NANOSCALE STRAIN CHARACTERIZATION IN MICROELECTRONIC MATERIALS USING X-RAY DIFFRACTION

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The engineering of strained semiconductor materials represents an important aspect of the enhancement in CMOS device performance required for current and future generations of microelectronic technology. An understanding of the mechanical response of the Si channel regions and their environment is key to the prediction and design of device operation. Because of the complexity of the composite geometries associated with microelectronic circuitry, *in-situ* characterization at a submicron resolution is necessary to verify the predicted strain distributions. After a brief survey of measurement techniques commonly used for strain characterization, examples of synchrotron-based x-ray microbeam diffraction will be presented. Applications include the mapping of strain distributions in silicon-on-insulator (SOI) features induced by overlying silicon nitride structures and embedded heteroepitaxial features. Interaction regions of the SOI strain are typically observed to extend large distances from the SOI / stressor interfaces, leading to significant overlap in the strain distributions at technically relevant dimensions. Experimental data is also compared to several mechanical models to assess their validity in predicting these strain distributions. The issues associated with extending x-ray diffraction to the nanoscale will be discussed along with recent measurements conducted on SOI device channel regions.