

Accuracy of Thickness Measurements of Thin Gate Dielectric Materials

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Introduction: Measurements using standard procedures to determine the thickness of gate dielectric materials on Si have demonstrated a wide variation of results when the thickness of the dielectric layer is less than 10 nm.

Methods and Materials: We have measured a series of gate oxynitride samples fabricated by SEMATECH using grazing incidence x-ray photoemission spectroscopy (GIXPS). XPS spectra are taken over a series of incidence angles between 0 and 1.5°. The integrated yields of photoemission peaks for the Si 2p lines in the bulk and dielectric layers, the O 1s and N 1s observed in the dielectric layers, and the C 1s surface surface contamination are all fitted for the thickness and content of a multilayer solution. The overall thickness obtained is compared with the results from x-ray reflectivity measurements made on the same samples at 8 keV.

Results: There is a strong correlation between the methods with the thickness of the sample. However the thicknesses obtained by x-ray reflectivity are consistently about 0.4 nm thicker than the GIXPS results.

Conclusions: The cause of the discrepancy may be errors in the optical constants used by one of the methods, or by the physics of the measurement at two different energies.

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