AN 414
N Distribution in SiON Gate Dielectrics Using TOF-SIMS

May 7, 2007 (Version 3.0)

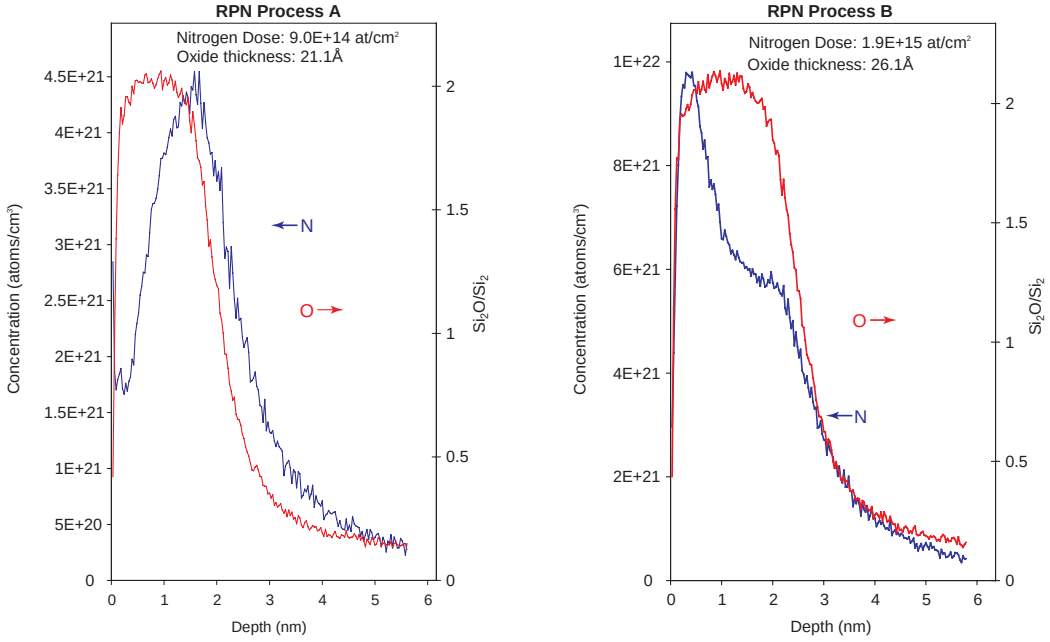
Discussion

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)

United States Locations

Tempe, Arizona
+1 480 239 0602 info.az@eaglabs.com
+1 602 470 2655 fax

Sunnyvale, California
810 Kifer Road
+1 408 530 3500 info.ca@eaglabs.com
+1 408 530 3501 fax

1135 E Arques Avenue
+1 408 738 3033
+1 408 530 3035 fax

785 Lucerne Drive
+1 408 737 3892
+1 408 737 3916 fax

Peabody, Massachusetts
+1 978 278 9500 info.ma@eaglabs.com
+1 978 278 9501 fax

Chanhassen, Minnesota
+1 952 828 6411 info.mn@eaglabs.com
+1 952 828 6449 fax

East Windsor, New Jersey
+1 609 371 4800 info.nj@eaglabs.com
+1 609 371 5666 fax

Syracuse, New York
+1 315 431 9900 info.ny@eaglabs.com
+1 315 431 9800 fax

Raleigh, North Carolina
+1 919 829 7041 info.nc@eaglabs.com
+1 919 829 5518 fax

Round Rock, Texas
+1 512 671 9500 info.tx@eaglabs.com
+1 512 671 9501 fax

International Locations

Shanghai, China
+ 86 21 6879 6088 info.cn@eaglabs.com
+ 86 21 6879 9086 fax

Tournefeuille, France
+ 33 5 61 73 15 29 info.fr@eaglabs.com
+ 33 5 61 73 15 67 fax

Frankfurt, Germany
+ 49 (0) 693053213 info.de@eaglabs.com
+ 49 (0) 69307941 fax

Tokyo, Japan
+ 81 3 5396 0531 info.jp@eaglabs.com
+ 81 3 5396 1930 fax

HsinChu, Taiwan
+ 886 3 5632303 info.tw@eaglabs.com
+ 886 3 5632306 fax

Uxbridge, United Kingdom
+ 44 (0) 1895 811194 info.uk@eaglabs.com
+ 44 (0) 1895 810350 fax