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

Will Chism[1], Victor Vartanian[2], and Michael Current[3]

[1]*Xitronix Corporation, 3925 W. Braker Lane, Third Floor, Austin TX, 78759*
[2]*International SEMATECH Manufacturing Initiative, 257 Fuller Road, Ste. 2200, Albany NY 12203*
[3]*Current Scientific, 1729 Comstock Way, San Jose, CA 95124*

ABSTRACT

Photoreflectance (PR) provides an optical means to measure the electronic properties of semiconductor nanostructures. Single wavelength PR has been suggested for process control measurements of strain and active dopants in silicon IC manufacturing if a probe beam with a suitable wavelength is chosen [1]. Recently, such an approach has proven effective for characterizing 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 ~1.5 to ~17.5 nm thick 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 thinner films to fully relaxed for 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.

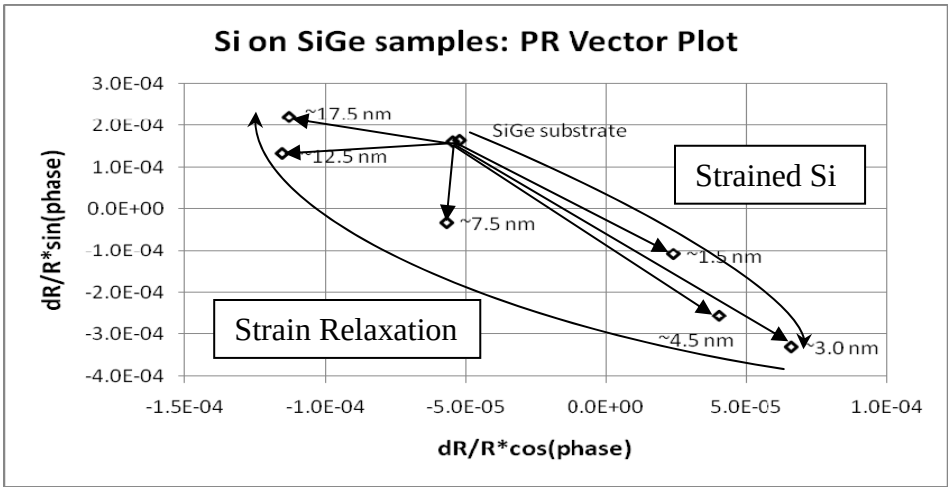

FIGURE 1. Measured photoreflectance vector for silicon films on silicon-germanium. Si thickness is indicated for each film.

REFERENCES

1. W. Chism *et al*., in *Frontiers of Characterization and Metrology for Nanoelectronics: 2007,* edited by D.G. Seiler *et al.*, AIP Proc. 931 (2007), pp. 64-68.
2. W. Chism, M. Current, and V. Vartanian, *J. Vac. Sci. Technol. B* **28(1)**, C1C15-C1C20 (2010).