A study on selective $Si_{0.8}Ge_{0.2}$ etch using polysilicon etchant diluted by H_2O for three-dimensional Si structure application

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Abstract

To overcome the difficulties of transistor scaling, three-dimensional structures like silicon on nothing (SON) or gate all around (GAA) structure using SiGe have been investigated[1-2]. For the implementation of these structures, c-SiGe etch techniques with high selectivity to c-Si are required. As one of the approaches, we performed the wet-etch experiments using polysilicon etchant for the samples with epitaxially grown c-Si and c-SiGe layers on silicon substrate.

In $Si_{0.8}Ge_{0.2}$ wet etch, we diluted polysilicon etchant, which is composed of 40:1:2:57, HNO_3 (70%):HF (49%):CH_3COOH (99.9%):H_2O, with H_2O to control etch rate and selectivity. Figs. 1 and 2 show the etch rate and the selectivity depending on diluent H_2O volume, varied from 0 to 5 volumes, with the polysilicon etchant held constant at 10 volumes, respectively. Figs. 3 (a) and (b) show the scanning electron microscope (SEM) images for the samples etched in low and high H_2O volumes. As shown in the figures, as the H_2O volume was increased, the excellent etch condition with low etch rate and high selectivity was obtained. It was thought that H_2O didn't affect the increase of selectivity directly and that the decrease of HNO_3 volume due to H_2O dilution mainly caused those effects as pointed by the previous researchers[3-5].

Conclusively, using the optimized condition, we could successfully etch single crystalline $Si_{0.8}Ge_{0.2}$ layers with the selectivity higher than 300:1 and easily obtain a SON structure as shown in Fig. 4. The newly developed etch condition for $Si_{0.8}Ge_{0.2}$ are very useful to the fabrication of three-dimensional FET or the similar structure to silicon on insulator (SOI).

References

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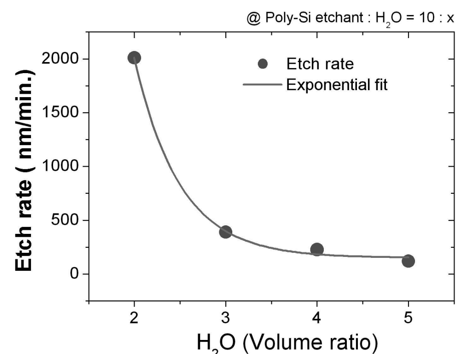

Fig. 1. The changes of etch rate depending on H_2O volume.

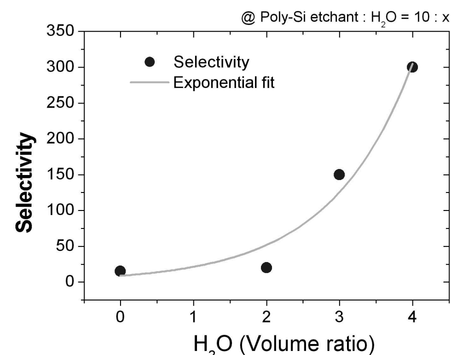

Fig. 2. The changes of selectivity depending on H_2O volume.

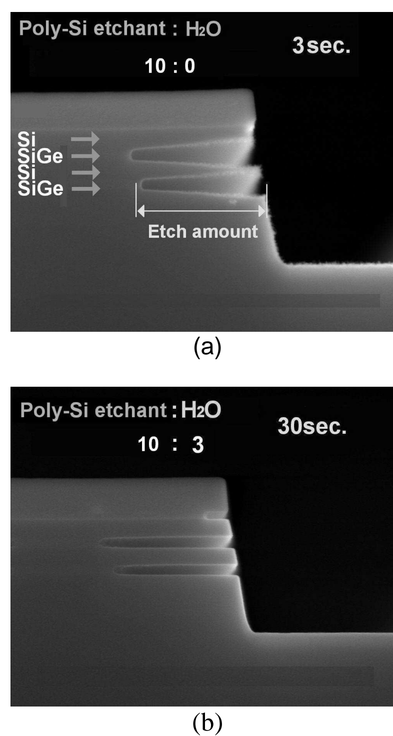

Fig. 3. The cross sectional views of (a) the sample etched with the polysilicon etchant (b) the sample etched with the newly developed $Si_{0.8}Ge_{0.2}$ etchant with high selectivity.

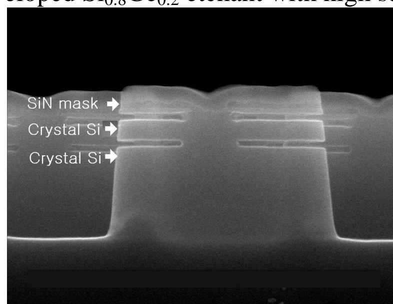

Fig. 4. The SON structure fabricated by using the newly developed $Si_{0.8}Ge_{0.2}$ etchant with high selectivity.