Metrological Raman shift calibration for strain quantification in semiconductor

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Abstract

Semiconductor industries producing innovative materials and devices face the urgent need for strain quantification methods. To ensure the reliability of the fabrication process and in R&D, standardized metrological assessment of strain quantification is crucial to be introduced within the production line. Micro-Raman spectroscopy is one of the established spectroscopic methods for measuring local mechanical stress and strain distribution. Probing the lateral crystal morphology and strain in materials (e.g., 2D materials like graphene and MoS_2, SiGe for FET applications, GaN pillars for LEDs) is non-destructive. It can be carried out without laborious sample preparation [1-4]. Furthermore, the mapping of strain in semiconductor epilayers and large-area devices is easily achieved with a lateral resolution better than 500 nm.

For the precise Raman spectroscopic quantification of strain in semiconductor materials (e.g., SiGe), a calibrated Raman spectrometer is a fundamental requirement. Raman peak positions can rapidly shift during measurements due to changes in environmental conditions or wavelength instabilities of the excitation laser, potentially distorting the strain quantification. Drawing inspiration from Itoh et al.'s bracketing method [5], we have developed an advanced Raman calibration technique. This method allows for a similar approach using solid-state lasers. By continuously monitoring the excitation laser's wavelength, we can detect and correct wavelength changes, thereby estimating the measurement uncertainty of strain quantification in SiGe.

References

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