Study on Geometry, Surface Damage and Rapid Thermal Annealing of 300 mm As-cut Silicon Wafers

Guohu Zhang, Bin Liu, Jing Zhao, Wenjie Chen
Jing Wang, Qigang Zhou and Hailing Tu
National Engineering Research Center for Semiconductor Materials, General Research Institute for Nonferrous Metals, Beijing 100088, China

300 mm silicon wafer has become the focus point in the semiconductor filed. Slicing is one major post-growth manufacturing process in wafer preparation.Wire saw technology has been developed in a few years ago. Some researchers have reported the cutting mechanism of wire saw (1). However, very little was reported regarding slicing process and wafer quality of 300 mm silicon crystals. In this paper, we studied geometric parameters, surface damage and rapid thermal annealing (RTA) of the as-cut 300 mm wafers.

Experimental

HCT E400E-12 wire saw was used in the study. Surface and cross section morphology were studied using an optical microscope. The depth of damage layer was measured using a double crystal X–ray diffractometer. AST100 furnace was used for RTA process. Wafers were annealed at 1150°C lamp for 60 senconds.

Results and Discussion

Figure 1 are total thickness variation (TTV) results of 300 mm wafers.

Cross section morphology of as-cut wafers sliced by wire saw and ID saw are shown in Figure 2. It is observed that wafers sliced by ID saw have larger damage than those by wire saw. The depth of damage layer for ID sawed wafers is almost two times as deep as that for wire sawed wafers.

Results of the double crystal X-ray diffraction experiments show that the depth of damage layer is about 11 micron for wire saw wafer, whereas the depth of damage layer is about 22 micron for ID saw wafer. This result confirmed the results observed under microscope.

Typical surface of a wafer sliced by wire saw resembles that of a lapped wafer. The reason is that wire saw manufacturing process is based on the so-called "free abrasive machining", which removes materials by abrasive slurry. The conventional ID saw removes materials by mechanical force.

It is very difficult to reduce COP quantity of 300 mm wafers during crystal growing process. After going through SC-1 cleaning four times, COP was measured using ADE Constellation surface inspection system.

Before annealing, the size of COP in a 300 mm crystal is normally below 0.15 μm. After RTA process at 1150 °C for 60s, the average density of COP decreases. Figure 3 is the result of COP inspection.

Conclusions

Wire saw is capable of slicing 300 mm wafers. Excellent geometric parameter has been obtained. The damage layer of wire saw wafer was uniform and its depth was about 11 micron using our process. The ID saw technology is a mechanic process producing a deeper and non-uniform surface damage layer. It is no doubt that wire saw is more suitable for slicing large diameter wafers. RTA process influences the average density of COP defect. But it is hard to completely eliminate COP using the RTA process in this study.

Reference

1. I. Kao etc., PV 98-1, P. 607, The Electrochemical Society Proceedings Series, Pennington, NJ (1998).

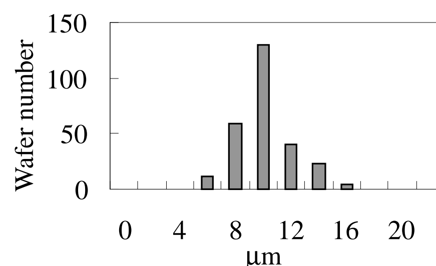
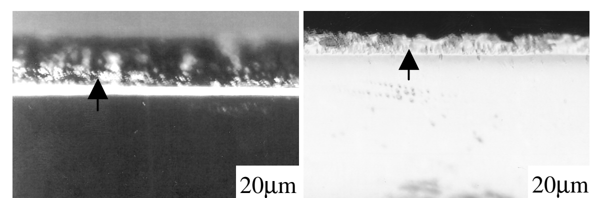


Figure 1 TTV histogram of 300 mm wafers



(a) ID sawed wafer (b) wire sawed wafer

Figure 2 Cross-section images of as-cut wafers (damage layers are marked by arrows)

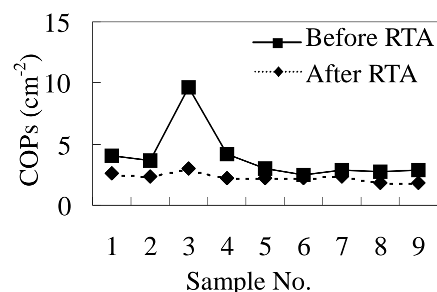


Figure 3 COP counts of 300 mm wafers before and after RTA process