Local strains in silicon structures

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The continuous scaling down in dimensions of electron devices has brought the issue of mechanical stresses at the forefront. Indeed bringing together materials with different thermal and mechanical properties at scales of few tens of nanometers result in extremely large and inhomogeneous stress fields. Although stresses can induce defects and impede the proper functioning of devices they can also be used to optimize the mobility of charge carriers. Measuring strain fields at the scale required by today's microelectronics, i.e. within transistor channels which are of the order of 45 nm, remain a great challenge. X-ray diffraction has a distinct advantage with respect to electron microscopy: it is basically non destructive. On the other hand the size of x-ray beams is still far behind the one of electron beams. Spatial resolutions of a few nms can therefore only be achieved via measurements in Fourier space. I will show a number of examples [1,2] where reciprocal space maps performed on various arrays (lines, trenches, …) can yield detailed information on the local strain field. Comparison with mechanical modelling allows sometimes for a full validation of the strain in these structures. Direct inversion is a very promising avenue [3] since it allows for a direct determination of the displacement field without any *a priori* mechanical model.

[1] M. Gailhanou, A. Loubens, J-S. Micha, B. Charlet, A. Minkevich, R. Fortunier, O. Thomas, Strain Field in Silicon On Insulator lines using High Resolution X-Ray Diffraction, Appl. Phys. Lett., **90**, 111914 (2007).

[2] M. Eberlein, S. Escoubas, M. Gailhanou, O. Thomas, J-S Micha, P. Rohr, R. Coppard, Investigation by High Resolution X-ray Diffraction of the local strains induced in Si by periodic arrays of oxide filled trenches, Phys. Stat. Sol. (a) **204**, 2542 (2007).

[3] A. Minkevich , M. Gailhanou, J-S. Micha, B. Charlet, V. Chamard, O. Thomas, Inversion of the diffraction pattern from an inhomogeneously strained crystal using an iterative algorithm, Phys. Rev. B **76**, 104106 (2007).