INVESTIGATE EFFECT OF THE SCALING ON MOS CAPACITOR USING CAPACITANCE MEASUREMENT

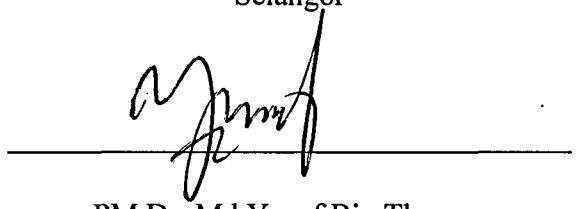
WAN MOHAMAD ROSIHAN BIN WAN AZIZ

Final Year Project Report Submitted in
Partial Fulfilment of the Requirements for the
Degree of Bachelor of Science (Hons.) Industrial Physics
in the Faculty of Applied Science
Universiti Teknologi MARA

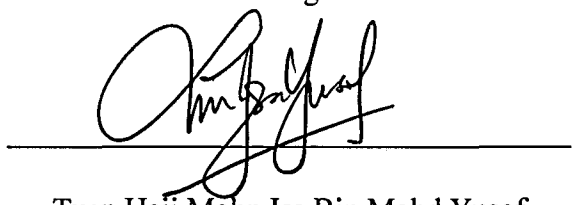
April 2010

This Final Year Report entitled "Investigate Effect of The Scaling on MOS Capacitor using Capacitance Measurement" was submitted by Wan Mohamad Rosihan Bin Wan Aziz, in partial fulfilment of the requirements for the Degree of Bachelor of Science (Hons.) Industrial Physics, in the Faculty of Applied Science, and was approved by

En. Azlan Bin Zakaria
Supervisor
B. Sc. (Hons.) Industrial Physics
Faculty of Applied Sciences
University Teknologi MARA
40450 Shah Alam
Selangor



PM Dr. Md Yusof Bin Theeran
Project Coordinator
B. Sc. (Hons.) Industrial Physics
Faculty of Applied Sciences
University Teknologi MARA
40450 Shah Alam
Selangor



Tuan Haji Mohn Isa Bin Mohd Yusof
Head of Programmed
B. Sc. (Hons.) Industrial Physics
Faculty of Applied Sciences
University Teknologi MARA
40450 Shah Alam
Selangor

Date: 12 MAY 2010

TABLE OF CONTENT

		Page
ACKNOWLEDGEMENTS		**iii**
TABLE OF CONTENT		**iv**
LIST OF TABLES		**vi**
LIST OF FIGURES		**vii**
ABSTRACT		**viii**
CHAPTER 1 INTRODUCTION		
1.1	Background	1
1.2	Objective	2
1.3	Problem statement	3
1.4	Significance of study	4
CHAPTER 2 LITERATURE REVIEW		
2.0	Introduction	5
2.1	Basic operation of MOSFET	5
2.2	MOS capacitor	6
2.3	Principle operation of MOS capacitor	7
2.4	Energy band diagram of MOS capacitor	8
	2.4.1 Flat band energy band diagram	8
	2.4.2 Bias energy band diagram	9
	2.4.3 Accumulation energy band diagram	10
	2.4.4 Inversion energy band diagram	10
	2.4.5 Depletion energy band diagram	11
2.5	Ideal C-V Characteristic	12
2.6	MOS capacitor material structure	13
	2.6.1 Dielectric material	13
	2.6.2 The need for alternate dielectric	14
	2.6.3 Alternate dielectric material	15
	2.6.4 Metal materials	16
2.7	Advantages of MOS capacitor	17
2.8	Application of MOS capacitor	18
CHAPTER 3 METHODOLOGY		
3.1	Material	
	3.1.1 Raw material	19
	3.1.2 Machines and tools	19
3.2	Introduction	20

ABSTRACT

INVESTIGATE EFFECT OF THE SCALING ON MOS CAPACITOR USING CAPACITANCE MEASUREMENT

The effects of the scaling on MOS capacitor using capacitance measurement were ascertained. The effects of different size of gate oxide ($0.01cm^2$, $0.04cm^2$, $0.09cm^2$, $0.16cm^2$ and $0.25cm^2$) on MOS capacitor were determined. It is not easy in order to produce ideal (theory) MOS capacitor when the dimension is scaled down. The qualities of oxide that produce always give effect to performance of device. The oxide layer need free from particle such contamination and fixed charge in order to produce ideal MOS capacitor. Besides that, fabrication of small device is difficult due to some limitation which is equipment capability and clean room environment. Five different sizes of gate oxides of MOS capacitor were fabricated on 4 inch n-type wafer and their effects were studied based on their capacitance value. All critical process to fabricate this device such cleaning, oxidation, lithography and metallization were done in UiTM Shah Alam semiconductor laboratory. According to the experiment result, working MOS capacitor successful fabricated on 4 inch n-type wafer. From experimental C-V curve, we can say that smaller gate oxide of MOS capacitor is recommended to produce better MOSFET-in term of speed.

CHAPTER 1

INTRODUCTION

1.1 Background

MOS capacitor is heart of the Metal-Oxide-Semiconductor-Field-Effect-Transistor (MOSFET). By understanding the fundamental of MOS capacitor is the way to know the operation and characteristic of MOSFET. The MOS capacitor is used in both monitoring integrated circuit fabrication and studying the electrical properties of the MOS system. The MOS capacitor has the advantages of the simplicity of fabrication and analysis. Using the MOS capacitor, nearly all of the properties of interest in the SiO_2, at the Si-SiO_2 interface, and in the silicon can be measured (Nicollian and Brews, 2003).

Besides that, by reducing some of the minimum feature size on MOS capacitor, one can make a more powerful device such MOSFET. Feature size will continue to reduce, while the wafer size gradually increases (Wyon, 2002). During the 1960s the IC industry developed rapidly. In 1964, Gardon Moore, one of the cofounders of Intel Corporation, noticed that the number of component on a computer chip doubled every 12 months, while the price stayed the same (xiao, 2001). His prediction that this trend would hold true in the future has become well known in the semiconductor industry as Moore's law. Amazingly, Moore's law proved accurate for more than 30 years.

In the semiconductor industry, feature size is usually measured in microns, which are equal to 10^{-6} of a meter and are noted as μm. In less than 40 years, the minimum feature