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UV Photoreflectance Characterization of Strain Relaxation in Silicon on Silicon-Germanium

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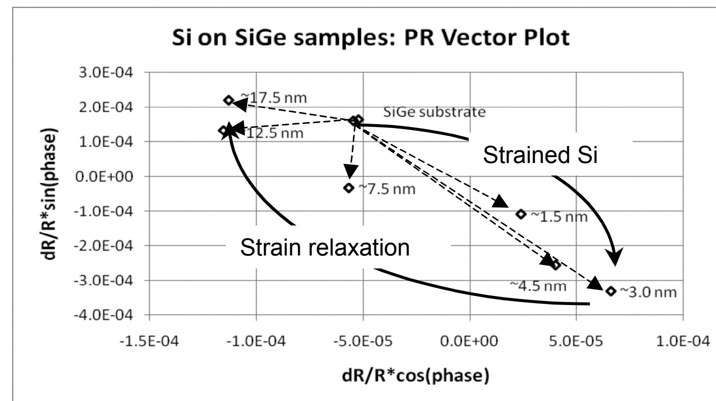
Photoreflectance (PR) measurements with ultraviolet probe beams provide sensitive measures of electrical effects within in semiconductor nanostructures, with numerous potential applications for in-line process control of strain and active dopants in advanced IC devices [1]. At the last Insight meeting, uv-PR methods were used to characterize ultra-shallow junctions activated by milli-second timescale, flash-lamp anneals [2].

This study reports the use of uv-PR to characterize strain relaxation in Si layers grown on graded SiGe multi-layers. The PR probe beam wavelength was selected nearby the Si “E1” direct interband transition (~375 nm) in order to detect the change of the PR response with strain. Si layers of thickness 1.5 to 17.5 nm were grown by CVD techniques on graded SiGe layers capped with a partially relaxed SiGe top layer with a Ge content of 20%. The range of top Si layer thickness was designed to transition from strained (for the thinner layers) to fully relaxed for the thicker layers. In addition to uv-PR measurements, reference metrology was used with x-ray diffraction (XRD), Raman spectroscopy and spectroscopic ellipsometry (SE). Methods to calibrate PR signals with residual strain in Si on SiGe layers are detailed.



Measured photoreflectance vectors for Si films on relaxed SiGe layers.
Si film thickness is indicated for each film.

References:

1. W. Chism et al., in *Frontiers of Characterization and Metrology for Nanoelectronics: 2007*, eds. D.G. Seiler et al., AIP Proc 931 (2007) 64-68.
2. W. Chism et al., Insight09 and J. Vac. Sci. Technol. B28(1) (2010) C1C15-C1C20.

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