INVESTIGATION AND MODELING OF BORON DIFFUSION REDUCTION IN SILICON BY FLOURINE IMPLANTATION USING NUMERICAL SIMULATION

by

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APPROVAL AND DECLARATION SHEET

This project report titled Investigation And Modeling Of Boron Diffusion Reduction In Silicon By Fluorine Implantation Using Numerical Simulation was prepared and submitted by Chuah Soo Kiet (Matrix Number: 031010634) and has been found satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirement for the Bachelor of Engineering (Microelectronic Engineering) in University Malaysia Perlis (uniMAP).

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I declare that this thesis is the result of my own research except some quotations of which I have cited the sources in the reference section. I furthermore declare that this thesis is not concurrently being submitted for any other degrees.

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KAJIAN DAN PEMODELAN PENGURANGAN RESAPAN BORON DALAM SILICON OLEH IMPLANTASI ION FLOURIN MENGGUNAKAN SIMULASI BERANGKA

ABSTRAK

Dengan peningkatan minat terhadap penggunaan flourin dalam penanaman dengan boron untuk pengurangan resapan boron dalam fabrikasi peranti semiconductor, adalah pentingnya untuk memahami mekanisme-mekanisme di mana fluorin mengurangakan resapan tertambah fana (TED) dan resapan termal boron. Dalam projek ini, dua struktur istimewa (stuktur A & struktur B) dibina menggunakan simulasi prosess untuk mengkaji mekanisme-makanisme yang bertanggungjawab terhadap resapan tertambah fana dan pengurangan resapan boron dalam silicon. Tiga tenaga implantasi F^+ iaitu 20, 35 dan 50 kev digunakan dengan dos yang sama pada $1 \times 10^{15} / cm^3$, diikuti oleh process resapan pada suhu 900°C selama 30 saat. Didapati bahawa implantasi flourine mengurangkan resapan tertambah fana yang disebabkan oleh implantasi boron. Peranan kepekatan boron, interstis, kekosongan, kluster boron dan evolusi resapan berdasarkan perubahan masa bagi resapan boron dalam silicon akan dibincangkan. Keputusan simulasi menunjukan bahawa fluorin mengurangkan resapan tertambah fana.

ABSTRACT

With the increased interest in the use of fluorine co-implantation with boron for boron diffusion reduction in the fabrication of semiconductor devices, it is important to understand the mechanisms by which fluorine reduces transient enhanced diffusion (TED) and boron thermal diffusion. In this project, two special structures (structure A and structure B) are generated using process simulation to investigate the mechanism responsible for boron transient enhanced diffusion and the reduction of boron diffusion in silicon. Three F^+ implantation energies of 20, 35 and 50 kev are used with same dose of $1\times10^{15}/cm^3$ and follow by process diffusion at 900°C for 30 second. It is obtained that fluorine implantation has occasionally reduced boron transient enhanced diffusion caused by the boron implant ion. The role of the boron concentration, interstitials, vacancies, boron clusters and evolution of diffusion based different time of boron diffusion in silicon will be discussed. The simulations results suggest that fluorine is reducing the boron transient enhanced diffusion.

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LIST OF SYMBOLS, ABBREVIATIONS OR NOMENCLATURE

TED	Transient enhanced diffusion
TEDB	Transient enhanced diffusion
NMOS	N-type metal oxide semiconductor
PMOS	P-type metal oxide semiconductor
CMOS	Complementary metal oxide semiconductor
IC	Integrated circuit
BJT	Bipolar junction transistor
MOSFET	Metal oxide semiconductor field effect transistor
BF^{2+}	Boron fluoride
F^{+}	Fluorine
B^{+}	Boron
USJs	Ultra shallow junctions
BED	Boride enhanced diffusion
OED	Oxidation enhanced diffusion
mm	Millimetre
cm	Centimetre
^{o}C	Degree Celsius
µm	micrometer
Ef	Energy Fermi level
Ei	Energy intrinsic Fermi level