ABSTRACT:

Automating 4D-STEM for Fast and Accurate Strain Mapping

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The importance of scanning transmission electron microscopy (STEM) in process development and failure analysis of semiconductor devices has been growing since the introduction of advanced technology nodes, in which the deposited layers and dimensions of transistors became much smaller and more complex. Especially, achieving the demanded performance improvements has been driven by facilitating faster electron transfer in the silicon channel using engineered Si-Ge stressors [1] and complemented with increasing the density of the active elements and cutting the signal path in the FinFET and NS GAA technology nodes.
The development of hybrid-pixel direct electron detectors with very fast readout speed and high dynamic range [2] have enabled measurements of strain at the nanoscale by scanning transmission electron diffraction mapping (4D-STEM). This technique has therefore become crucial for validating theoretical models in the development of new and improved transistors [3]. Full integration and automation of electron beam precession in analytical STEM microscopes [4] have provided very precise alignments of the microscope optics that enables accurate strain analysis by 4D-STEM at the sufficiently high spatial resolution even for the latest and future technology nodes, while maintaining the advantages of fast analysis of large regions of interest (transistor circuits) in contrast to the emerging alternative approaches [5]. Moreover, implementation of full automation and streamlined workflows for strain analysis has enabled such advanced 4D-STEM measurements to be done routinely by regular TEM operators in semiconductor labs [4].

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