Realization of UTB-SGOI with tensile strain through hetero-layer transfer technique

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1. Introduction

Strained $Si_{1-x}Ge_x$ alloy with high Ge fractions is promising for replacing Si channel in the present CMOS technology owing to the increased carrier mobility for both electrons and holes.[1] It is of interest to combine the advantages of Si-on-insulator (SOI) technology and SiGe technology to realize ultra thin body (UTB) SiGe-on-insulator (SGOI) substrates.

2. Experimental procedure

Fig. 1 is a schematic flow for fabricating tensile strain UTB-SGOI substrate by hetero-layer transfer technology. The epitaxial strained SiGe/Ge/AlAs/GaAs heterostructure was grown by low-pressure CVD as a donor wafer. After ALD Al_2O_3 deposition, the wafer was patterned into stripe shapes by RIE. Subsequently, the bonding with SiO_2/Si host substrate was performed in the press machine under vacuum. To release GaAs wafer, the AlAs layer was laterally etched by HCl solution at room temperature. Finally, the top Ge layer was selectively etched in HCl/H_2O_2 solution to obtain SGOI structure. To characterize the quality of transferred SiGe layer, micro Raman spectroscopy with the 488 nm lasers was used.

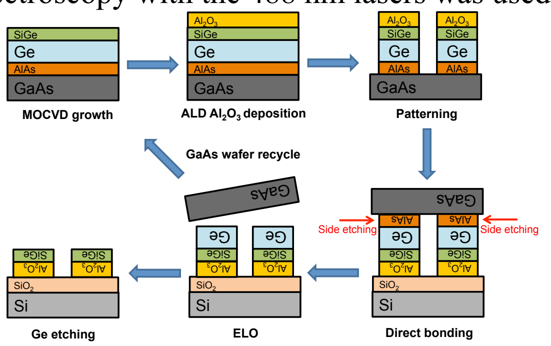

Fig. 1 Schematic flow of ELO process for fabricating tensile strain UTB-SGOI substrate.

3. Results and discussions

Fig. 2 shows the Raman spectra of (a) the as-grown SiGe/Ge/AlAs/GaAs heterostructure, (b) the epitaxial SiGe layers after RIE and (c) the layer-transferred SiGe. The domain peak at 288 cm^{-1} and 399 cm^{-1} corresponds to the Ge-Ge and Si-Ge phonon band from the SiGe layer, respectively. Aside from the main peaks, the additional phonon peak observed at 300 cm^{-1} is associated with Ge-Ge modes of the underlying relaxed Ge layer. It is observed that the relaxed Ge-Ge peak vanished in the fabricated SGOI substrate, indicating the top Ge layer has been completely removed by the etching process.

Based on the relationship between Ge content and strain distribution,[2] Ge fraction of 67% with +1% partially tensile strain was extracted from the fabricated SGOI substrate. The Raman peak positions of Ge-Ge and Si-Ge modes from the SiGe layer remained almost the same after etching and layer-transfer process as shown in Fig. 2. Than, high quality UTB-SiGe layers have been successfully transferred onto Si host substrate without strain degradation, which is very encouraging for further device fabrication using strain engineering.

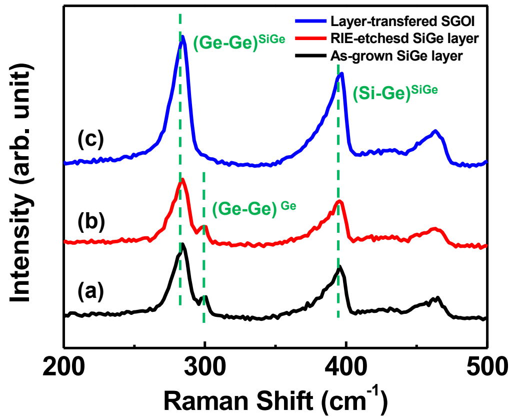

Fig. 2 Raman spectra of three different SiGe layers: (a) as-grown SiGe, (b) RIE-etched SiGe and (c) layer-transferred SiGe, respectively.

4. Conclusion

UTB-SiGe layer with Ge fraction of 67% has been successfully transferred onto the host substrate while maintaining +1% tensile strain by hetero-layer transfer technique. The smooth and flat UTB-SGOI is a good platform for fabricating SiGe MOS devices with enhanced carrier mobility.

References

[1] M. L. Lee et al., *J. Appl. Phys.* **97**, 011101 (2005).
[2] F. Pezzoli et al., *J. Appl. Phys.* **103**, 093521 (2008).