Changes in the parameters of silicon-on-insulator structures under irradiation

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Due to small thickness of the top silicon layer and its isolation from radiation defects generated in the substrate, the most important parameters for SOI structures from the point of view of changes under irradiation are a charge in a buried oxide and interface states. We had investigated the SOI structures fabricated by means of wafer bonding and hydrogen slicing. SOI structures with different types of conductivity both in the top silicon layer and the substrate were studied. The thickness of a buried oxide is ranged in (0.11-0.41) μm and thickness of the film was of (0.48-1.70) μm. MOS structures prepared on the initial silicon wafers and oxides were also fabricated for comparison. High frequency capacity – voltage measurements were used for investigation of oxide charge, carrier concentration and interface state density. The irradiation sources were electrons with energy 2.5 MeV and gamma rays. The last source of irradiation was ^{137}Cs providing continuous gamma rays radiation with energy 662 keV. The temperature of the sample during irradiation was not exceeding 50 ^{0}C. The irradiation was carried out in a dose range of 10^5-10^7 rad in both cases.

An accumulation of additional positive charge (generation of the hole traps) was observed in the buried oxide of SOI structures under irradiation. Generation of additional states at the Si/SiO_2 interfaces in SOI structures was not found under the both kinds of the irradiation though it was observed at interface of the initial thermal oxide.

An internal electric field in the buried oxide of SOI structure is depended on the conductivity in the top silicon layer and the substrate. The internal field is able to result in to more effective division of charge carriers ionized during irradiation. It is clear that in the case of hole traps in buried oxide and dependently on sign of the internal field the charge accumulation will proceed mainly near one of the interfaces. Fig.1 presents the difference between charges at the bonded interface (Q_b) and interface formed during thermal oxidation thermal (Q_t) in SOI as a function of the internal field strength (E). The presence even small built - in field ($E \geq 5x10^3$ V/cm) in SOI structures was found to result in effective division of the ionized carriers. The number of the traps generated under irradiation is higher near the thermal interface then near bonded interface. The comparative analysis of the interfaces in SOI and MOS structures on initial wafer is given in the report.

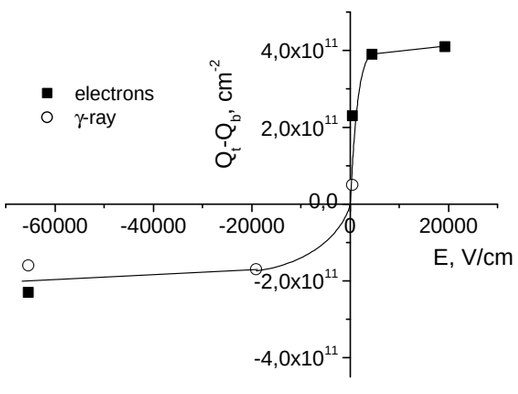

Fig.1. Difference between charges at the bonded interface (Q_b) and interface formed during thermal oxidation thermal (Q_t) in SOI as a function of the internal field strength (E) for dose of irradiation of $3x10^4$ rad.