THE CURRENT STATUS AND FUTURE TRENDS OF SIMOX/SOI, NEW TECHNOLOGICAL APPLICATIONS OF THE SiC/SOI SYSTEM.

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Abstract

The state of the art of the Silicon On Insulator (SOI) technology is presented. The significant difference in the formation of thermally grown oxide and the buried oxide (BOX) produced by high dose oxygen implantation in silicon (SIMOX) will be highlighted. The different sources of the defects in the Si-overlayer and the SiO₂ buried layer produced during implantation and annealing treatment including Si-islands formation and strained Si-Si bonds in the BOX are discussed. A comparative study of the two most successful technologies SIMOX and wafer bonding is included. The feasibility to extend the SOI structures in the SiC is shown.

1. Introduction

One of the most promising structures, which are suitable for the deep-sub-0.1μm devices, is Silicon On Insulator (SOI) which is especially useful for the low-voltage, low-power, CMOS technology [1,2]. MOSFET devices fabricated on SOI have several advantages such as reduced parasitic capacitance, latch-up elimination, soft-error-rate reduction and simple device isolation [3].

SOI permits the realization of fully depleted (FD) MOSFET which exhibit sharper subthreshold slope, reduced short-channel effects and are free of kink phenomena, even without body contacts. Moreover, they are more dynamically stable than partially depleted devices in terms of dynamic floating body effects [4]. The SOI structures are also of substantial importance for the future Si nanodevices operating on the basis of quantum mechanical phenomena [5].

From all the different approaches for SOI technologies only SIMOX and wafer bonding (WB) are seriously considered for production in an industrial scale [6]. In the present paper the main characteristics of the SIMOX wafers will be discussed. SIMOX permits an excellent thickness control of the Si-overlayer even for thickness below 50nm, which is especially useful for FD MOSFETs.

Three are the main methods for realization of wafer bonded SOI structures, namely by plasma-assisted chemical etching (PACE) [7], by bond and etch-back SOI (BESOI) [8] and by the new Smart-Cut® technology [9]. The advantages and the disadvantages of SIMOX and the wafer bonded SOI methods regarding the quality of...
the Si-overlayer and the buried oxide will be discussed.

The wafer bonding technique is also applicable in other semiconductors, which can be bonded with SiO₂. The formation of such structures with the SiC (SiC0IN) seems to be very promising for SiC devices working at high temperature [10]. Also the advantages of the 3C-SiC epitaxially grown on the Si-overlayer of SOI wafers will be presented [11].

2. SIMOX technology

Silicon separation by implanted oxygen (SIMOX) in order to form a buried SiO₂ layer is one of the best examples of the successful co-operation of recent technological advancements in the field of ion-implantation and materials science [12].

2.1 General characteristics of standard SIMOX

Commercially available SIMOX wafers are produced in the Eaton NV-200 implanters at energy 190 keV with a dose 1.8X10¹⁸O⁺cm⁻² at implantation temperature 600 to 650°C, subsequently annealed for 6h at 1320°C under Ar + 1% O₂ atmosphere. In standard SIMOX the Si-overlayer and the buried oxide (BOX) layer are about 220nm and 390nm thick, respectively [13]. The dislocation density in the Si-overlayer of the standard material is of the order 1-5X10⁵ cm⁻². These are threading edge type dislocations with Burger vectors of 1/2<110> types. They appear in pairs with distance usually less than 0.1 μm, denoted by the letter T in Fig.1. However a multistep implantation and annealing process can reduce the dislocation density to 10⁴ cm⁻² [14].

![Fig.1. Defects in the Si-overlayer of the standard SIMOX, pair dislocations are denoted by the letter T, stacking fault complex in the form of orthogonal pyramid is denoted by the letter P, a shallow prismatic stacking fault is denoted by the letter R. The fault is located on the Si/SiO₂ interface.](image1)

![Fig.2. Schematic showing the differences in the formation of Si/SiO₂ interfaces in a) thermally grown oxide b) buried oxide.](image2)