An Oliver & Pharr Method for Lateral-Force Nanoindenters

Norbert Schwarzer
Peggy Heuer-Schwarzer
Nick Bierwisch

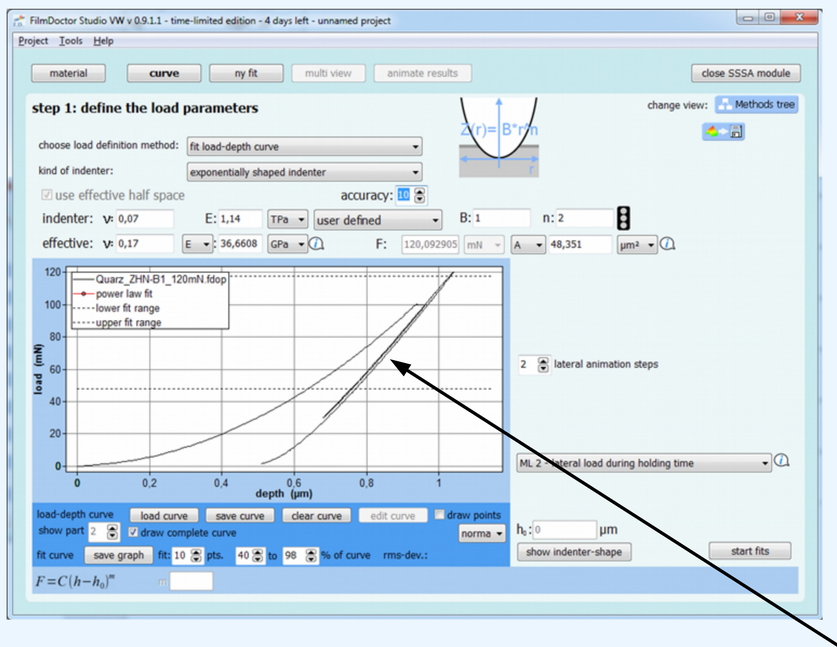
Sächsisches Institut für Oberflächenmechanik

Saxonian Institute of Surface Mechanics

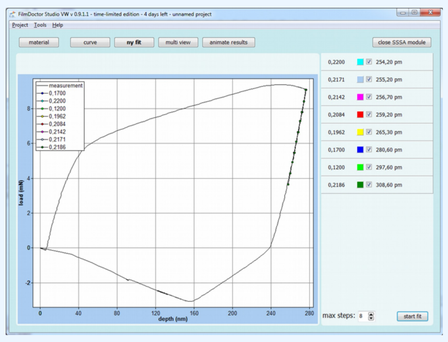
Abstract

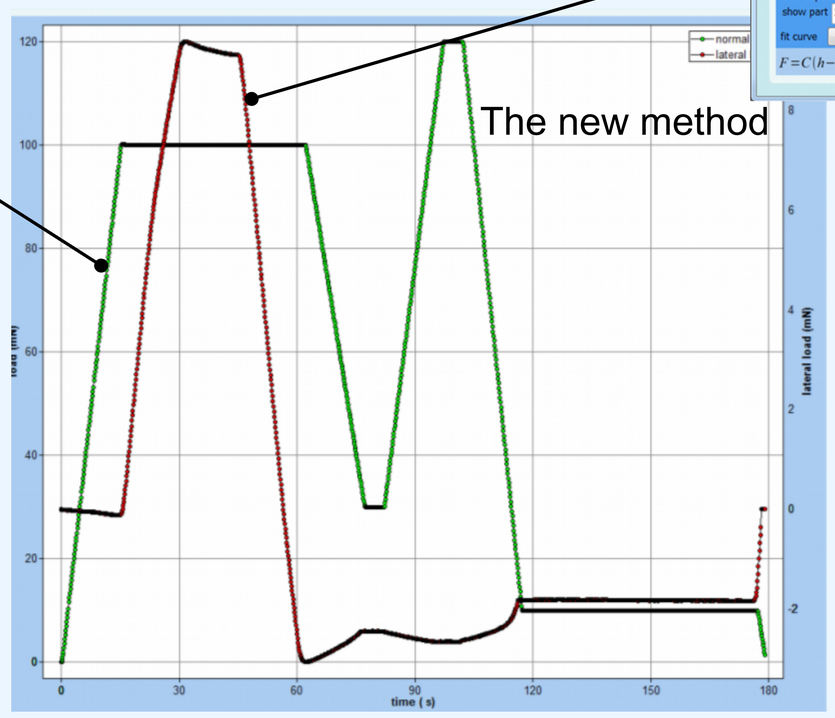
It is shown how the classical Oliver and Pharr method [1] has to be extended in order to make it fit for the performance and analysis of mixed loading nanoindentation tests. While the classical Oliver and Pharr method can only deal with pure normal loads and allows the extraction of hardness and Young's modulus for a given Poisson's ratio [1, 2, 3], the extended method principally allows for the simultaneous parameter identification of hardness, yields strength in two directions, Young's modulus and Poisson's ratio. Under proper experimental conditions, also the extraction of intrinsic stresses is possible. The authors present the method and the theoretical background on the basis of a few experimental examples (data from T. Chudoba, ASMEC GmbH, with thanks).

The Method and Examples

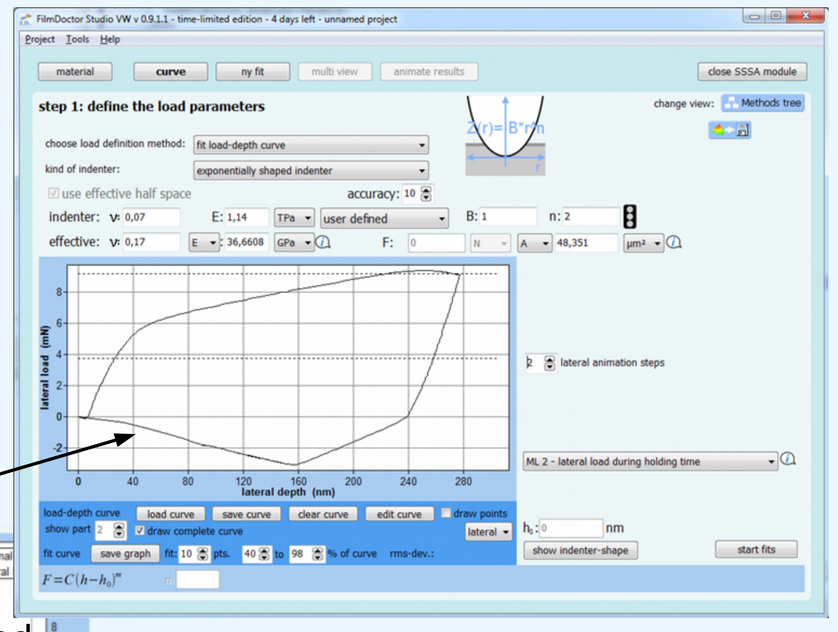


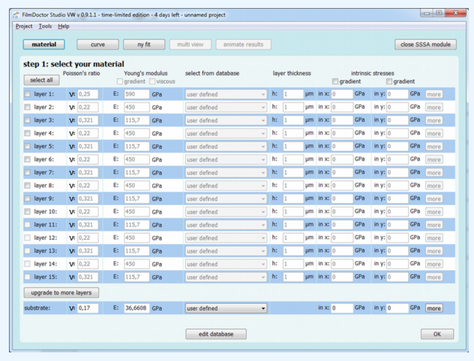
With Young's modulus, hardness, yield strength and Poisson's ratio fit





The new method

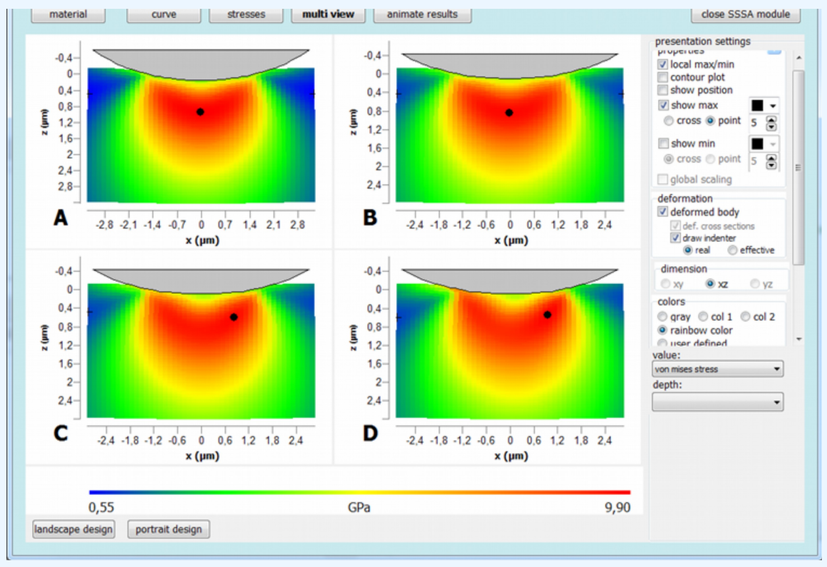




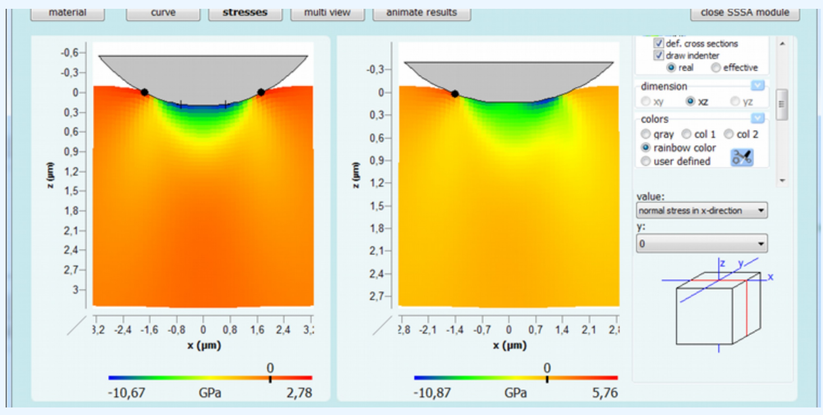
Also for infinite number of layers

And Comprehensive Stress and Strain Determination at Maximum Load Situations

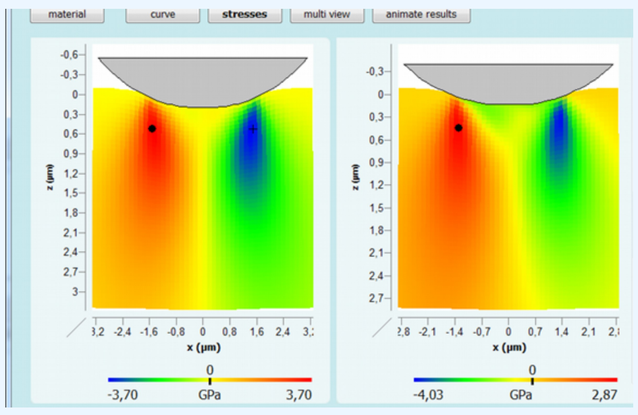
As simulation for v. Mises stresses



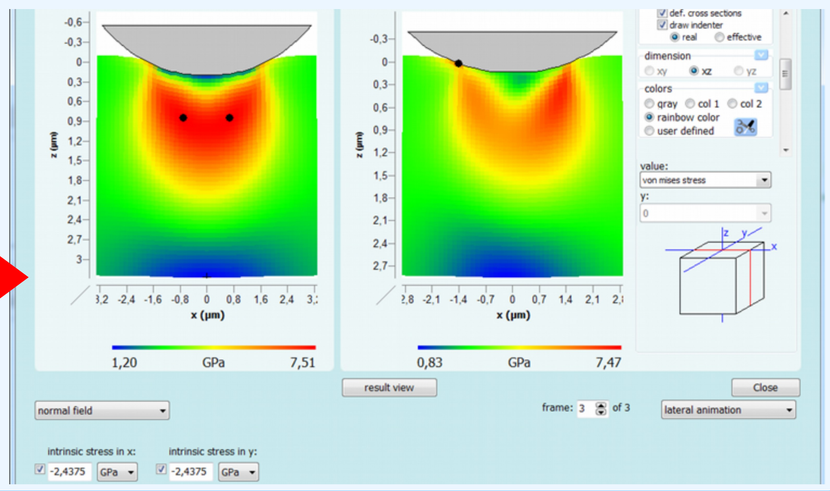
For normal stress in direction of scratch



For main shear stress… and more



Or even with intrinsic stress fit



[1] W.C. Oliver and G.M. Pharr, J. Mater. Res. 7, 1564 (1992)
[2] N. Schwarzer, G. M. Pharr, Thin Solid Films, Vol. 469-470C pp. 194-200
[3] N. Schwarzer, T. Chudoba, F. Richter: „Investigation of ultra thin coatings using Nanoindentation", S & C Technology, Vol 200/18-19 pp 5566-5580

Benefits

- ✔ While classical O&P method only gives Young's modulus and hardness, new method also
- ✔ Gives yields strength and all stress strain fields for max. load positions
- ✔ Poisson's Ratio, Anisotropy in pure normal and mixed loading situations, Inhomogeneities
- ✔ potentially intrinsic stresses

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