The composition and Properties of Si-SiO_2 Structures with Zinc-Doped Oxide

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Though the Si-SiO_2 interface is the most studied interface in solid state physics, attempts to improve the properties of these structures are being continued. The controlled introduction of impurities in the oxide during its growth can be one of such methods. As it was demonstrated in [1] the doping of the Si-$Si0_2$ system in MOS structures with moderate amounts of zinc can be beneficial to their radiation hardness. It was found that though the electrophysical parameters of the modified MOS structures are similar to those of the reference ones, the presence of zinc in the Si-$Si0_2$ system enhances the effect of the so-called radiation-stimulated ordering in which radiation-then-annealing treatments result in lower values of both the density of interface states and the oxide charge compared to those of simply postmetallization-annealed (PMA) structures. The mechanism of this effect is not fully understood, therefore the purpose of our investigation is to clarify it.

Experiments were carried out on the Si-$Si0_2$ structures with oxides grown in atmosphere containing zinc. The (111) oriented n-Si wafers (ρ = 4.5 Om·cm) served as substrates. Oxide films of 70-80 nm thickness were thermally grown at 950 °C with the oxidation sequence of dry/wet/dry. *In situ* doping with zinc atoms was performed during the wet oxidation stage by means of introducing controlled amounts of aqueous solution of $ZnCl_2$ into the hot zone of the oxidation furnace. The doping dose was varied by means of changing $ZnCl_2$ concentration in the solution and the samples with the concentration of Zn in oxidizing ambient the most beneficial for the MOS properties were studied. Positive and negative SIMS measurements were performed in a TOF-SIMS V instrument (IONTOF, Muenster, Germany). For depth profiling two ion beams were used in the Dual Beam Mode: while the first beam 2 keV Cs^+ was sputtering a crater, the second beam (30 keV Bi^+) was progressively analyzing the crater bottom.

It was established that the concentration-depth profiles on the most important components in the zinc-doped oxide structures were unchanged in comparison with the reference structures. Therefore, the observed radiation-induced ordering effects in the zinc-doped structures can be explained only by the appearance of Zn, ZnCl and ZnO ions, having a different distributions at the oxide surface, bulk and Si-$Si0_2$ interface. The models explaining such distribution were proposed.

[1] T. Brozek, P. Didenko, V. Kiblik, O. Logush, et all. *Jpn. J. Appl. Phys.* **33**, 5823(1994).