Stability of ultra-shallow junction formed by 0.2 keV boron implantation and spike annealing*

Lin Shao[1] Joe Bennett[2], Larry Larsen[2], Xuemei Wang[1], Irene Rosokova[1], Jianyue Jing[3], Hui Chen[1], Jiarui Liu[1], and Wei-Kan Chu[1]

[1] *Texas Center for Superconductivity and Dept. of Physics, University of Houston, Houston, Texas 77204*
[2] *SEMATECH, Austin, Texas 78741*
[3] *Varian Semiconductor Equipment, MA 01930*

Stability of ultra shallow junctions formed by very low energy boron implant followed by spike annealing was investigated. Continued scaling of the Si device dimensions into the sub-100 nm dimensions requires ultra-shallow and highly doped junctions. In order to increase dopant concentration and minimize boron enhanced diffusion, advanced annealing techniques like spike annealing or impulse annealing currently gain the extensively interests.[1] Junctions formed by laser annealing have been shown intrinsically unstable.[2] However, stability of the junctions formed by spike annealing has not been reported previously. In this study, 0.2 keV B implanted silicon was thermally spiked annealed at temperature 1100 C. Samples were then furnace annealed under temperature between 550 and 750 ^{o}C. Secondary ion mass spectrometry measurement revealed the redistribution of boron during the followed furnace annealing. Such diffusion was transient with enhancement $10^{3}\times$ equilibrium at the early stage of annealing at the temperature as low as 700^{o}C.

The enhancement factor of 10^{3} is two orders larger than that of BED reported by Agarwal *et al.*,[3] but within reported range of TED.[1] It implies that the 0.2 keV-implanted samples have the source of excess interstitials from the ion implantation damage. The thermal budget of spike annealing at 1100 C for 0 or 1 second may not be enough to eliminate the TED sources. The diffusion enhancement is combined contribution from TED and BED, if not TED only.

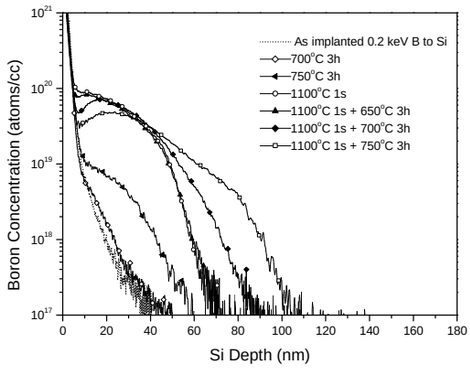

Figure 1. SIMS profile of boron in boron-implanted and annealed samples. After 0.2 keV boron implantation, half of the samples was spike annealed at 1100 ^{o}C for 1 sec, followed by furnace annealing at 600 ^{o}C, 700 ^{o}C or 750 ^{o}C for 3 h, respectively. Half of the samples without spike annealing was annealed at 700 ^{o}C or 750 ^{o}C for comparison.

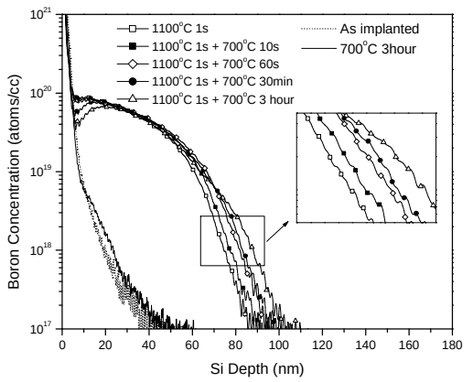

Figure 2. SIMS profiles of boron in as-implanted and annealed samples. After 0.2 keV boron implantation, samples was spike annealed at 1100 ^{o}C for 1 sec, followed by furnace annealing at 700 ^{o}C for 10 s, 60 s, 30 m, and 3 h, respectively. Sample annealed at 700 ^{o}C for 3 h without spike annealing was included for comparison.

References:

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