High-Sensitivity Sidewall Residue Metrology for a Single-Wafer Cleaning Platform

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Surface preparation steps in semiconductor processing have become increasingly challenging due to ever tightening process cleanliness specifications. For both front-end-of-line (FEOL) and back-end-of-line (BEOL) processes, it is a common practice to remove post-etch sidewall residue through a combination of dry strip and wet clean processes. The chemistry used for the wet clean needs to be tailored to the chemical and morphological particularities of the post-etch residues, which in turn depend on such factors as etch process chemistry and sequence and also the time lapsed between dry etch/strip and wet clean steps [1].

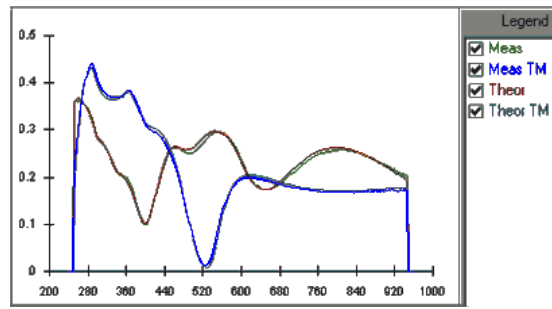
Precise measurement of thin sidewall residues of unknown material deposited on etched structures is a non-trivial task. Normal-incidence (NI) polarized reflectometry is shown to be capable of measuring thin vertical sidewall residues. The NI polarized reflectometry has superior sensitivity to detect the presence of, and separately measure, these vertical residues.

In this paper, we demonstrate angstrom-level (2-3 Å, 3-sigma) capability for the detection of nanometer-thick sidewall residue. First, we establish the model (Figure 1) using Nova's metrology setup and NovaMARS™ analysis software and demonstrate the capability for the detection of sidewall residue presence. We setup the model to independently measure the sidewall (vertical) residue and the bottom (horizontal) residue.

Second, in a detailed cleaning experiment, wafers were subjected to sequences of well-controlled cleans using the Lam Research single-wafer wet clean chamber on the 2300® cluster tool. Measurements performed on the NovaScan® 3090Next indicate a linear residue removal rate (Figure 2) and demonstrate the ability to correctly measure sidewall residues from 5-6 nm down to almost zero.

In summary, scatterometry-based metrology for thin residue measurement on sidewalls of etched structures is demonstrated. In conjunction with a rework mechanism, this normal-incidence polarized reflectometry capability can be implemented for fault detection and process control.

1. I. Vos, S. Peeters, R. Verbeeck, W, Boullart, and J. Vertommen, 'Confined Chemical Cleaning: A Novel Concept Evaluated for Front End of Line Applications', Solid State Phenomena (UCPSS2006 proceedings) 2007 (in press).



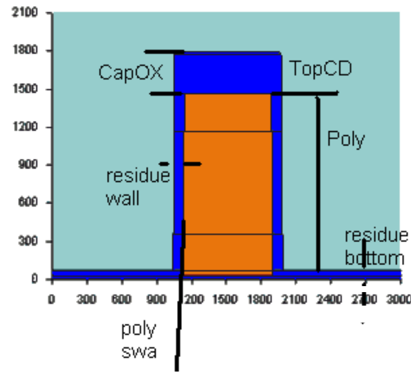


Figure 1. Scatterometry modeling for cross-section with sidewall residues. Spectral matching (top) and geometrical description (bottom)

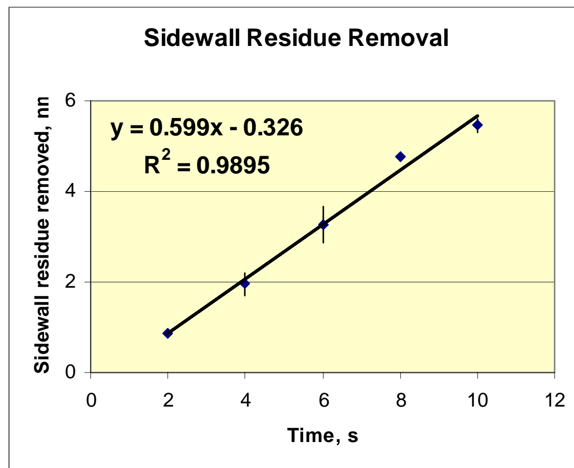


Figure 2. Post-etch sidewall residue removal as a function of wet clean time. A linear behavior is obtained, indicating good control of the clean exposure time and measurement reliability.