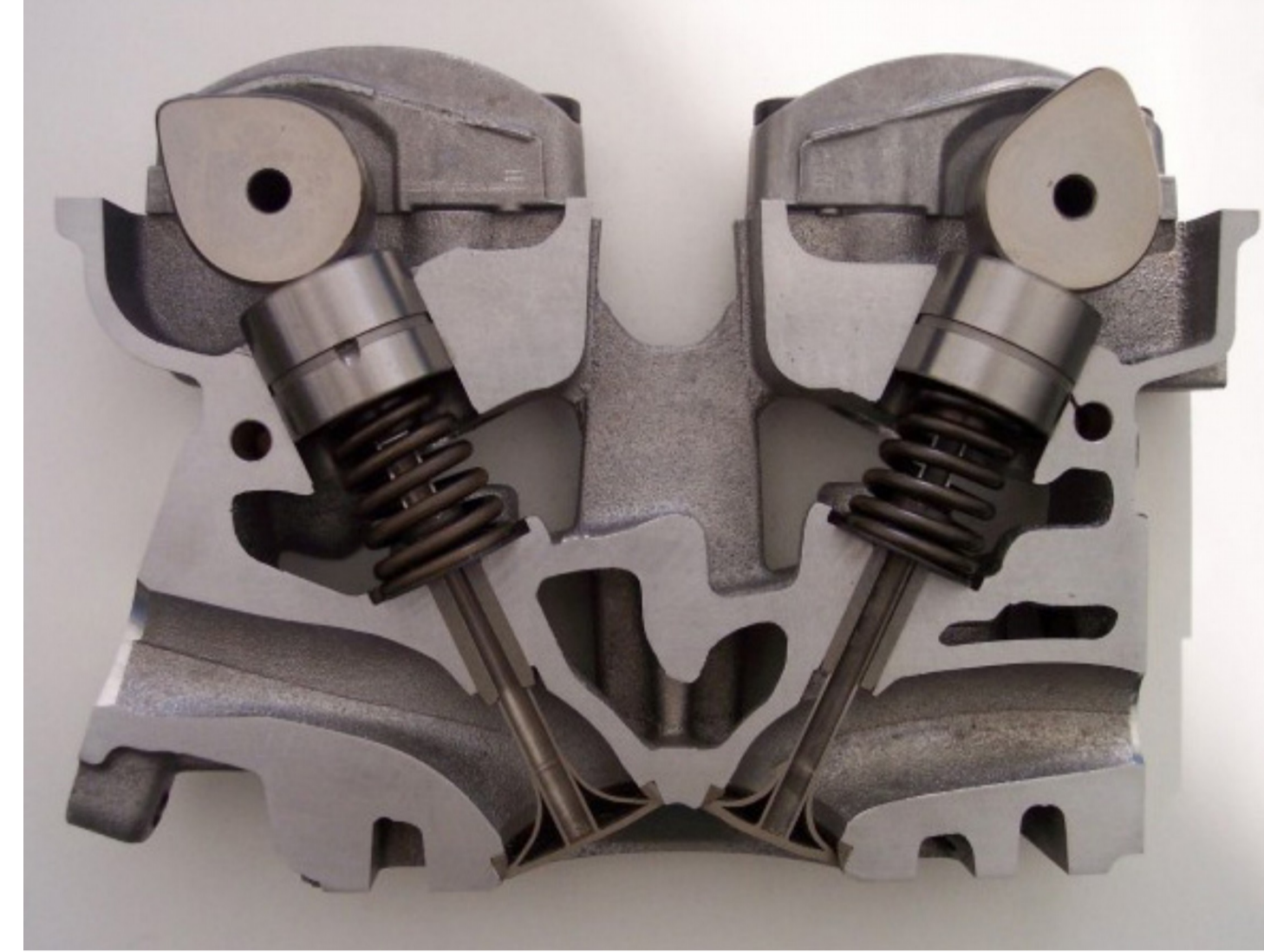
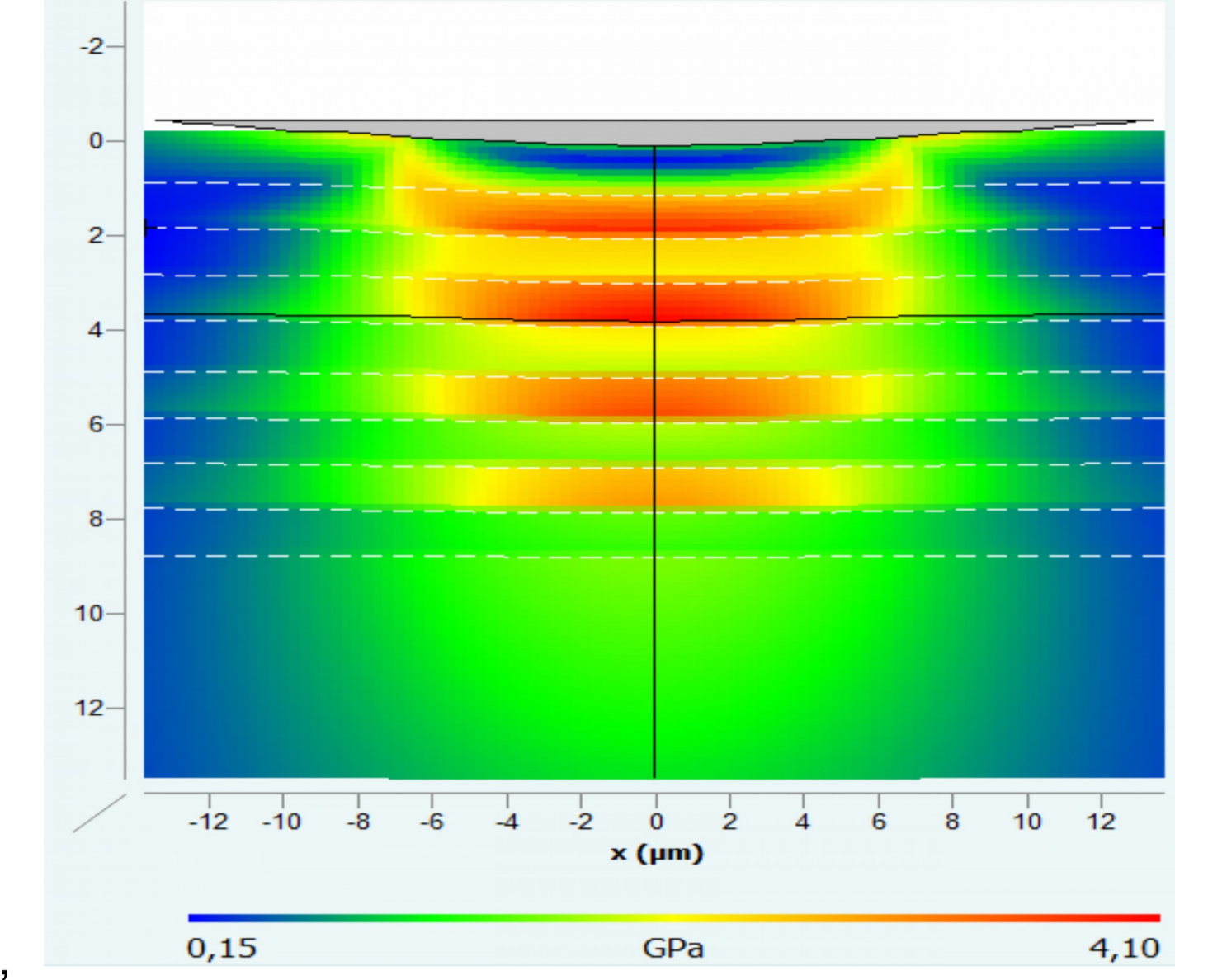


Motivation

Depending on the material structure (e.g. layer thicknesses, Young's moduli and yield strength ratios ...) and the indentation device capabilities (e.g. force range), it's often not possible to measure the true coating parameters without any substrate (or underlying material) effect. A few years ago, SIO developed a model and a dedicated software package called Oliver & Pharr for Coatings (OpfC® [1]) which allows the determination of true generic material parameters (like Young's modulus and yield strength) for a coating by knowing the parameters of the substrate and all underlying layers.

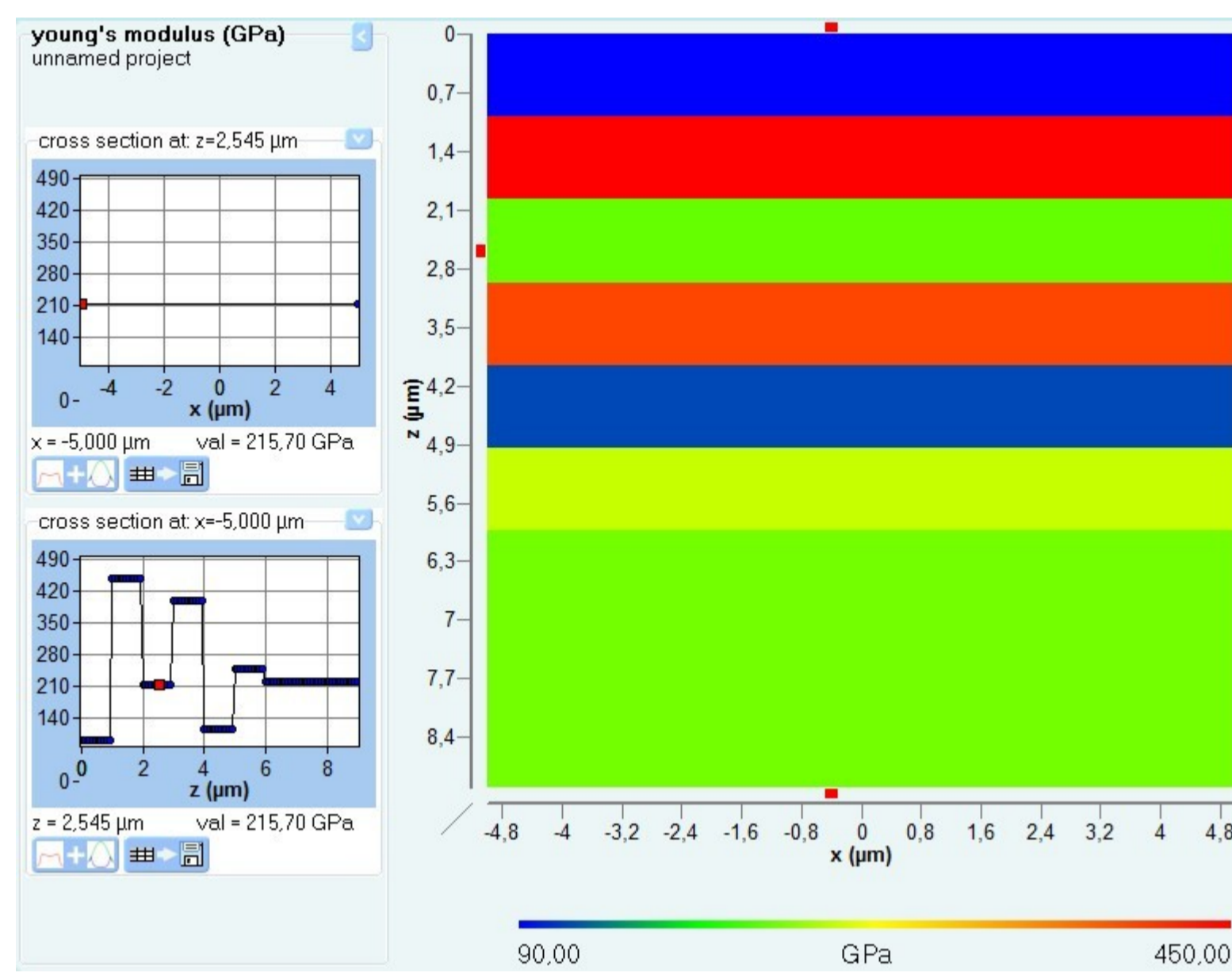


Von Stahlkocher - Eigenes Werk (Uploaded to commons by: Milkmandan), CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=227760>

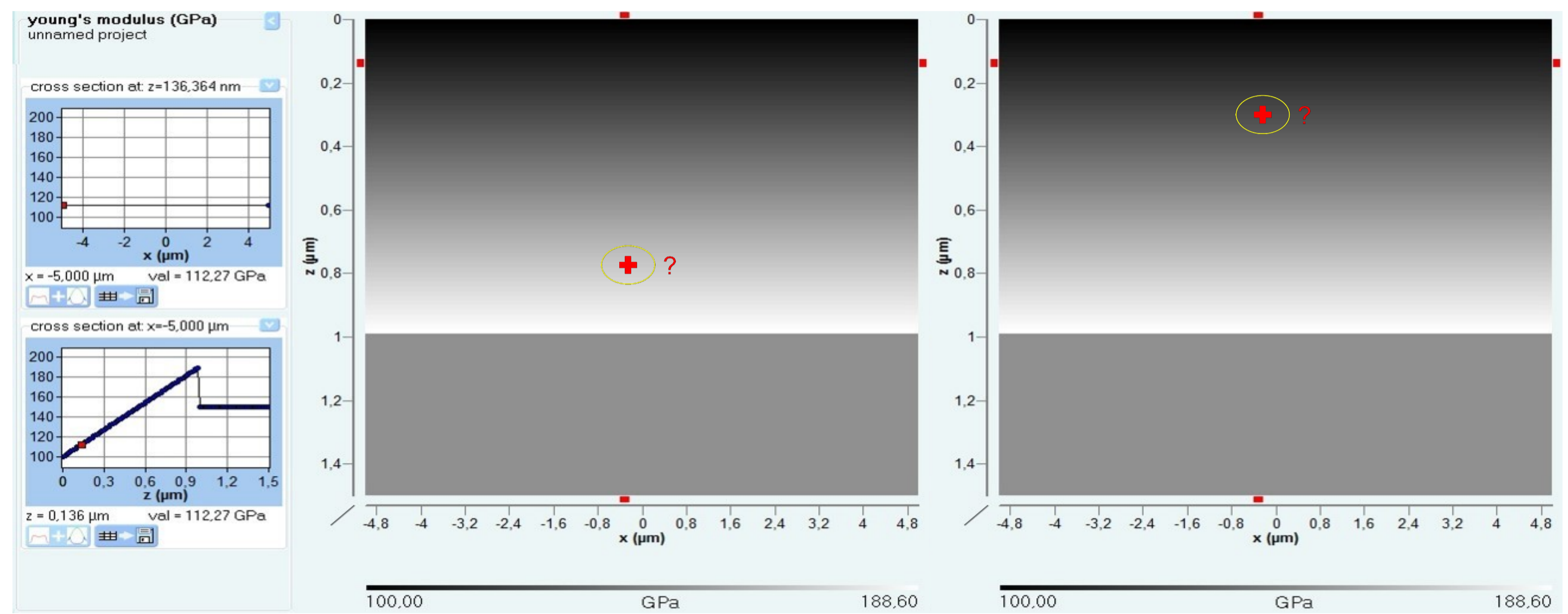


Complex material structures

Proper characterization and optimization of such structures requires invertible mathematical tools of sufficient holistic character. SIO developed analytical models which dramatically speed up the simulation of complex contact situations compared to FEM systems.



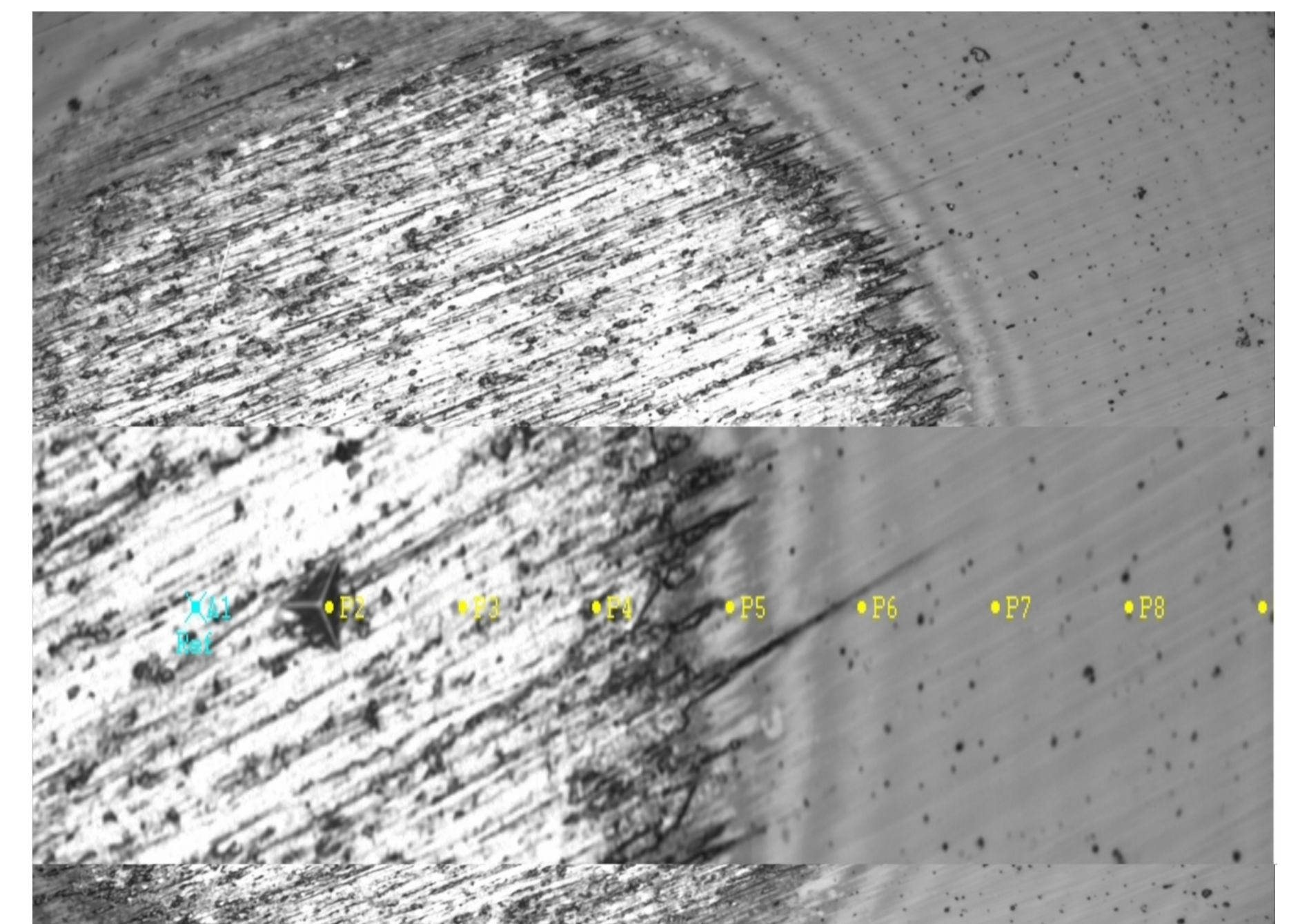
Complex multi layer stack on substrate



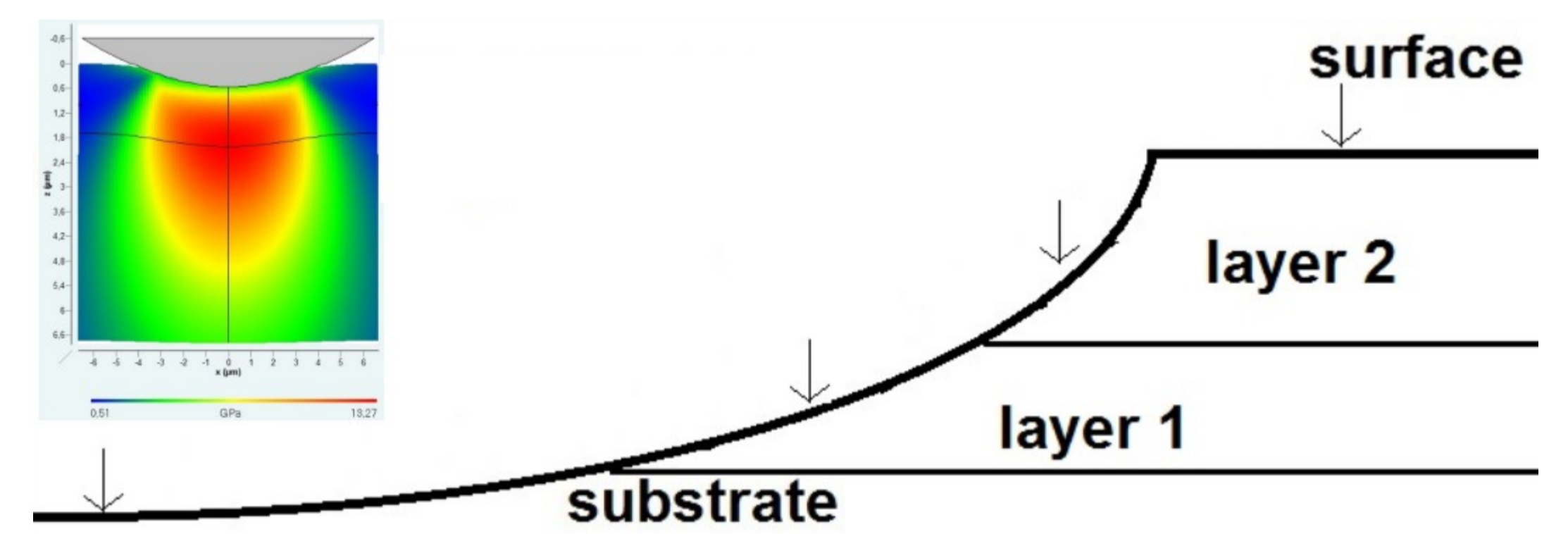
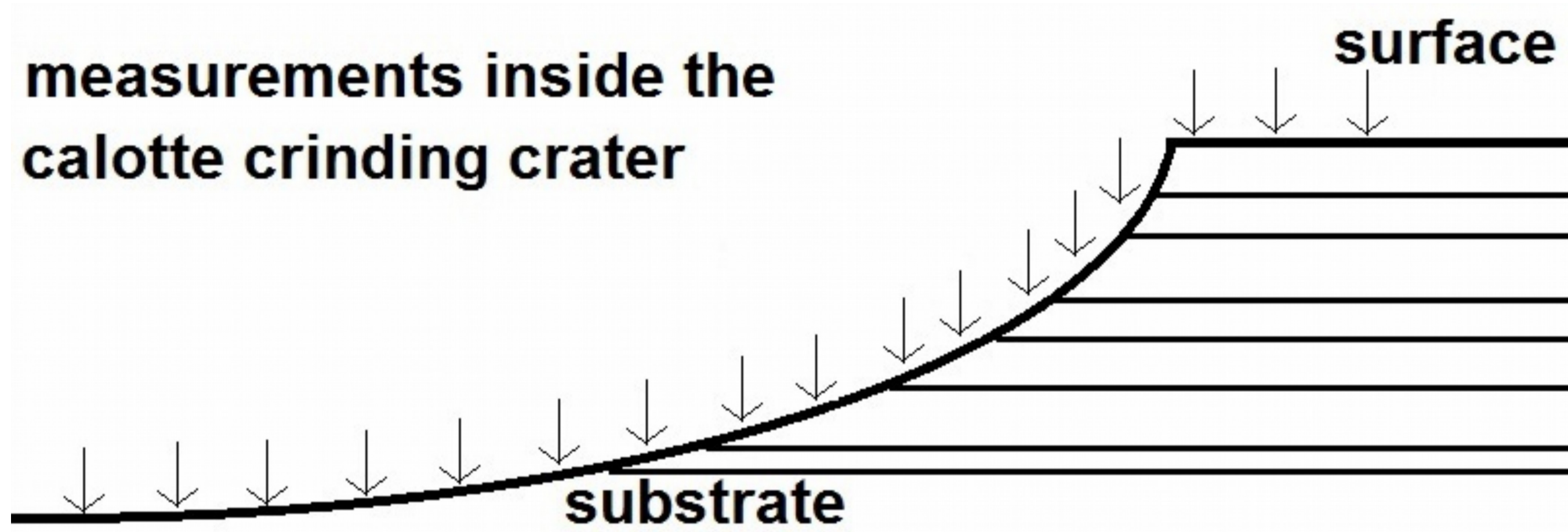
Extract information at different positions within a coating with gradient structure

New combination of calotte grinding and indentation test

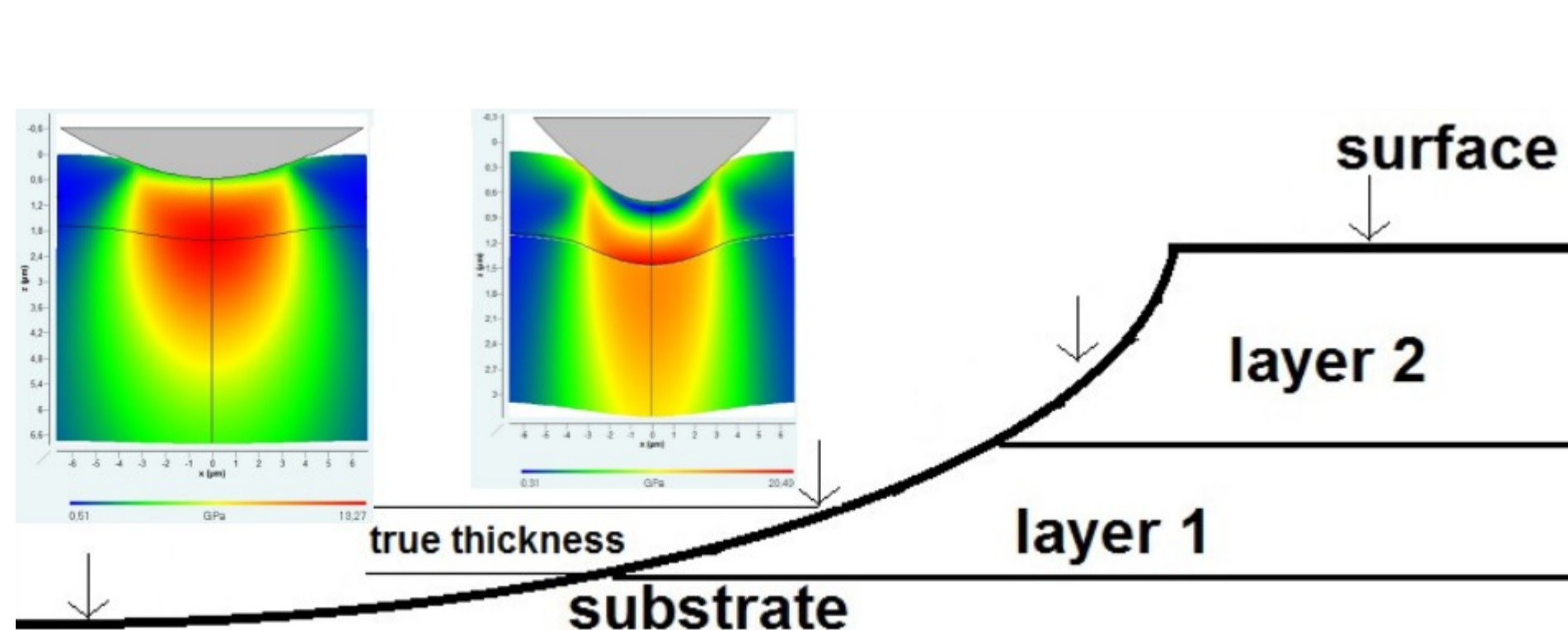
Because the calotte grinding tests are widely used to determine the layer thicknesses, SIO thought about using the possibility to directly access the deeper parts of a complex layer stack by applying a combination of calotte grinding and subsequent indentation testing. We created a new module which analyzes a series of indentation measurements which were performed from the inside (focal point) to the outside of the calotte test crater. So it's possible to perform tests on the substrate and all layers. This module was built into the software package FilmDoctor® [2], which subsequently analyzes such a measurement series starting with the substrate measurements. All evaluated values are used for the next iteration step of the new analysis method. At the end the material parameters for all layers are determined without the need of stopping or changing the production process.



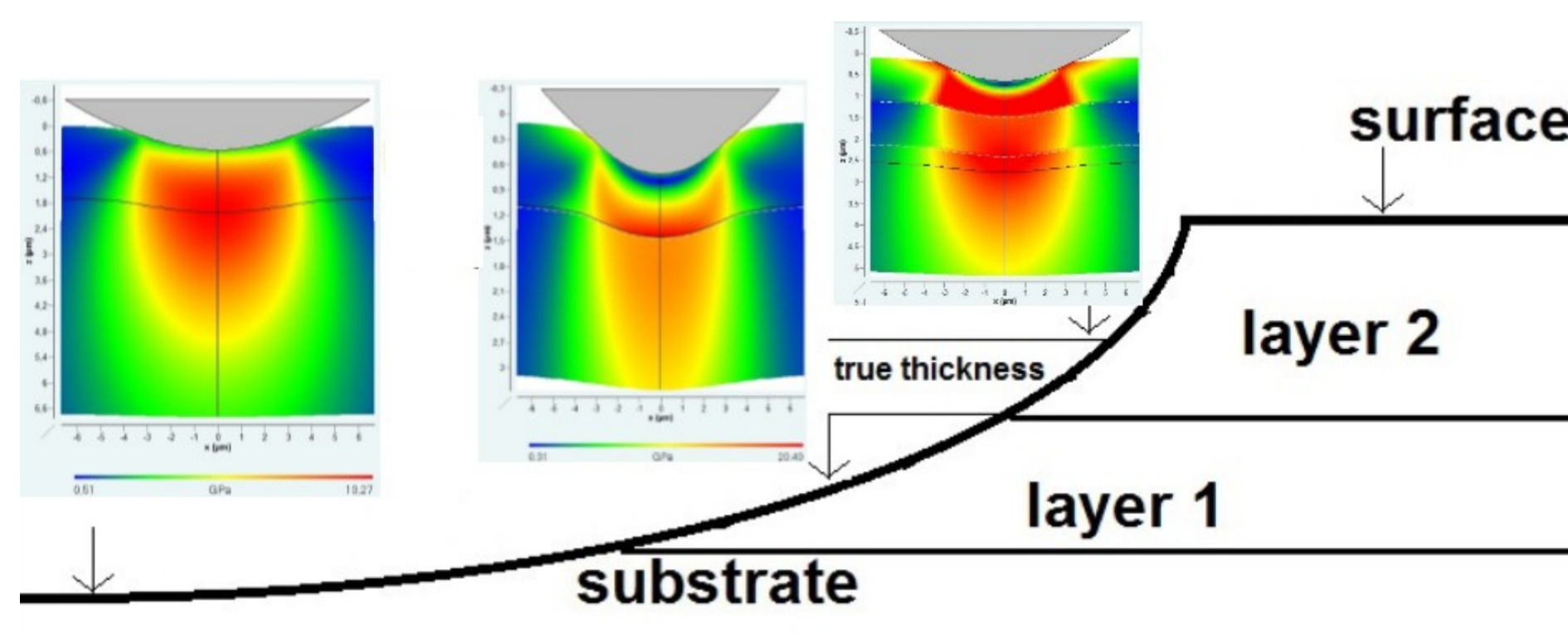
Easily programmable with new devices



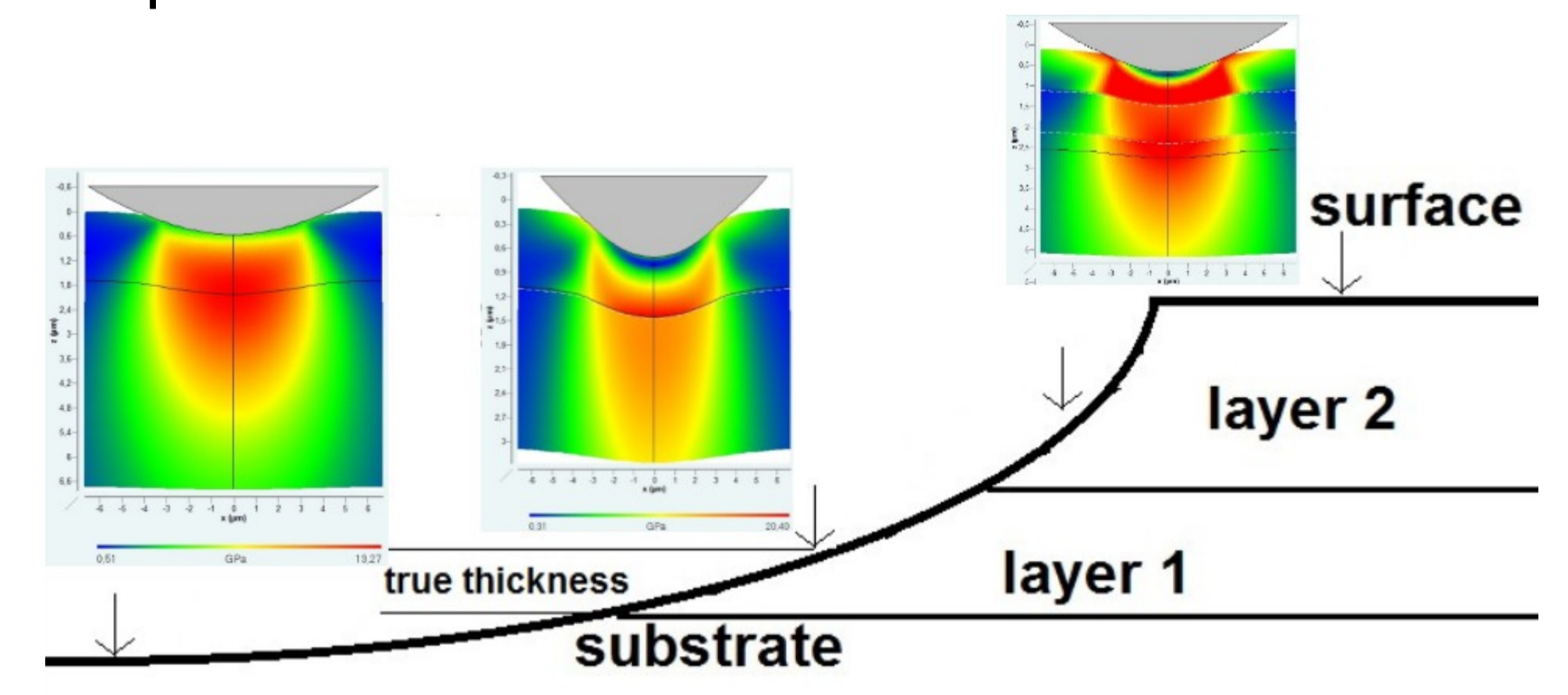
Step 1: Measurement in substrate



Step 2: Measurement in layer 1



Step 3: Measurement in layer 2



Step 4: Measurement at surface

References

- [1] www.siomec.de/opfc
- [2] www.siomec.de/FilmDoctor

All the features shown and much more is included in our software FilmDoctor® (www.siomec.de/FilmDoctor).

