SIMULTANEOUS DIFFUSION OF BORON AND PHOSPHOROUS INTO SILICON FOR THE FABRICATION OF SOLAR CELLS

BY

RAVINDER KUMAR KOTNALA

DEPARTMENT OF PHYSICS

THESIS SUBMITTED
IN FULFILMENT OF THE REQUIREMENT OF THE
DEGREE OF
DOCTOR OF PHILOSOPHY

TO THE

INDIAN INSTITUTE OF TECHNOLOGY, DELHI

JANUARY, 1982

THESIS SUPERVISORS:

PROFESSOR G.C. JAIN
SCIENTIST (DIRECTOR)
NATIONAL PHYSICAL LABORATORY
NEW DELHI - 110 012

PROFESSOR K.L. CHOPRA
THIN FILM-SOLID STATE TECHNOLOGY CELL
DEPARTMENT OF PHYSICS
INDIAN INSTITUTE OF TECHNOLOGY, DELHI
NEW DELHI - 110 016.

ACKNOWLEDGEMENTS

The author record his d ep sense of gratitud and ind btedne s to Prof.G.C. Jain for his keen int rest and constant encouragement throughout the course of this work.

An equally important contributory factor goes to Prof.K.L. Chopra for extending his laboratory facilities and valuable guidance throughout the course of this work.

I take this opportunity to express my profound gratitude to Dr.S.N. Singh for his valuable guidance and involvement. He has been a source of inspiration throughout, through his stimulating discussions.

It is indeed a pleasure to thank Dr.B.K. Das, P.V.N. Ramanathan, Dr.B.C. Chakarvarty, Dr.(Miss) S. Kumari and Mr.N.K. Arora for their valuable collaboration in this research project. I am highly thankful to all of my colleagues and friends for all the advice and help they have given me in my research.

Due thanks are accorded to the C.S.I.R. for having granted me a fellowship for the tenure of this res arch.

The author is greatful to Prof.A.R. Verma, Director, N.P.L. for extending all laboratory facilities.

The author wishes special thanks to K.S. Rawat and Ramesh Chander for neat tracing work.

Finally, I would like to record indebtness throughout my life to Prof. A. Ramchandran and my parents for their invaluable efforts in all respects.

R. K. Kotnala

(RAVINDER KUMAR KOTNALA)

ABSTRACT

It has been well established that P^+-N-N^+ (or N^+-P-P^+) structure based back surface field (BSF) silicon solar cells have a definit advantage over the conventional P^+-N (or N^+-P) cells. In this work a systematic study has been carried out to fabricate P^+-N-N^+ BSF silicon solar cells by a low cost process. A new process of fabrication of P^+-N-N^+ structure silicon solar cells by simultaneous diffusion of boron and phosphorous into silicon through a thermally grown silicon dioxide layer into silicon has been developed. The simultaneous diffusion of boron and phosphorous into silicon through silicon dioxide has been found highly suitable for fabrication of P^+-N-N^+ BSF silicon solar cells. This is evidenced by the fact that the cells fabricated using float-zoned silicon of 100 ohm cm. base resistivity have exhibited open circuit voltages about 0.6 volt at 28°C under AM1 illumination of 100 mw/cm^2 intensity. In addition to this, the process reduces the number of processing steps of P^+-N-N^+ or N^+-P-P^+ cell fabricated and is therefore very attractive with the view of large scale production. Also it is established from experiments that this process is highly reproducible to yield good quality solar cell .

Investigations have been made to explore the usefulness of phosphorous and boron diffusion through silicon dioxide layer into silicon. For this purpose, the three most important

parameters of diffusion, viz., surface concentration, doping profile nature and junction depth have been measured accurately for various diffusion conditions. A new method of determining diffusion length in N^+-P-P^+ (or P^+-N-N^+) structur based cells has also been developed.

C O N T E N T S