Structural Evolution of GeSn Thin-Film on Silicon Under Microwave Annealing

Yue-Tong Jheng[1] and Guo-En Chang[1,*]

[1]Department of Mechanical Engineering and Advanced Institute of Manufacturing with High-Tech Innovations (AIM-HI), National Chung Cheng University, Taiwan

E-mail: imegec@ccu.edu.tw

Recently, Group-IV GeSn alloys have been regarded as a promising candidate for efficient light emitters on silicon for silicon photonics, due to their ability to transition to a direct bandgap with the introduction of a sufficient amount of tin (Sn) content into germanium (Ge). However, the lattice mismatch and the strain relaxation in the GeSn layers are significantly affect the material quality. Thermal annealing has been reported to improve the material quality. Here, we present results on the effects of low thermal budget microwave annealing (MWA) at different powers on the structural and optical properties of GeSn alloys.

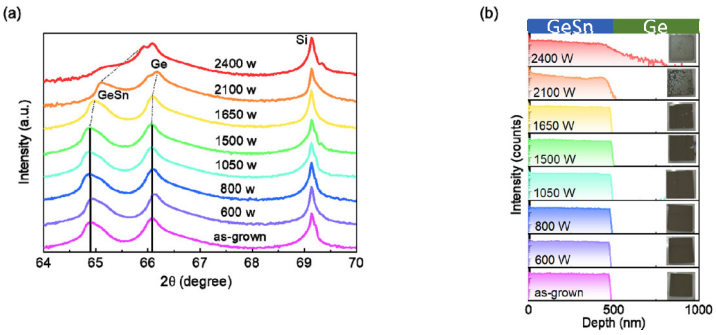

Figure 1. (a) X-ray diffraction ω-2θ for annealed GeSn samples (b) SIMS atomic distribution of Sn atoms and optical images for the annealed GeSn samples.

The sample used in this study was deposited on a Si substrate using a reduced-pressure chemical vapor deposition (RPCVD). To reduce the lattice mismatch between the GeSn layer and the Si substrate, a 640 nm Ge buffer layer was grown first. Then, a 500 nm GeSn layer was grown at a low temperature to prevent Sn segregation. Figure 1(a) displays three distinct peaks can be assigned to the Si substrate, Ge buffer layer, and the GeSn active layer. The Ge and GeSn peaks remain almost unchanged up to MWA power of 1500 W. However, the GeSn diffraction peaks shift to larger angles and the GeSn peak at MWA powers above 1650 W, indicating strain relaxation or reduction of Sn content in the GeSn layer. Figure 1(b) shows the SIMS atomic distribution of the Sn atoms and the optical images. The SIMS results reveal a reduced intensity of the Sn signal in the GeSn layer, with the reduction being closer to the Ge layer at MWA power above 2100 W. The observation of white spots on the sample surface suggests Sn segregation to the surface.

Acknowledgment

This work at CCU was supported by Ministry of Science and Technology of Taiwan under the Grant Nos. MOST 111-2636-E-194 -002., MOST 112-2636-E-194 -001, and MOST 113-2636-E-194 -001.