



AN 414

N Distribution in SiON Gate Dielectrics Using TOF-SIMS

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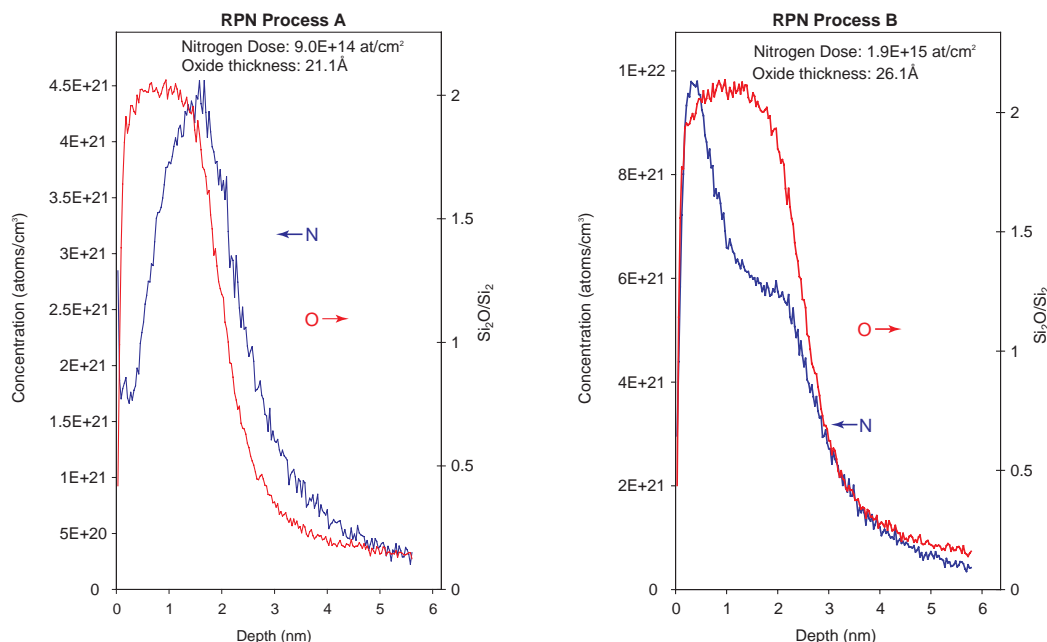
Discussion

TOF-SIMS (Time-of-Flight Secondary Ion Mass Spectrometry) is typically used for the analysis of elemental and molecular contaminants on surfaces. However, TOF-SIMS depth profiling can successfully demonstrate differences in the shapes of the nitrogen distributions from silicon oxynitride (SiON) gate oxides as thin as 15Å. It is a useful complement to XPS (X-Ray Photoelectron Spectroscopy), which provides a fast and reliable way to determine the nitrogen dose and thickness of SiON gate dielectrics with high precision, but does not provide the actual shape of the nitrogen distribution within the gate oxide.

TOF-SIMS can provide significant value and useful information for oxynitride gate development and production throughout the semiconductor industry, including for both device and tool manufacturers. TOF-SIMS has successfully been used in the development, monitoring and optimization of various methods of silicon oxynitride production.(1)

The two depth profiles shown in this application note demonstrate the types of information obtained from the measurement. The two samples were generated using different remote plasma nitridation (RPN) processes (for example, using different pressures, temperatures and times). The conditions for process A clearly show that there is little or no nitrogen at the sample surface, whereas process B clearly shows that the nitrogen is built up towards the sample surface. The doses and depths on these profiles were determined by calibration with a standard oxynitride sample of known nitrogen dose and thickness.

TOF-SIMS data can be extremely useful in understanding the results from other analytical techniques such as XPS and dynamic SIMS. However, its primary use is as another analytical tool to help understand variations in sample structure (especially very thin films) induced by process changes, and, ultimately, to correlate structural changes in dielectric films with changes in their electrical characteristics.



TOF-SIMS depth profiles from two different nitridation conditions. In TOF-SIMS, profiling is carried out in a 'phased' mode. This means that the same primary ion gun is used in a consecutive step-wise mode for both sputtering and acquisition of mass spectra between sputter steps (these are the two phases of the analysis).

References and Acknowledgements

(1) M.A. Douglas, S. Hattangady, K. Eason; J. Electrochem Soc. 147, (S) 1893-1902 (2000)

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