MS27-P05 | CORRELATION OF HIGH-RESOLUTION X-RAY DIFFRACTION WITH MECHANICAL EXPER-IMENTS AND FINITE ELEMENT ANALYSIS

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A concept for the investigation of mechanically loaded MEMS materials on an atomic level is introduced combining high-resolution X-ray diffraction (HRXRD) measurements with finite element analysis (FEA) and mechanical testing. In situ HRXRD measurements were performed on tensile loaded single crystal silicon (SCSi) specimens by means of profile scans and reciprocal space mapping (RSM) on symmetrical (004) and (440) reflections. A comprehensive evaluation of the rather complex X-ray diffraction and scattering features was enabled by the correlation of measured with simulated, 'theoretical', patterns. These simulated patterns were calculated by a specifically developed simple and fast approach based on continuum mechanical considerations [1]. Qualitative and quantitative analysis confirmed the admissibility and accuracy of the presented method. In this context, the [001] Poisson's ratio was determined providing an error of less than 1.5% with respect to the analytical prediction [2].

Consequently, the introduced procedure contributes to further going research of weak scattering being related to strain and defects in crystalline structures and therefore supports investigations on materials and devices failure mechanisms.

[1] "Where is the limit? Yield strength improvement in silicon micro-structures by surface treatments" A. Schifferle, T. Bandi, A. Neels, A. Dommann, Phys. Status Solidi A 213, 2016, 102–107.
[2] "In situ MEMS testing: correlation of high-resolution X-ray diffraction with mechanical experiments and finite element analysis" A. Schifferle, A. Dommann, A. Neels, Science and Technology of Advanced Materials (2017) 18(1), 219–230.