AN 408
High Depth Resolution SIMS of Strained Si in Si/SiGe

May 7, 2007 (Version 3.0)

Discussion

The outdiffusion of Ge from the SiGe underlayer into the thin Si cap layer in Strained Si/SiGe material systems can greatly affect the mobility of carriers in the Si channel. This outdiffusion can be affected by epi growth temperature and rate, as well as point defects introduced by ion implantation processes and annealing in different ambients.

The Si cap layer is very thin, on the order of 10 nm, and the lattice-mismatch induced undulations (cross-hatch pattern) can be significant, so that the required depth resolution information of the Ge outdiffusion is very challenging.

Ultra low energy (ULE) SIMS was used to profile Strained Si wafers with and without chemical mechanical polishing (CMP). Without CMP, the roughness features can vary up to the thickness of the Strained Si cap layer, which may affect the SIMS depth resolution. ULE SIMS profiles were acquired on both wafers with similar results of ~8Å/decade depth resolution (Figure 1). Subsequently, AFM was used to profile the SIMS craters and shows that the surface topography was maintained throughout the sputtering process (Figures 2 and 3). Furthermore, it is believed that the similarity of the SIMS results is due to the epitaxial growth of the Si cap layer, and the layer by layer erosion of the ULE SIMS sputtering process. These results show that conformal nature of the Si cap layer with the SiGe substrate allows for excellent SIMS data quality regardless of the surface roughness for Strained Si systems.

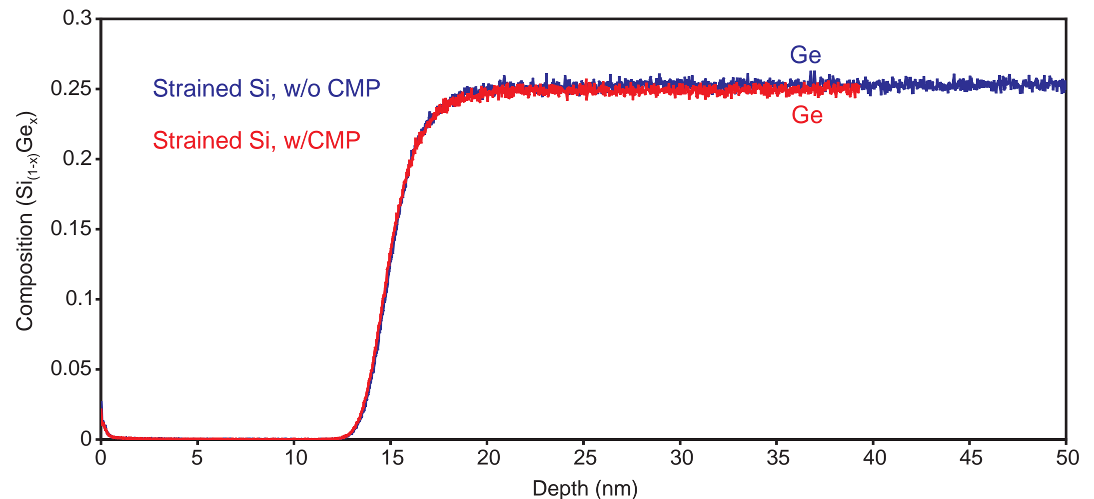

Figure 1. 500eV ULE SIMS Data

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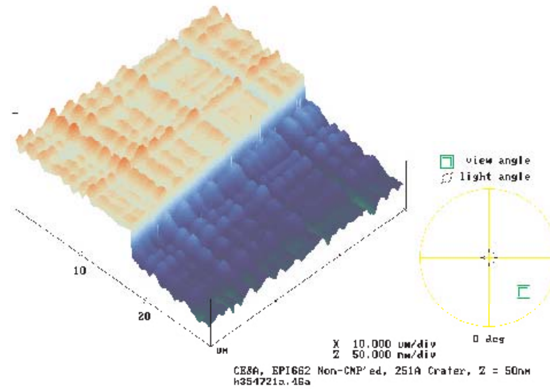
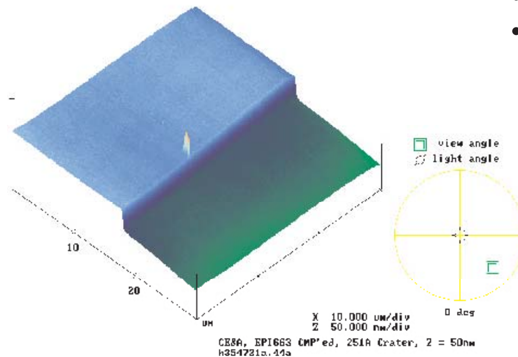


- Crater Depth = 25.1nm
- Surface RMS = 3.56nm
- Crater Bottom RMS = 3.49nm

Figure 2. AFM Data from Sample w/o CMP



- Crater Depth = 25.1nm
- Surface RMS = 0.85nm
- Crater Bottom RMS = 0.83nm

Figure 3. AFM Data from Sample w/ CMP

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