Modeling of Internal Gettering for Metal Impurities by Oxide Precipitates in CZ-Si Wafers

Koji Sueoka

Department of System Engineering,

Okayama Prefectural University

111 Kuboki, Soja, Okayama 719-1197, Japan

(Email address: sueoka@cse.oka-pu.ac.jp)

An introduction of double-side polishing for CZ-Si wafers requires the internal gettering (IG) to remove the metal impurities from surface active regions to ensure high device performance. The use of 300mm wafers and rapid thermal anneal (RTA) processes cause further difficulties in the control of oxygen precipitation by trail and error technique. In order to find optimized IG solutions without expensive experiments on the production line, several groups have developed algorithm and quantitative models for predictive simulations of IG.[1)]

In this paper, we have extended the computer modeling to involve the reaction process of metals with oxide precipitates. The morphology of oxide precipitates was also considered. The reported experimental results of Ni and Cu gettering[2)] were simulated with the present simulator. It was found that the diffusion-limited model, which well explained Fe gettering,[1)] could not explain the reported experimental results of Ni and Cu gettering. Ni and Cu gettering was analyzed to be reaction-limited as shown in Fig.1. The simulator also showed that (1) a higher density of precipitates provides more efficient IG sites than a low density of larger precipitates at a fixed amount of precipitated oxygen, and (2) the precipitate morphology of platelet is more effective for IG than that of sphere at a fixed precipitate volume. Further, the oxide precipitates with high density of about $1x10^{12}/cm^3$ should be prepared just below the device active region in RTA process as shown in Fig.2. We have further combined the oxygen precipitation model[3)] with IG model describe above. These models make possible to control the oxygen precipitation for optimized IG without expensive experiments.

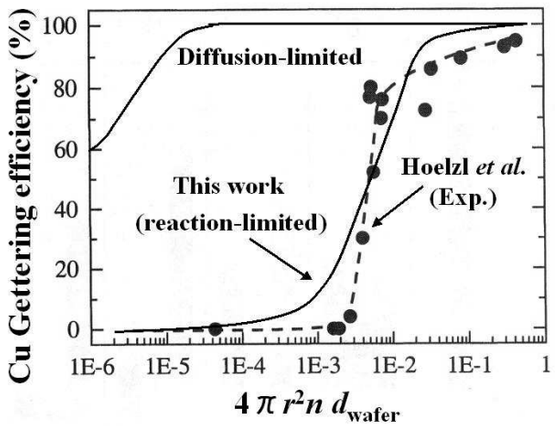

Fig.1 Simulated results of the reported Cu gettering experiments.[2)] The simulation was performed to the experimentally confirmed precipitate density n = $4x10^9$ $/cm^3$ with the diffusion-limited or reaction-limited cases. Cooling rate was 27°C/min from 580°C to 200°C and 8°C/min from 200°C to 160 °C. d_{wafer} (=725 μ m) in horizontal axis indicates the wafers thickness. Denuded zone thickness was set to 0 μ m.

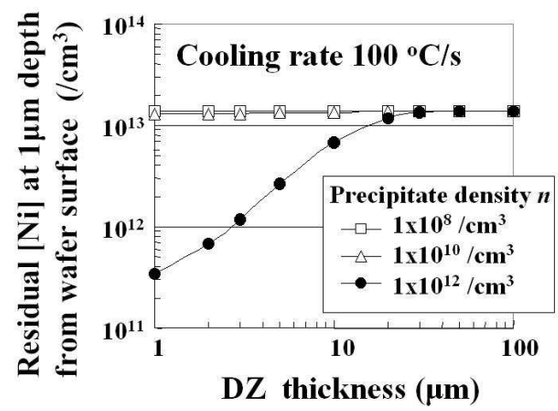

Fig.2 Dependence of the residual Ni concentration at 1 μ m depth from the wafer surface on the denuded zone thickness with the cooling rate of 100°C/sec from 1000°C to 200°C. The platelet oxide precipitates with length of L=100nm and the aspect ratio β=0.01 were given in this simulation.

References

1.H.Hieslmair *et al.*, Semiconductor Silicon 1998, p.1126.

2.R.Hoelzl *et al.*, Semiconductor Silicon 2002, p.608.

3.K.Sueoka *et al.*, Semiconductor Silicon 2002, p.540.