SIMULATIONS OF THE STRAINED $Si_{0.3}Ge_{0.7}/Si$ FOR NMOS

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ABSTRACT

The aim of this paper is to design the strained $Si_{0.3}Ge_{0.7}$ on relaxed Si N-MOS semiconductor and to compare the electrical characteristics with the conventional Si N-MOS using a device simulator SILVACO. In the first part, the simulation of basic fabrication processes to create the material of conventional Si NMOS devices will be developed. In the second part, the material of the $Si_{0.3}Ge_{0.7}$ N-MOS will be developed and interfaced with Si. In this part, simulation of the electrical characteristics will be done and compared with the process in the first part. From the electrical characteristics, the results will prove that the $Si_{0.3}Ge_{0.7}$ N-MOS gives better performance compared to the conventional Si N-MOS. Based on the simulated electrical characteristics; the strained SiGe/Si heterostructure influences the threshold voltage, Vt. The faster turn on of transistor is important to achieve a high speed in complementary MOS technology. The process and device simulation method have proved that the SiGe NMOS is much better performance than Si NMOS in term of low Vt and higher Id saturation as shown in I-V curves. A lower Vt means less power supplies and faster to turn on. Different thickness also contributes to the I-V characteristic. The impurity that used in the device also effects the I-V characteristic.

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CHAPTER 1

1.1 Introduction

The use of SiGe quantum wells is to improve the speed power performance of MOSFET by offering higher electron and hole mobility and the ability to control the threshold voltage and the short of channel effects [2].

The bulk electron mobility and the MOS inversion-layer mobility are enhanced when strained SiGe is grown pseudomorphically on relaxed Si NMOS. The control of MOSFETs is done by controlling the doping level of the MOSFETs channel region (under gate) using the ion implantation technology [9].

SiGe as an alloy offers a significant increase in device performance due to its superior transport properties as compared to Silicon.

The main objective of the project is to develop SiGe in n-channel MOSFET. Silicon and Germanium are both well-known as semi conducting elements. Si and Ge have the same crystal structure. Thus the layer of one material can be placed on the other if consistent atomic order is maintained. However, there is an approximately four percent greater natural spacing between atoms in germanium [10].

1.2 Objective

1) To develop SiGe/Si n-channel MOSFET using SILVACO TCAD tools
2) To compare the characteristics of Id-Vd between conventional Si n-channel MOSFET and SiGe n-channel MOSFET
3) To compare the characteristics of Id-Vg between conventional Si n-channel MOSFET and SiGe n-channel MOSFET
4) To investigate the bahaviour of SiGe n-channel MOSFET for the different thickness and composition of SiGe layers