Single-Wavelength Photoreflectance Characterization of Strain Relaxation in Silicon on Silicon-Germanium

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ABSTRACT

Photoreflectance (PR) provides an optical means for the measurement of electronic properties of semiconductor nanostructures. Single wavelength PR has been suggested for process control measurements of strain and active dopant in silicon IC manufacturing provided a suitable wavelength probe beam is chosen [1]. Recently, such an approach has been established effective for characterization of milli-second anneal processes used in ultra-shallow junction formation [2]. This paper reports the use of single wavelength PR to characterize strain in silicon on silicon-germanium films. Silicon films of thicknesses ~1.5 to ~17.5 nm were deposited on graded silicon-germanium layers formed by chemical vapor deposition (CVD). The silicon film thicknesses were designed to achieve a progression of physical strain values, ranging from fully strained for the thinner films to fully relaxed for the thicker films. Reference metrology was performed using x-ray diffraction (XRD), Raman spectroscopy, and spectroscopic ellipsometry (SE). Methods to calibrate PR signals to physical strain in strained silicon on silicon-germanium layers are detailed. Single wavelength PR is shown to exhibit excellent sensitivity to physical strain in silicon on silicon germanium films.

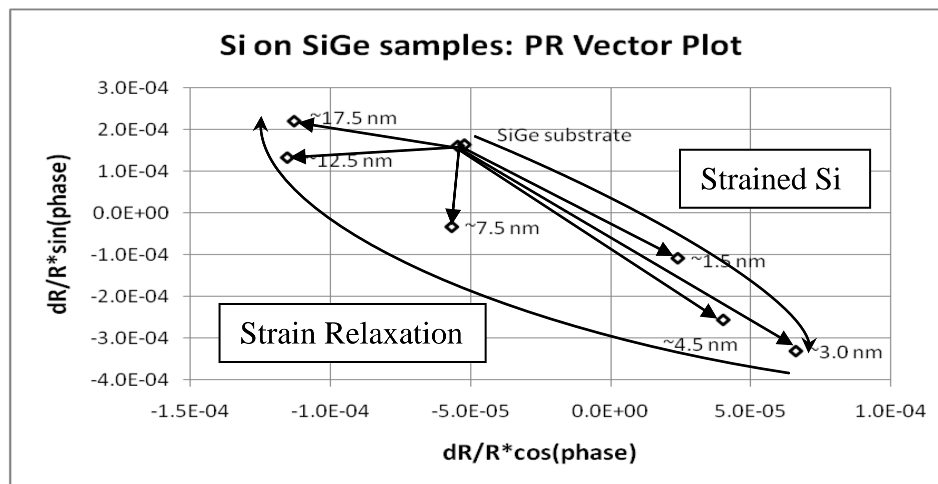

FIGURE 1. Measured photoreflectance vector for silicon films on silicon-germanium. Si film thickness is indicated for each film.

REFERENCES

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2. W. Chism, M. Current, and V. Vartanian, *J. Vac. Sci. Technol. B* **28(1)**, C1C15-C1C20 (2010).