

Ionic Contamination of the Silicon Wafer from Wafer Cleaning Process

Henryson O. Omoregie, Sr., Stephen Buffat and Drew Sinha
SCP Global Technologies
Boise, Idaho 83704

Control of ionic contamination of the silicon wafer is important for the prevention of haze, organic contamination, particle contamination, metallic contamination and metallic corrosion. Better understanding of the deposition and rinse behavior of the ionic contamination is important for optimizing the overall cleaning process.

A number of anions including sulfate and selected water-soluble cations have been investigated following their deposition and subsequent removal by DI water rinsing and dilute SC1 processes. Particular attention has been paid to sulfate anion. The sulfuric-peroxide (SPM) mixture is traditionally used for the removal of surface organics from the wafer surface.¹ Highly viscous nature of SPM solution, even at elevated temperature, make sulfate anion as the most difficult ions to be removed from the wafer surface. Furthermore, high level of residual sulfate anion known to produce excessive light-point-defect (LPD) on wafer surface when stored in cleanroom environment.² The objective of the current study is to evaluate the factors affecting removal of these anions from the wafer surface following SPM process.

Silicon wafer with 14-20 ohm-cm resistivity and 200 mm in diameter are processed in SPM (6:1) solution and rinsed either with hot DI (50 C) water or hot DI water followed by dilute SC1 (1:2:100). They were subsequently dried in IPA vapor in an automated wet bench with 50-wafer cassette. Variation of ion rinse efficiencies as a function of rinse type, immersion times in sulfuric acid and rinse parameters is investigated in the present study.

The surface concentration of the anions and cations on the wafer surface was identified with ion-chromatography (IC) following leaching with DI water. The level of ionic contamination on the control wafer was less than 5.0×10^{11} atoms/cm² except for Cl⁻, NO₃⁻ and NH₄⁺, which were about 1.0×10^{12} atoms/cm².

Following observation can be made from the result:

- 1) Increase in NO₂⁻, SO₄⁻ and NH₄⁺ ions are more significant compared to the increase in other anions and cations in SPM process only. Na⁻ and Cl⁻ concentration decreased by 50%.
- 2) All the ions decreased following SPM + SC1 process except for Cl⁻.
- 3) Extended overflow rinse did not decrease surface concentration of the ions. An increase in surface concentration is observed for Cl⁻ ion.

- 4) QDR rinse is more effective in reducing SO₄⁻ ion concentration compared to OFR.
- 5) The residual SO₄⁻ ion on the wafer following SPM process increased with the residence time in the bath.
- 6) LPD growth rate following SPM process correlates with residual SO₄⁻ level.

This behavior have been discussed with reference to contamination source including rinse water quality. The information can be used to control ionic contamination and optimize RCA based cleaning process. Additional benefits include reduced water and chemical consumption, reduction of cycle time with higher wafer throughput which results into lower cost of ownership.

References:

1. P. J. Clews et. al.; Proceedings of the Electrochemical society Conference, pg. 695, vol. 95-2,1995. Chicago, Illinois.
2. R. M. Hall et al.; Proceedings of Semiconductor Pure Water and Chemical Conference, pg. 101, 1995.