LD-7-6

THE CHARACTERISTICS OF NITROGEN IN SILICON CRYSTALS

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The preventions of wafer warpage caused by oxygen precipitates in Intrinsic Gettered wafers, and dislocation generations for device processing using ultra large diameter wafer and future ULSI device structures such as U-type isolation grooves and trench capacitors are requested.

Nitrogen doping mechanisms into the silicon melt, measurements by Charged Particle Activation Analysis (CPAA), IR, DLTS, PL and SIMS, and nitrogen concentration distributions in FZ and CZ crystals are described.

Two pieces of anomalous annealing behavior of nitrogen in silicon are observed. First, nitrogen concentration in CZ crystals measured by IR absorption are always lower than that by CPAA, if we use the correlation curve of FZ crystals between IR and CPAA. It is discussed whether the thermal history of CZ crystals during growth differs from that of FZ or nitrogen interacts with oxygen. Second, there is a specific temperature around 900°C that IR absorptions are decreased by the annealing time, IR active nitrogen atoms may be shift to inactive sites in the lattice.

Figure 1 shows the dislocation expansion from indentations as a function of the oxygen concentrations in the CZ and nitrogen -doped CZ (N-CZ) crystals. Under 10 ppma oxygen (×1.6 = OLD ASTM), the toughness of CZ crystals againist dislocation generation is decreased significantly. Over 10 ppma range, the toughness is increasing with oxygen concentration increase. In case of N-CZ crystals, the toughness depends on not oxygen concentration but nitrogen. X-ray topogrophs shows the slippage distributions of 100 mm diameter FZ, CZ and N-CZ wafers after an epitaxial processing.

IG effects without dislocation generations for normal and MOS epitaxial wafers will be performed with N-CZ crystals.