Laser anneal technology for Poly-silicon dopant activation enhancement


Applied Materials, 974 E. Arques Ave, Sunnyvale, CA 95086

Abstract:

Poly depletion, a reduction in active dopant in the poly near the gate dielectric, accounts for an increasing fraction of tox_inv with smaller gate lengths and gate dielectric thicknesses. Because of this, reducing poly depletion will provide significant enhancement of device performance for future technology. For the 65nm node, conventional solutions, like spike anneal, will fail to meet device requirements. One possible method for reducing poly depletion is laser annealing. Laser anneal technology produces transient temperatures near the Si melting point within a few milliseconds, which results in high dopant activation with no dopant diffusion.

In this paper, we present the study of poly activation and material properties with non-melting LASER anneal technology. Poly-silicon was deposited using single wafer CVD tool on in-situ grown plasma-nitrided oxide. After boron implant and conventional RTA, the wafers were laser annealed. We have studied the effect of LASER annealing temperature and time on dopant activation, dopant diffusion and poly structure change. Sheet resistance (Fig. 1) was reduced with higher temperature and longer annealing time. As much as 47% of sheet resistance reduction was observed while little dopant diffusion occurred as shown by SIMS analysis in Fig. 2. All laser anneal conditions produced the same dopant profile. TEM (Fig. 3) and XRD (not included) show no significant change in the poly grain structures. Since laser anneal has no effect on dopant concentration or poly grain structure, we conclude that the reduction of poly sheet resistance by laser anneal is due to the enhanced dopant activation.

Fig.1 Poly sheet resistance reduces with increasing LASER annealing temperature.

Fig.2 Dopant profile by SIMS

Fig.3 Poly grain structure for as RTA (a) and RTA + LASER annealing (b).