Reduction of Boride Enhanced Diffusion in Silicon by High Energy Si implantation*

L. Shao[1], P. E. Thompson[2], X. Wang[1], H. Chen[1], R. J. Bleiler[3], S. Baumann[3], J. Liu[1], and Wei-Kan Chu[1]

1. *Texas Center for Superconductivity and Dept. of Physics, University of Houston, Houston, Texas 77204*
2. *Code 6812, Naval Research Laboratory, Washington, DC 20375-5347*
3. *Evans Texas, 425 Round Rock West, Round Rock, TX 78681*

We demonstrated that implantation of MeV Si ions into a Si substrate can significantly reduce boride-enhanced diffusion associated with a high B concentration layer. Anomalous profile spreading caused by transient enhanced diffusion[1] (TED) and boride-enhanced diffusion[2] (BED) hampers the formation of ultra shallow p^+/n junctions for the next generation silicon technology. It has been demonstrated that BED exists in the proximity of a silicon layer containing a high concentration of B.[2] BED is attributed to a silicon boride phase which injects Si interstitials during annealing. it is extremely difficult to avoid the formation of the boride phase since a high boron concentration is needed in the processing of a ultra shallow p^+ layer.

Inspired by Venezia *et al*.[3] using a superlattice structure for diffusion studies, we used similar sample configurations. In this study, a molecular-beam-epitaxy grown Si layer with a B concentration of $10^{21}/cm^3$ over a 10 nm region capped with 100 nm Si was used as a source of boride-enhanced diffusion. A sequence of four B delta-doped layers with 100 nm Si spacers was grown prior to the source layer to monitor the diffusion. Half of the sample was implanted with 1 MeV Si ions at a dose of $10^{16}/cm^2$, followed by annealing at 800 ^oC, 900 ^oC and 1000 ^oC for different periods of time. For control samples without the MeV Si implant, boride-enhanced diffusion was observed while the MeV Si-implanted sample showed reduced diffusion, with boride-enhanced diffusion completely suppressed at 900 ^oC.

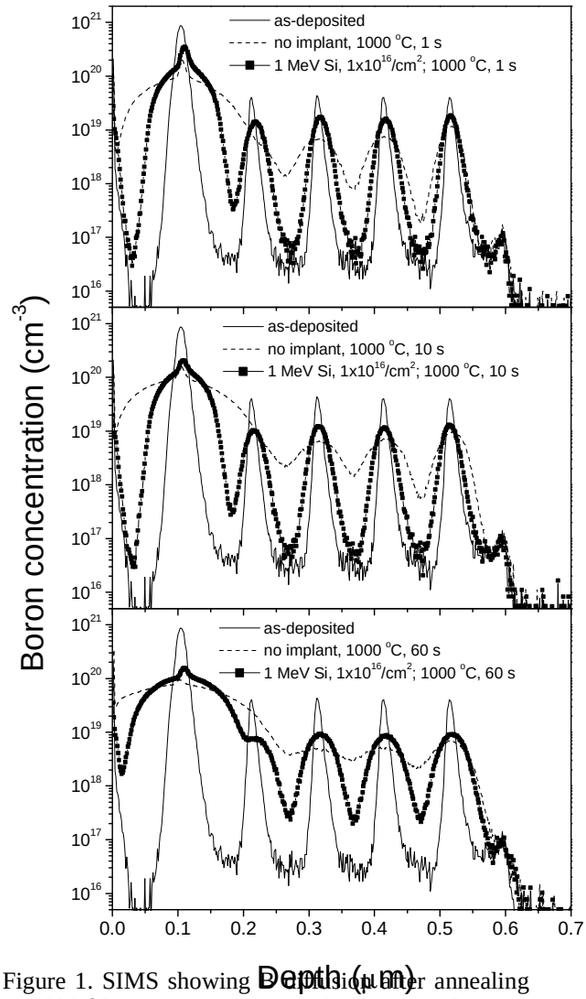

Figure 1. SIMS showing B diffusion after annealing at 1000 ^oC for periods of 1s, 10s and 60s. Samples with 1 MeV $10^{16}/cm^2$ Si^+ implant (the squares) show suppressed diffusions in comparison with non-implanted one (the dash lines).

References:

* Research supported in part by the state of Texas through the Texas Center for Superconductivity at the University of Houston, and by International SEMATECH.

1. W.K. Hofker, H.W. Werner, D.P. Oosthoek, and N.J. Koeman, Appl. Phys. Lett. 4, 125(1974).
2 Aditya Agarwal, H.-J. Gossmann, D.J. Eaglesham, S.B. Herner, A.T. Fiory, and T.E. Haynes, Appl. Phys. Lett 74, 2435(1999).
3 V. C. Venezia, T. E. Haynes, Aditya Agarwal, L. Pelaz, H.-J. Gossmann, D. C. Jacobson, and D. J. Eaglesham, Appl. Phys. Lett 74, 1299(1999).