SIMULATION AND CHARACTERIZATION OF HIGH VOLTAGE TRENCH MOS BARRIER SCHOTTKY DIODE

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ABSTRACT

A diode structure which called High Voltage Trench MOS Barrier Schottky Diode has been designed and described in this paper. This type of diode has high voltage blocking capability that suitable to be used for rectifier circuits in various applications such as solar cells, reverse battery protection, switching power supply, dc-to-dc converter and many more. This Schottky diode has low forward voltage, low leakage current and high reverse voltage characteristics. In this study, deep trench MOS structures were introduced to the conventional Schottky diode which then increased the reverse voltage blocking capability. It was confirmed by simulation results which the trench structure has reduced the electric field at silicon surface and distribute it into the silicon bulk hence increasing the breakdown voltage. This trench structure of Schottky Diode has been characterized by looking at the forward and reverse characteristics. From the simulation result, the device is capable to hold higher breakdown voltage which is more than 45 V with lower leakage current. Same electrical characterization has been performed on fabricated sample to support the simulation result. Another critical parameter, gate oxide thickness is also can directly affect the device characteristic. It was experimentally studied and verified which thicker oxide has higher reverse breakdown voltage.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Schottky diode has been widely used in power supply circuits with low operating voltage due to the availability of excellent devices based upon silicon technology. This device offers some attractive applications such as low on-state voltage drop and fast switching behavior.

Unfortunately, the maximum breakdown voltage of Schottky Diode has been limited by resistance in the drift region and this can cause a trade-off between breakdown voltage and forward voltage. The resistance of the drift region increases rapidly with the increasing blocking voltage which causes the forward voltage drop to increase (M. Mehrotra, 1993). Another factor that influenced the premature breakdown voltage is the metal sharp edge effect in metal to semiconductor contact hole (M.P. Lepselter, 1968).

For industry, the developers are demanding to an improved forward voltage drop and reverse leakage current characteristics. Due to this reason, the process to improve of Schottky Diode makes it necessary to direct the efforts in the development of the freewheeling diode in order to take full advantage of the excellent switching capabilities of the Schottky Diode. Various concepts have been discuss to improved the diode characteristic such are reverse leakage current, switching application, forward voltage, and also the breakdown voltage (R.N. Gupta, 1999).