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Boron diffusion in High Ge content SiGe alloys

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Large hole mobility enhancements in SiGe virtual substrates with Ge content varying from 50 to 100% have been reported [1, 2]. High Ge content SiGe virtual substrates are also acting as substrates for strained SiGe, and quite recently, the successful application of hi-κ dielectrics on pure Ge has lead to demonstration of Ge MOSFET technology [3, 4]. However, for better process optimization, understanding of dopant diffusion in these materials is required. Dopant diffusion data in high Ge content alloys as well as in pure Ge is almost scarce. Boron, an important p-type dopant, forms an exceptional case in the SiGe system with a diffusion behavior opposite to other dopants [5]. In this report, we present the results of a comprehensive investigation of B diffusion in high Ge content SiGe alloys.

Previous experiments on B diffusion in SiGe alloys (Ge content < 50%) have shown a retardation in B diffusion [6]. However, this behavior is unique for B since other dopants studied (P, As, Sb) show diffusion enhancements in SiGe alloys over Si [7, 8]. A recent investigation has shown that B diffusion in pure Ge is much slower than reported in literature [5]. Motivated by this observation, we investigate B diffusion in 50, 65, 75 and 86% Ge content SiGe alloys.

The samples were grown using Low Energy Plasma Enhance Chemical Vapor Deposition (LEPECVD) using a grading technique (Fig. 1) and possess a low dislocation density (< 10^6 cm^{-2}). Two methods of dopant introduction (implantation and delta doped layers) have been employed. The preliminary results using implantation (shown in Fig.2) indicate that B diffusion in SiGe starts to increase above 50% Ge content and slowly approaches a value calculated for pure Ge in a recent investigation. The study is extended for delta doped layers and over a temperature range to understand more clearly the diffusion behavior over the whole alloys spectrum.

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References

[1] J. Jongwan et al., IEEE EDL, **24**, 460, 2003
[2] M. L. Lee, *et al* Appl. Phys. Lett., **79,** 3334, 2001.
[3] A. Ritenour et al., IEDM 2003, to be published
[4] C. O. Chui et al. IEDM 2003, to be published
[5] S. Uppal, et al Submitted to J. Appl. Phys.
[6] P. Kuo, et al. proc. MRS, **395**, 373, 1995
[7] S. Eguchi et al., Appl. Phys. Lett. **80**, 1743, 2002
[8] A. N. Larsen et al. Appl. Phys. Lett., **68**, 2684, 1996

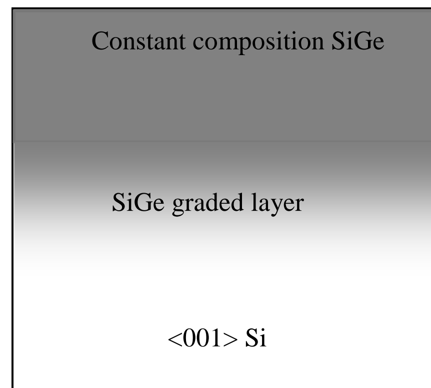

Figure 1: Sample structures: Relaxed SiGe layers are grown on Silicon substrate using LEPECVD at ~ 720 °C using a grading technique (7% per micron). A constant composition part of approximately 1 µm was finally grown which is either implanted or in-situ doped during growth for diffusion studies.

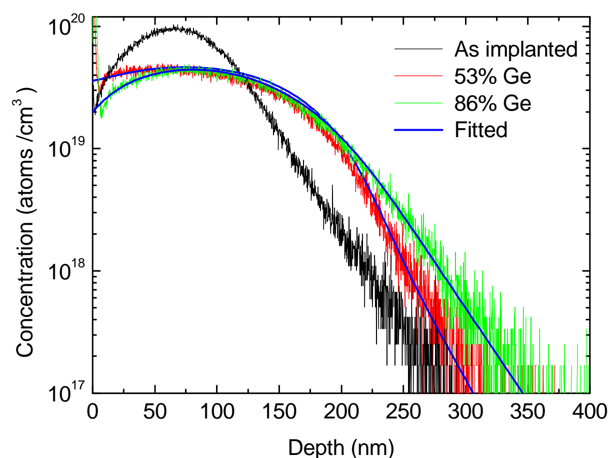

Figure 2: As-implanted and diffused (900 °C, 8 hrs, ampoule) boron concentration profile in relaxed SiGe. Enhancement with Ge content is visible but the increment in diffusivity is not substantial on going from 53 to 86% Ge. Fitting is achieved using SSUPREM.