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Department of Engineering Physics and Mathematics

Modeling of radiation effects in modern deep submicron MOS structures

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Submitted by

George Bassem Botros Abadir

B. SC. of Electronics and Communication Engineering
Faculty of Engineering- Ain Shams University 2000

Supervisors:
Prof. Dr. O. A. Omar
Prof. Dr. H. F. Ragai
Dr. W. F. Fikry

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STATEMENT

This thesis **" Modeling of radiation effects in modern deep submicron MOS structures "** is submitted to Ain Shams University for the degree of Master of Science in Engineering Physics.

The work included in this thesis was carried out by the author in the Department of Engineering Physics and Mathematics, Faculty of Engineering, Ain Shams University, September 2002 to June 2005.

No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

DATE: / /2005

SIGNATURE:

Author: George Bassem Botros Abadir

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C.V.

Name of the researcher: George Bassem Botros Abadir

Date of Birth: 18th of November 1977

Place of Birth: Cairo

Degree: B.Sc. in Electrical Engineering

Department: Electronics and Communication Engineering

Faculty: Faculty of Engineering

University: Ain Shams University

Date of Degree: 2000

Abstract

George Bassem Botros Abadir
"Modeling of radiation effects in modern deep submicron MOS structures"
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Radiation effects are having a great impact on modern deep submicron MOS structures characteristics. They are widely classified into two categories: total dose effects resulting with the accumulation of absorbed radiation energy in the structure, and single event effects which result from single ions and particles striking the MOS structure in a localized area and during a short interval of time.

In this work, we have presented a survey for the radiation effects on MOS structures. We have studied the origins of radiation effects, the categories of radiation effects; namely; total dose effects and single event effects. We have also described the mechanisms involved in producing each type of effects.

A full description of the most eminent models of the transient currents induced by single events has been presented, showing the deficiencies associated with each one of them.

We have made a detailed study using device simulation of the effect of the angle of ion incidence and of scaling as well as the following operating conditions on the single event induced transient current and the subsequent collected charge:

- Bias.
- Doping.
- Temperature.
- Channel length (for MOSFETs).

Finally, we have developed a complete model for the transient current induced by single events. The ultimate goal of the model is to calculate the subsequent collected charge by integrating the current. We have verified the model using device simulation results. The error

in the collected charge prediction was shown to be always less than 1%. This model can then be integrated into circuit simulators. First a number of device simulations need to be performed for the different expected doping levels, bias conditions, temperature and geometry. Next, the results should be fitted to the model and a look-up table constructed for the results. This look-up table can be then integrated to the circuit simulator. This model can be used primarily for DRAM cells where the mechanism of single event induced errors is linked directly to the amount of the collected charge.

Keywords: Radiation effects - Single event effects – Modeling

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