AN 448

Measuring B Implants Produced by Plasma Ion Implantation using PCOR-SIMS^{SM}

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Introduction

The development and improvement of Ultra Low Energy (ULE) boron ion implantation is an area of intense interest as device dimensions continually shrink. Correct characterization of these implants requires accurate profile shape and accurate oxide layer thickness determination within the upper several nanometers of the wafer surface. PCOR- SIMS^{SM}* represents the latest improvements in ULE B characterization that incorporates point-by-point data corrections for all regions of the profile. This method avoids near-surface profile distortions introduced by the older oxygen flooding technique and yields the most accurate junction depth measurements due to accurate measurement of surface oxide thickness.

Discussion

One current method of forming ultra shallow junctions is low energy plasma implantation. Pulsing the sample bias at low voltage causes implantation of ions from the plasma. Figure 1 shows measurements of a series of 300eV BF3 implants, a net impact energy of 48.5eV per boron atom. Despite this extremely low impact energy, the profiles show a retrograde peak below the surface.

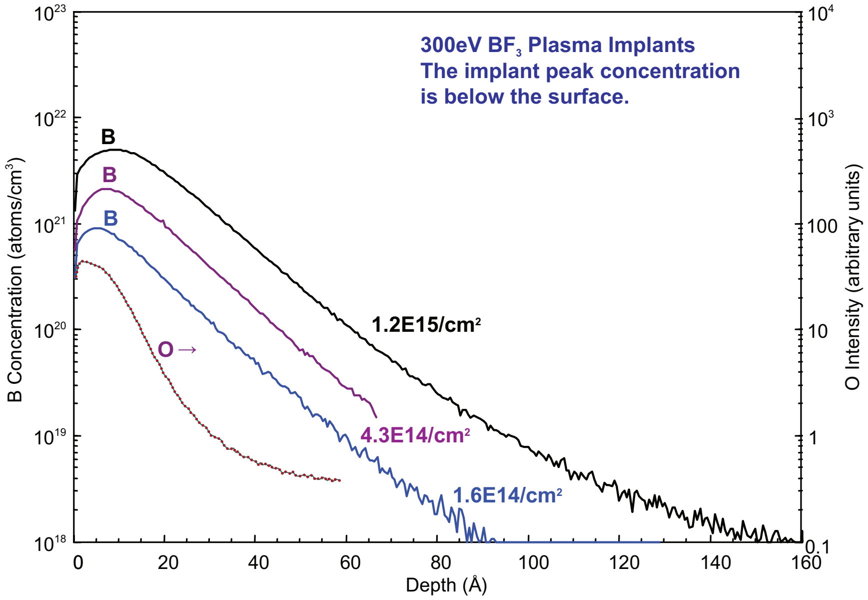

Figure 1. PCOR-SIMS^{SM} profiles of ULE B plasma implantation profiles. Boron concentrations are plotted relative to the left axis in atoms/cm^3 whereas the oxygen profile is plotted relative to the right axis in arbitrary units.

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* The new PCOR-SIMS^{SM} for ULE B protocol is the result of extensive development efforts by EAG. The "PCOR-SIMS^{SM}" name describes, in part, EAG's proprietary methodology that includes point-to-point correction resulting in the most accurate SIMS profiling yet for ultra shallow implants.

Note that due to the very low implant energy, boron peak concentrations are extremely high near the surface. We have studied the effect of this high B concentration on the SIMS calibration and incorporated corrections for both concentration and depth scale into the PCOR-SIMS^{SM} protocol. In this case a point-by-point correction is essential because of the continuously changing boron concentrations near the surface. To evaluate the accuracy of SIMS analysis, a set of 14 B plasma implanted Si samples was analyzed with 3 separate protocols. The same sample set was also measured by Nuclear Reaction Analysis (NRA) at two different independent laboratories. Figure 2 shows the doses obtained from the SIMS measurements in comparison to NRA measurements of the same samples. The excellent correlation up to concentrations of 2.5x10^{22} atoms/cm^3 (almost 50 atom% boron) shows that PCOR-SIMS^{SM} correctly accounts for changes caused by high B concentrations commonly observed in plasma implants. Also note the improved dose correlation for PCOR-SIMS^{SM} when compared to older SIMS protocols using oxygen leak.

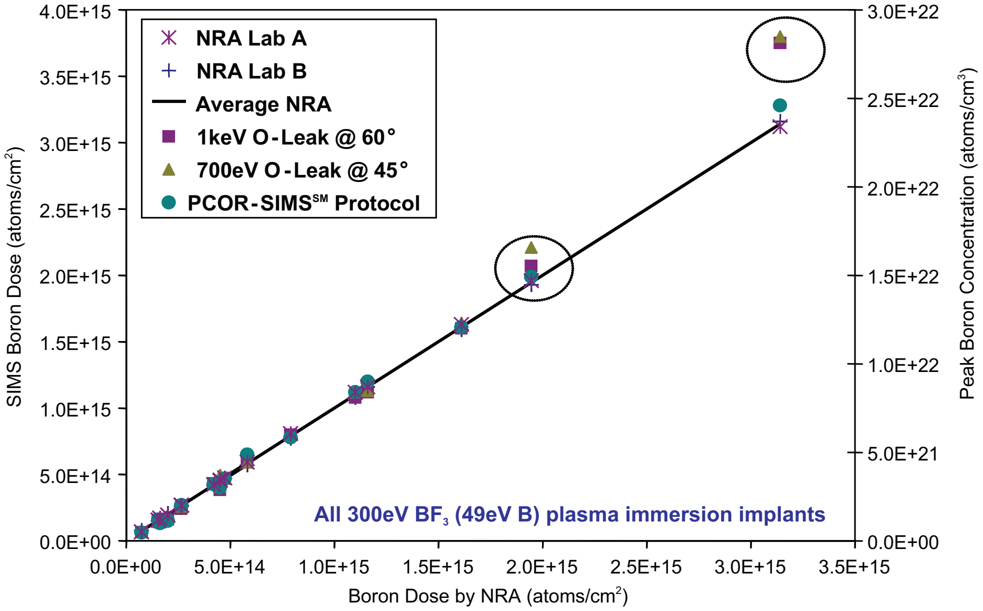

Figure 2. Comparisons of B doses measured from 14 plasma implanted Si samples by PCOR-SIMS^{SM} and by NRA