Measuring crystals strain in the TEM: techniques and accuracy

R. Balboni[1], M. Ferroni[1,2], F. Liscio[1].

[1]CNR-IMM, via Gobetti 101,40129 Bologna, Italy
[2]University of Brescia, Via Branze 43, 25123 Brescia, Italy

Despite the lengthy, generally difficult and destructive sample preparation, transmission electron microscopy (TEM) is however considered an attractive analytical tool, in addition to its imaging capabilities, when high spatial resolution is required. Several TEM methods to evaluates strain in crystalline structures were developed in the last decades and applied to different materials [1]. In this presentation a short overview of the most used TEM methods for the analysis and measurement of strain in crystalline materials is given, together with their application field, accuracy, sensitivity and limitations. Then we report on the application of three TEM techniques to strain measurements in in three different SiGe films, epitaxially grown on perfect Si substrates, with nominal Ge concentration and thicknesses of 10%/45 nm, 30%/29 nm and 40%/22 nm. The data were collected in the framework of the CHALLENGES project [2], financed by the EC (Grant Agreement n. 861857) and act as reference measurements, together with other standard analytical techniques, such as μRaman and x-ray diffraction (XRD). Convergent Beam Electron Diffraction (CBED), High Resolution Geometrical Phase Analysis (GPA) and selected area micro-diffraction (SAD) were used to measure the SiGe film strain with respect to the Si substrate. These methods, as all TEM ones, can be influenced by sample preparations and in these analyses possible strain relaxation should also be considered. It is shown that in case of large strain values, good accuracies can be obtained only when relatively thick TEM lamellae are measured.

[1] A. Béché, J. L. Rouvière, J.P.Barnes and D.Cooper, Ultramicroscopy 131, (2013) 10-23
[2] https://www.challenges2020.eu/