Ultra-Shallow Implant Anneal using Short Wavelength Flash Light Source

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For shallow junction implant anneal, rapid thermal annealing (RTA) has became a preferred method. A very short time annealing at higher temperature with a very fast ramp up/down rate ("spike anneal") has been introduced as an effective method for shallow junction implant annealing to electrically activate the implant species while minimizing diffusion. The annealing time is less than 1s. For ultra-shallow junction (USJ) formation, excimer laser-based annealing and non-filament based arc lamp RTA techniques are actively investigated. The response times for the excimer laser and arc lamp are in the range of ns and ms, respectively.
Since the size of boron (B) atom is small and diffuses faster in Si compared to other n-type dopants such as P and As atoms, proper boron implant anneal is critical for USJ formation. To form an effective USJ annealing strategy for maximum electrical activation with the least amount of dopant diffusion, it is necessary to understand the fundamentals of damage recovery, solid solubility of dopants, electrical activation and dopant diffusion during an implant annealing thermal cycle.

In this study, Si wafers implanted with $^{11}B^+$ (1keV, $1x10^{15}$ ions/cm^2)and $^{49}BF_2^+$ (3kev, $1x10^{15}$ ions/cm^2) with various implant energies and doses were annealed using a short wavelength flash light source. A xenon (Xe) arc lamp was used as a light source. The duration of flash exposure is controlled between 1ms and 10sec. Annealing characteristics of ultra-shallow $^{11}B^+$ and $^{49}BF_2^+$ implanted Si wafers were also investigated in terms of electrical activation and dopant redistribution after annealing. Sheet resistance of implanted wafers were measured after annealing under various flash annealing conditions. Change in depth profiles of implant species was investigated using secondary ion mass spectroscopy (SIMS).

Figure 1 shows the sheet resistance of $^{11}B^+$ and $^{49}BF_2^+$ implanted wafers as a function of junction depth x_j after annealing under various conditions using different annealing techniques. In the case of Xe arc lamp flash anneal, the sheet resistance of 250~350 ohm/sq. was achieved at a junction depth of 24 nm. No significant dopant diffusion was observed after the Xe arc lamp flash anneal. Details of experimental conditions and electrical activation mechanisms will be discussed at the conference.

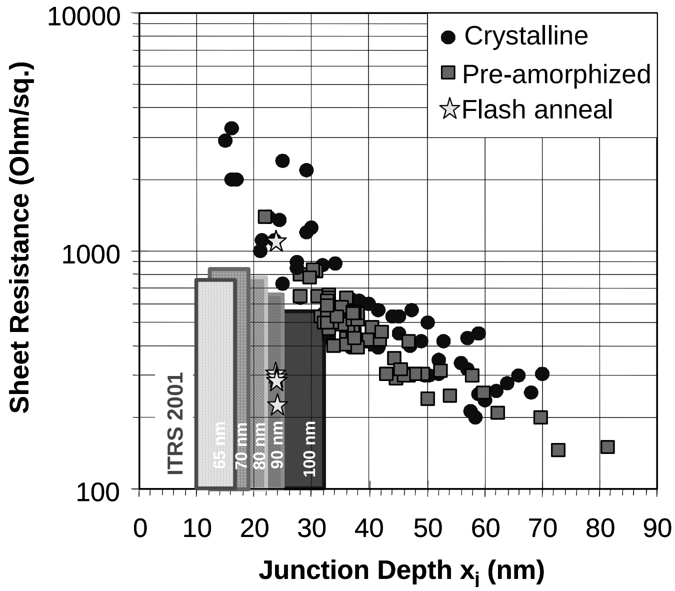

Fig. 1. Sheet resistance versus junction depth of $^{11}B^{+}$ and $^{49}BF_2^{+}$ implanted wafers after annealing under various conditions using various annealing techniques.