SIMS MEASUREMENT of OXYGEN in FZ-SILICON

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In order to detect O at levels relevant to diffusion into FZ Si, it was necessary to employ Si$^{18}$O$_2$ as a source; [Mikkelsen, 1986]

Our first results in ROSE using 16O; note decreasing concentration at surface
To check correctness of the profiles, one analysis was done until perforation of the wafer.

Oxygen depth profiles for FZ-Si wafers annealed at 1150 °C for: (1) – 16 hrs, (2) – 72 hrs, (3) – 6 hrs.

Immediate observations:

i – the profile1 is not symmetrical with respect to the mid-thickness as it should be since diffusion proceeds from both sides of the (oxidized) 280µm thick wafer.

ii – the O signal levels off at ~2*10^{16} i.e. well above the bkg; hence, direct background correction not feasible.

iii – the mean sputter rate differs markedly from that established at shallow depths from either stylus profilometry or the location of the implant maximum.
Calculated curves for diffusion into a slab

To verify the degree of reliability - a test epi-structure was manufactured for step-by-step measurement on beveled surface (top) or by standard profiling (bottom)
The loss of depth resolution is evident, also the removal rate is not constant; a polynomial fit was derived to enable corrections.

\[
Y = -0.398 - 0.085t - 1.71t^2 + 3.408t^3 - 2.632t^4
\]
Comparison of different results concerning deep O diffusion into FZ Si: (1) calculated, for D=2e-10, C₀=1.7e17, (2) line scan with bkg correction,; continuous profiling: (3) – this work, (4) - ref. [6]
Figure showing the origin of the observed „depletion“ at the surface: it takes place upon prolonged cooling and segregation back to the oxide.
CONCLUSIONS

When a dynamic range of at least two orders of magnitude is required over a depth exceeding 50-70 µm, the beveling of the sample followed by line-scan analysis is necessary.

For shallower [O] distributions, a continuous analysis can be applied; however, the variation of the sputter rate with depth should be taken into account.

When investigating deep diffusion together with the process of oxygen segregation at the SiO$_2$ – Si interface, both methods are recommended.