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Progress towards standardization of focused ion beam methods for micron-scale residual stress assessment on nano-structured materials and micro-devices

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Analysis and control of residual stresses in advanced engineering materials are important issues for reliability assessment at small scales, e.g. for micro-electromechanical systems (MEMS) and nano-crystalline and amorphous bulk and thin film materials. This presentation gives an overview of the recent advances in the field of sub-micron scale residual stress assessment by the use of focused ion beam (FIB)-controlled material removal techniques.

The two step method consists of incremental FIB ring-core milling combined with high-resolution in-situ SEM-FEG imaging of the relaxing surface and a full field strain analysis by digital image correlation (DIC). The through-thickness profile of the residual stress can be also obtained by comparison of the experimentally measured surface strain with finite element modelling using Schajer's integral method.

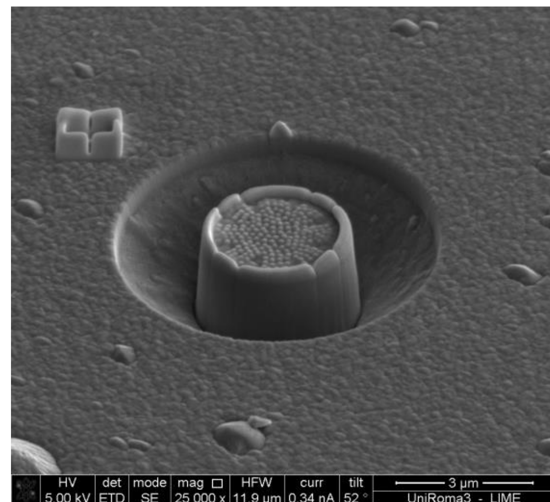

Fig.1 Example of a ring-core FIB-DIC experiment on a titanium nitride (TiN) thin film synthesized by physical vapour deposition

The **European project ISTRESS**, grant agreement n. 604646, is entirely focused on the standardization of the FIB-DIC methods for residual stress assessment at the micro and nano scales with efforts dedicated to the development of automated procedures for local residual stress analysis of (i) thin films, (ii) microelectronics devices and (iii) polycrystalline and amorphous bulk materials.

Practical applications from this project, including examples from the industry partners, and validation of the method on several systems are described and discussed. In particular, the issues of residual stress assessment on very thin films and micro-devices, stress depth profiling, stress measurement on amorphous materials and the effects of ion induced damage and elastic anisotropy on the relaxation strains are analysed.