Growth of Relaxed $Si_{1-X}Ge_X$ by Using Oxidation of $Si_{1-X}Ge_X$

B. G. Min[1], K. S. Jeon[1], Y. H. Pae[1], D. -H. Ko[1*],
M. –H. Cho[2], T. –W. Lee[3], D. –H. Ko[1]

[1]Department of Ceramic Engineering, Yonsei university, Seoul, Korea
[2]Korea Research Institute of Standard and Science, Daejeon, Korea
[3]Jusung Eng. Co. Ltd., Kyunggi-Do, Korea

Many works about semiconductor have been interest in enhancement of carrier mobility in resent years. Because it can be a solution of the problem happening when high-k dielectrics are used for gate oxide. The most usual method to enhance carrier mobility is forming tensile stress at channel by growing Si on relaxed $Si_{1-X}Ge_X$ substrate. The lattice parameter of $Si_{1-X}Ge_X$ can be changed with Ge contents along Vegard's law because $Si_{1-X}Ge_X$ is absolute solid solution of Si and Ge. Therefore, we can control the tensile stress formed at channel with Ge contents of relaxed $Si_{1-X}Ge_X$ substrate. Such relaxed $Si_{1-X}Ge_X$ is made by growing it over critical thickness with increasing Ge contents. But this method has problems that are generating defects and surface roughening. So many studies about making relaxed $Si_{1-X}Ge_X$ have pointed out to solve it.

In this work, we study the growth of relaxed $Si_{1-X}Ge_X$ by using oxidation of $Si_{1-X}Ge_X$. According to previous works, it is reported that dry oxidation of $Si_{1-X}Ge_X$ is the reaction only between oxygen and silicon. Thus, oxide is consisted of only SiO□and germanium which is not used in the reaction piles up at the interface between oxide and $Si_{1-X}Ge_X$ substrate. It can be used a relaxed substrate. Because this thin layer is relaxed during oxidation.

Strained $Si_{1-X}Ge_X$ was grown on Si(001) wafer by using ultra high vaccum chemical vapor deposition. After than, Ge rich layer was formed by dry oxidation at 800°C and wet etching using 10% HF. We grew $Si_{1-X}Ge_X$ again on this layer to estimate the properties of it easly. Because the layer whose thickness is 5~10nm is hard to observe the properties. As a result, We observed that grown $Si_{1-X}Ge_X$ on pile up layer was relaxed (Fig. 1,2) and improvement of surface roughening (Fig. 3.) when using oxidation.

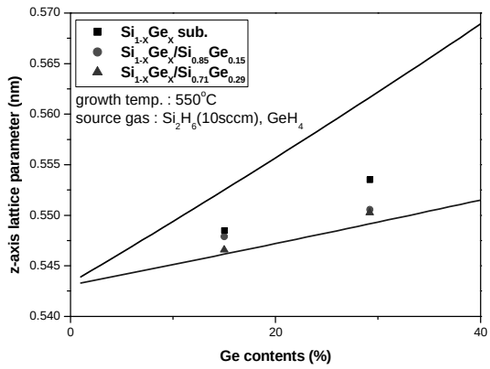

Figure 1. Comparison of lattice parameter of z axis with Ge contents in $Si_{1-X}Ge_X$ substrate.

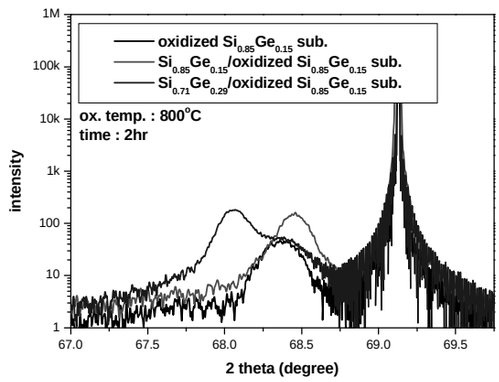

Figure 2. Comparison of XRD spectrum of $Si_{1-X}Ge_X$ grown on Ge rich layer with Ge contents

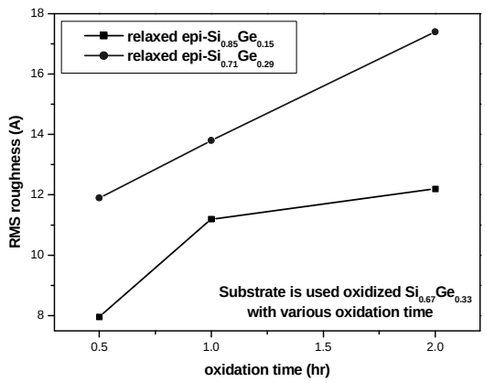

Figure 3. Comparison of surface roughness of relaxed $Si_{1-X}Ge_X$ with oxidation time and Ge contents of $Si_{1-X}Ge_X$ substrate