AN 431

Identification of Fluorocarbon Flower Defects by Auger Measurements on the 300mm Whole Wafer SMART-Tool™

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Discussion

A critical defect problem on an etch tool resulted in severe yield loss on production wafers. Particle adders from the etch tool were collected with a Si monitor wafer. Subsequent optical inspection located 105 defects. Compositional defect analysis of 20 defects was performed on a 300mm whole-wafer SMART-Tool instrument which combines high performance Auger capabilities with FIB (Focused Ion Beam) for in-situ cross-sectioning of defects and with EDS (Energy Dispersive X-ray Spectroscopy) for analysis of larger defects and structures. 90% of the detected defects were “flower” defects which showed a central particle surrounded by a thin film contamination, as shown in the SEM image of Figure 1. Auger analysis showed that about 80% of the central particles contained Al and F, with the remainder consisting of Si and Fe-Ni-Cr (stainless steel).

Auger measurements showed that the petal portion of the flower defects were composed of a C and F surface contamination, indicating a thin fluorocarbon residue. The C-based residue was only ~1-2nm thick, as shown in the Auger sputter depth profile of Figure 2. Auger is the only definitive method capable of measuring such a thin surface contaminant because of its unique high spatial resolution and surface sensitivity. EDS measurements were not sensitive to this thin surface residue.

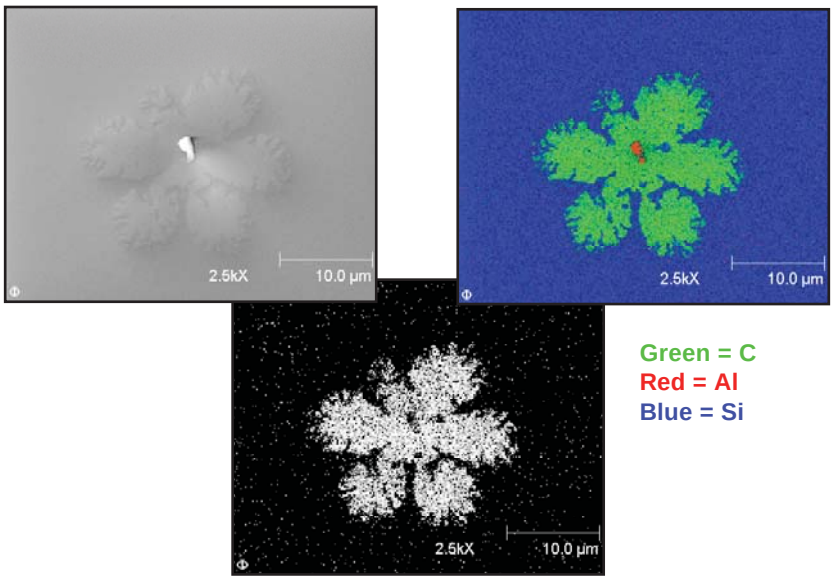

Figure 1. Secondary electron image and Auger maps of flower defect. The Auger maps show the Al central particle and the fluorocarbon petals surrounding the particle.

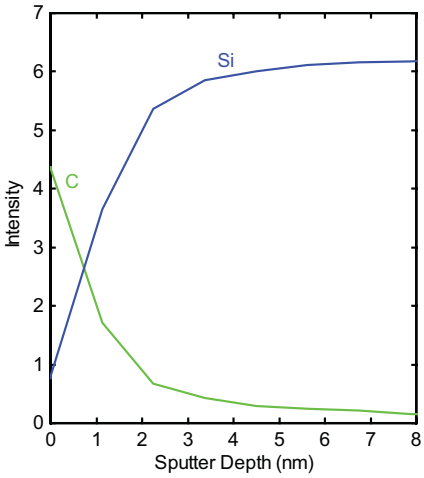

Figure 2. Auger sputter depth profile through fluorocarbon petal of flower defect.

A quick SEM examination of random areas on the full wafer using the SMART-Tool revealed many flower defects without a central particle. Such defects were not detected by the optical inspection tool, resulting in a much higher real defect count than indicated by the optical defect detection tool. The high density of surface contamination resulted in severe yield loss on production wafers. Compositional defect analysis using Auger Electron Spectroscopy on the SMART-Tool identified the contamination as C and F, which was traced to condensed fluorocarbon originating from pump oil in the etch tool wafer pre-pump chamber. The central particles may act as an initiation site for condensation. The presence of numerous flower defects with no central particle is unexplained. However, subsequent wafer handling may have dislodged the particles prior to optical inspection. Auger Electron Spectroscopy was the only analytical method that was able to provide conclusive identification of the flower defect source.

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