FABRICATION AND CHARACTERIZATION OF 130nm PMOS DEVICE USING SILVACO SIMULATOR

This project is presented in partial fulfillment for the award of the Bachelor of Engineering (HONS) in Electrical

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ACKNOWLEDGEMENT

All praise to Allah, The Most Beneficent and The Most Merciful. Thee do I worship and thee do I beseech help. Thank you to Allah Almighty for granting me patience and confidence in completing this project.

Firstly, I would like to express my deepest gratitude to the project supervisor, Puan Hanim Binti Hussin for her invaluable guidance and advice in the preparation of this report. This project would not be accomplished without her guidance, encouragement, and her constructive critics.

Among fellow student, I would like to thank to my friends, Mas Fezah Latib, Noor Azura Ishak and to all my friends for their invaluable assistance and discussion concerning this project.

Finally, special thanks to my husband, Sharani Ibrahim, my parents and family for their understanding, support and pray for my success to complete this project.

ABSTRACT

Nowadays, downsizing the size of Metal-Oxide Semiconductor Field Effect Transistor (MOSFET) is the recent trends in MOSFET technologies such as the aggressive scaling of gate length, the decrease in on-current with scaling, and the increased demand for a variety of transistor types for use in a wide range of target products. This research is focused on the development of 0.13μm channel length of p-channel (PMOS) enhancement mode MOSFET. Simulation of the process is carried out using Silvaco Athena to modify theoretical values and obtain accurate process parameters.

The most common effect that occurs in the short channel MOSFETs are channel modulation, drain induced barrier lowering (DIBL), punch-through and hot electron effect. Several advanced method such as lightly-doped drain (LDD), halo implant and retrograde well is applied to reduce the short channel effects. At the device simulation process, the electrical parameter is extracted to investigate the device characteristics.

Several design analysis are performed to investigate the effectiveness of the advanced method in order to prevent the varying of threshold voltage or short channel effect of a MOSFET device.

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CHAPTER 1

INTRODUCTION

1.1 DEFINITION OF SEMICONDUCTOR

A semiconductor is a material that may act as a conductor or as an insulator depending on the conditions [7]. Diodes and transistor are made on or semiconductor materials as well. Resistors and capacitors as individual are commonly made without the use of semiconductor material but the ability to make them with semiconductor material made it possible to integrate them with diodes and transistors.

The specific properties of a semiconductor depend on the impurities, or *dopants*, added to it. An *N-type* semiconductor carries current mainly in the form of negatively-charged electrons, in a manner similar to the conduction of current in a wire. A *P-type* semiconductor carries current predominantly as electron deficiencies called holes. A hole has a positive electric charge, equal and opposite to the charge on an electron. In a semiconductor material, the flow of holes occurs in a direction opposite to the flow of electrons.

1.2 TRANSISTOR SCALING

Metal Oxide Semiconductor Field Effect Transistor (MOSFET) has been the most important device for today's advanced Integrated Circuit (IC) industry. The size of the Metal Oxide Semiconductor (MOS) transistor has been continually reduced by a factor of two every two years, which has resulted in chips which are significantly faster, contain more transistors, and consume less power per transistor in every generation. With ever demanding market for higher speed and, lower dissipation and higher packing density, the MOS transistor size has shrunk from a few micrometers to less than a quarter micrometers. Transistor scaling has been made possible by the improved lithographic capability to print shorter gate lengths and the ability to grow nearly perfect insulators with ever decreasing thickness.

Smaller MOSFETs are desirable for two main reasons. First, smaller MOSFETs allow more current to pass. Conceptually, MOSFETs are like resistors in the on-state, and