CLOSED STACKS

STUDIES OF UV-IRRADIATION EFFECTS ON THE RECOMBINATION LIFETIME OF SILICON WAFER

by

LEE WAH PHENG

A Dissertation submitted in partial fulfillment for the Degree of Master of Technology (Material Science) at the Institute of Advanced Studies University of Malaya Kuala Lumpur July 1996
ACKNOWLEDGEMENTS

I am deeply indebted to my supervisor, Associate Professor Muhamad Rasat Muhamad for his unflinching support during my research and thesis preparation.

My sincere thanks also go to my co-supervisor Associate Professor T. Y. Tou for his penetrating criticism, suggestions and remarkable insight to make this thesis in proper form.

Appreciation is also expressed to my advisor Y. L. Khong in S.E.H (M) Sdn. Bhd. for his helpful discussions and suggestions during my research.

I would like to thank Madam B. C. Lim of R & D Department, S.E.H (M) Sdn. Bhd. for allowing me to use the necessary facilities.

Finally, special gratitude is expressed to my family and my wife, Miss Eng, for their love, understanding and patience in the long hours of neglect during the entire period of this research.

Lee Wah Pheng
February 1997
ABSTRACT

The change of effective minority carrier lifetime with UV irradiation of deliberately contaminated and thermally oxidized silicon wafers have been investigated with the laser-microwave photo-conductive decay (LM-PCD) technique. In the contaminated wafers, it has been found that the effective lifetime increases after a specific accumulative UV irradiation time called “threshold time”. With UV irradiation, a rapid lifetime enhancement have been observed for the wafers oxidized at 700 °C and 900 °C while for wafers oxidized at 1000 °C, the lifetime decreases. A model is proposed which employs a combination of surface defect interconversion and band-bending during the UV irradiation to explain the observed phenomena.
CONTENTS

ACKNOWLEDGEMENTS i

ABSTRACT ii

CONTENTS iii

CHAPTER ONE : INTRODUCTION

1.0 Introduction to Semiconductor Material : Silicon 1
1.1 Silicon Wafer Production 2
1.2 Recombination Lifetimes 5
1.3 The Effect of UV-Irradiation 7
1.4 Motivation and Objectives 9
1.5 Outline of This Thesis 10

CHAPTER TWO : SEMICONDUCTOR SURFACES

2.0 Introduction 11
2.1 Surface Recombination Velocity, $S_r$ 11
2.2 Minority Carriers Under Continuous Pulsed Optical Excitation 14
2.3 Relationship Between Effective Minority Carrier Recombination Lifetime and Surface Recombination Velocity 18

CHAPTER THREE : EXPERIMENTAL TECHNIQUES

3.0 Introduction 20
3.1 Metal Contamination 20
3.2 Thermal Oxidation

3.3 Measurement Techniques

CHAPTER FOUR: RESULTS ANALYSIS AND MODELING

4.0 Introduction

4.1 Metal Contamination Results

4.2 Effects of Thermal Silicon Dioxide

4.3 Proposed Mechanisms of UV-Irradiation Effect on Silicon Wafer Surface

CHAPTER FIVE: CONCLUSIONS AND SUGGESTIONS

REFERENCES