CHAPTER 1

INTRODUCTION

Introduction

The metal oxide semiconductor field effect transistor (MOSFET) is composed of an MOS diode and two p-n junctions placed immediately adjacent to the MOS diode. Since its first demonstration in 1960, the MOSFET has developed quickly and has become the most important device for advanced integrated circuits such as microprocessors and semiconductor memories mainly due to its low power consumption. The MOS diode is of paramount important in semiconductor device physics because it is extremely useful in the study of the semiconductor interfaces [1]. In practical application, the MOS diode is the heart of the MOSFET, the most important device for advanced integrated circuits. Therefore, the interface properties of the MOS diode are essential in determine the device performance. Characteristics of MOS devices are very much related to the quality of their Si/SiO_2 gate interface and it is normally carried out when the device is in its steady-state conditions. However, devices like transistor in an operational circuit may be operating at speeds faster than the respond time of some surface states, therefore, high frequency characteristics may be significantly different from its steady-state value. From a different perspective, due to the small gate area of the transistor, the conventional MOS capacitor structure method is not always suitable to characterize the interface properties. Charge pumping technique (CPT) was introduced in 1969 by Brugler and Jespers [2]. It was further demonstrated by Elliot that the CPT can be successfully employed to study interface characteristics of a MOSFET [3].

It is the aim of this work to design and construct a Charge Pumping (CP) Measurement System to characterize MOSFET device. The measurements are

compared to the Capacitance-Voltage measurement to see whether CP can be use to measure the interface traps density of a MOSFET device. The work is divided into two sections. First section is to fabricate a MOSFET as the test device which includes device fabrication steps like photolithography, diffusion, oxidation, metallization, etc. The second section is the setting up of the CP measurement system. Besides CP measurements, Capacitance-Voltage (C-V) measurement is also taken in order to compare with the CP results on the interface properties.

Chapter 2 discusses the basic theory of ideal MOS diode, MOSFET, Charge Pumping Technique and the characteristics of Capacitance-Voltage (C-V), Current-Voltage (I-V) and the Charge Pumping measurements. Chapter 3 describes the experimental techniques of the fabrication processes of the MOSFET and the measurement of C-V, I-V and CP. Chapter 4 outlines all the results obtained from the experiments including the C-V, I-V and CP characteristics. The effect on these measurements after the sample was annealed are also described and discussed. The results and analysis of various CP setting on the interface traps density are also presented in this chapter. Chapter 5 provides the conclusion of the work.