Impacts of Back Surface Conditions on the Behavior of Oxygen in Heavily Arsenic Doped Czochralski Silicon Wafers

Q. Wang, Manmohan Daggubati, and Hossein Paravi
Fairchild Semiconductor Corporation, 3333 West 9000 South, West Jordan, UT 84088

Rong Yu and Xiao Feng Zhang
Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720

The precipitation and diffusion of oxygen in heavily arsenic doped Czochralski (CZ) silicon wafers (with resistivity at 3mΩ-cm and interstitial oxygen concentration of $7x10^{17}/cm^3$) have been studied for different thermal budgets and different back surface treatments. After annealed at 1200°C for 45 minutes and 900°C for 15hrs sequentially, the wafers with damaged back surface show rodlike and platelike SiO_x precipitates. These defects extended about 1μm into silicon bulk from the back surface. They all have a habit plane of {111}. This morphology has only been observed at low temperature (<900°C) in lightly doped CZ silicon wafers. For the same annealing condition, the wafers sealed with polycrystalline film of 1.3μm (polysilicon) show no oxygen precipitates in the silicon substrates. Only polyhedral oxygen precipitates were observed at the interface between the polysilicon film and the silicon substrate. They have a habit plane of {100}. These results differ significantly from the previous observations in heavily boron and antimony doped silicon wafers which show drastically enhanced oxygen precipitation when the back surface is sealed with polysilicon film. The kinetics of this oxygen precipitation behavior is discussed in detail. The SIMS and EDS analysis indicate that the diffusion of oxygen from the substrate to the epitaxial layer has been significantly reduced in the wafers with damaged back surface, compared with those with polysilicon sealed back surface. This diffusion difference shows significant impact to the performance of the devices built on these substrates.