTH OF THE NITRIDES,THE PLASMA SYSTEM MUST BE USED IN THE ETCHING PROCESS. HOWEVER, THE ION BOMBARDMENT WILL RESULT IN GAN SURFACE DAMAGE, SUCH AS THE POINT DEFECT AND LATTICE DISORDER. IN THIS THESIS, THE EFFECT OF BC BIAS ON N- GAN IS INVESTIGATED,AND FINALLY THE OHMIC CO -NTACT AT 110V IS LOWER THAN AT 380V.BY THE SAME TOKEN,WE PRESENT THE PHOTIC AND ELECTRONI -C STUDIES OF N-GAN BY ANNEALING TREATMENT.A PHOTOLUMINESCENCE MEASUREMENT ILLUSTRATES THE RESULT OF THE N-GAN LAYER. ALTHOUGH THE ANNEALING TREATMENT CAN NOT COMPLETELY REPAIR THE LUMINESCENCE INTENSITY, BUT THE PL INTENSITY IS MORE HIGHER THAN THE SAMPLE OF NON-ANNEALI -NG TREATMENT.EVENTUALLY,THE DEVICE BEHAVIOR OF THE LOWEST OHMIC RESISTANCE AND HIGH PHOT -OLUMINESCENCE INTENSITY IN 550°C FOR 40 MINUTE ATE ANNEALING IS FOUND. MEANWHILE,THE WAVE -LENGTH DOES NOT CHANGE AFTER ETCHING AND ANNEALING TREATMENT. FINALLY,THIS OPTIMUM CONDIT -ION OF THE ANNEALING TREATMENT IS INTRODUCED IN THE BLUE LIGHT EMITTER DIODES MANUFACTURE PROCESS,AND THE FOLLOWING LIFE TEST IN WHAT WE FOUND,THE ILLUMINATION DECAY RATE IS 18.2％ AND IT REACHES -26.3％ WITHOUT ANNEALING TREATMENT.

Keywords : GAN, ICP, ANNEALING TREATMENT.

Table of Contents

第一章　緒論 1.1 背景介紹--P1 1.2 研究方向--P1 第二章 氮化鎵的蝕刻機制--P3 2.1 簡介--P3 2.2 蝕刻機制--P3 2.3 感應式耦合電漿(ICP)蝕刻系統--P5 2.4 蝕刻後影響--P6 第三章 光激發N型氮化鎵的機制--P7 3.1 輻射躍遷--P7 3.1.1 帶間輻射復合--P8 3.1.2 重摻雜半導體輻射復合--P8 3.2 非輻射復合--P9 3.2.1 表面復合--P9 3.2.2 歐傑效應--P10 2.2.3 缺陷與雜質中心的復合--P10 第四章 元件製程--P11 4.1離子轟擊試片的製作--P11 4.2蝕刻後活化晶片的製作--P14 4.3壽測元件的製作--P14 第五章 量測分析與討論--P18 5.1蝕刻後電性分析--P18 5.2蝕刻後活化處理電性及光性分析--P19 5.3晶粒壽測分析--P22 第六章 結論--P24 附錄--P56

REFERENCES

【1】THE BLUE LASER DIODE, EDITED BY NAKAMURA, 1997. 【2】S.YOSHIDA AND S.GON DA, APPL. PHY. LETT. 42,427, 1983. 【3】H.AMANO,T.ASAHI AND I. AKASAKI, JAP, J. APPL. PHYS. 29, L205,1990. 【4】H.AMANO,M.KITO,K. HIRAMATSU, AND AKASAKI, JAP. J. APPL. PHYS. 28, L2112, 1989. 【5】S.NAKAMURA"HIGH POWER GAN P-N JUNCTION BLUE LIGHT EMITTING DIODE"，JAP. J. APPL. PHYS.，VOL.30，PP. 1998~2000，(1991) 【6】J.HAN,M.H.CRAWFORD, R. J. SHUL, J. J. FIGIEL, M. BANAS, L. ZHANG, Y. K. SONG, H. ZHOU, AND A. V. NURMIKKO, APPL. PHYS. LETT. 73, 1688. 1998. 【7】CHARLES R.EDDY."ETCH PROCESS OF 3-5 NITRIDES."，NITRIDE SEMICOND. RES.4S1,G10.5, 1999. 【8】J.SZMIDT，A.SZXZESNY，R.B.BECK，"PHYSICAL-CHEMICAL ETCHING OF GAN LAYERS ON SAPP -HIRE" IEEE TRANS. ELECTRON DEVICES，P159，2001. 【9】KESHRA SANGWAL "ETCHING OF CRYSTALS." 【10】S.J.PEARTON，R.J.SHUL，FAN REN，" A REVIEW OF DRY ETCHING OF GAN AND RELATED MAT -ERIALS." MRS INTERNET J. NITRIDE SEMICOND. RES. 5，11，2000. 【11】R.J.SHUL，G.B.MCCLELLAN，S. J.PEARTON，C. R. ABERNATHY，C.CONSTANTINE，C.BARRATT，ELECTRON. LETT. 32，1408，1996. 【12】DURGA BASAK，KENJI YAMASHITA，TOMOYA SUGAHARA，QHALID FAREED，DASISUKE NAKAGAWA，KATSUSHI NISHION，SHIRO SAKAI.，"REACTIVE ION ETCHING OF GAN AND ALXGA1-XN USING CL2/CH4/AR PLASMA."，JAPANESE JOURNAL OF APPLIED PHYSICS，VOL38，1999. 【13】S.A.SMITH，C.A.WOLDEN，M. D.

BREMSER, A. D. HANSER, R. F. DAVIS., "SELECTIVE AND NON-SELECTIVE ETCHING OF GAN,ALGAN,AND ALN USING AN INDUCTIVELY COUPLED PLASMA." IEEE TRANS. ELECTRON DEVICES, P349, 1998.