Oliver & Pharr extended to creep and viscous material behavior

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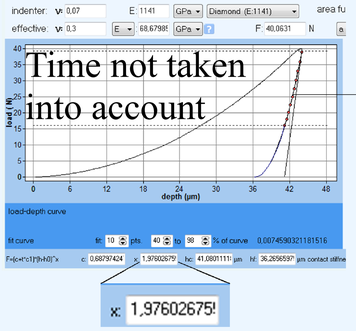
Abstract

There is a relatively great variety of nanoindentation results to be found in the literature, where there are illogic exponents from the exponential fit to the unloading curve. Apparently, it is not sufficiently known, that exponents bigger than 1.5 are questionable from the physical point of view. Especially in the case of materials showing significant creep, this sort of problematic results are very likely to appear. **Why is this?**

The answer can easily be given by the means of Pharr's concept of the effectively shaped indenter. Interestingly, the author found many such strange analyzing results, where, by taking the time-dependency of the measurement into account, all such "funny" results disappeared. In the poster it will be demonstrated how the classical Oliver and Pharr method can be extended to "creepy" materials and how this method can be connected with the effective indenter concept mentioned above.

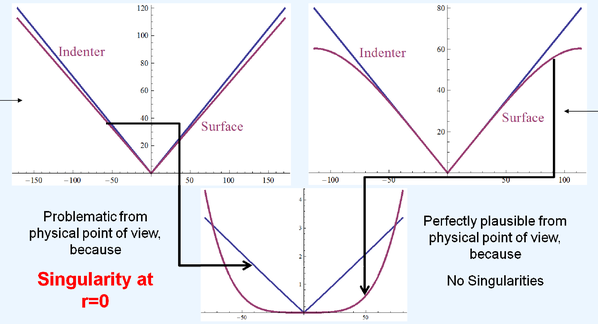
Creepy materials give creepy results

Apparently ordinary measurement, classically analyzed



Pharr's concept of the effectively shaped indenter directly gives the new surface shape under indenter

and



Problematic from physical point of view, because

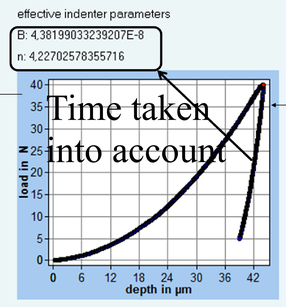
Singularity at r=0

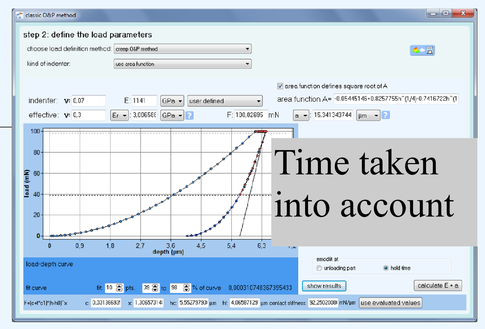
Perfectly plausible from physical point of view, because

No Singularities

Creepy materials give meanigful physical results

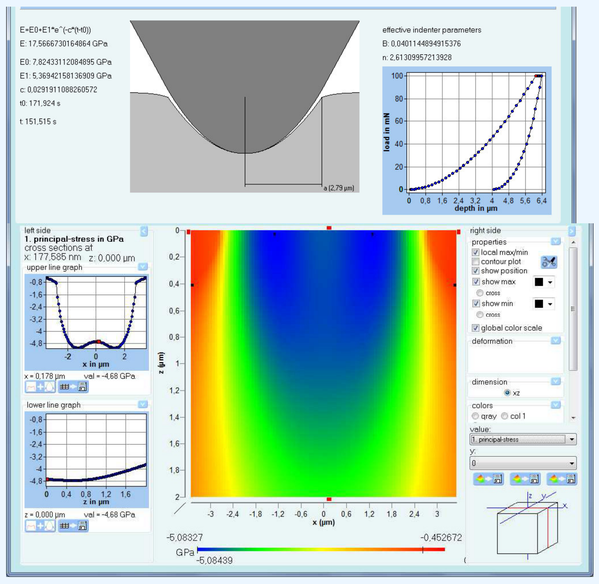
analyzed with Oliver & Pharr time dependent



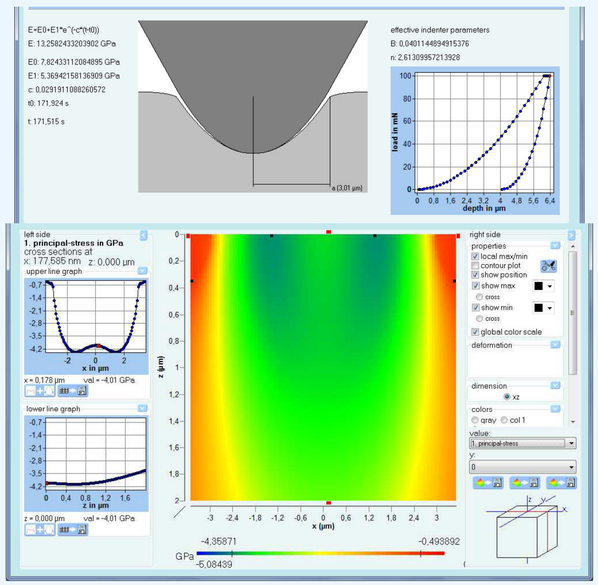


After corrected analysis , complete stress-strain evaluation, extension to layered materials, rough surfaces etc. is possible (example*: polymer with classical exponent 2,38 — now around 1,3)

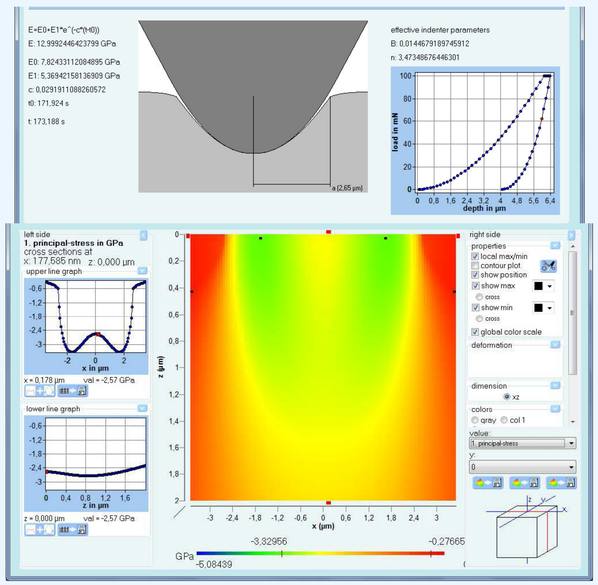
Begin of holding period



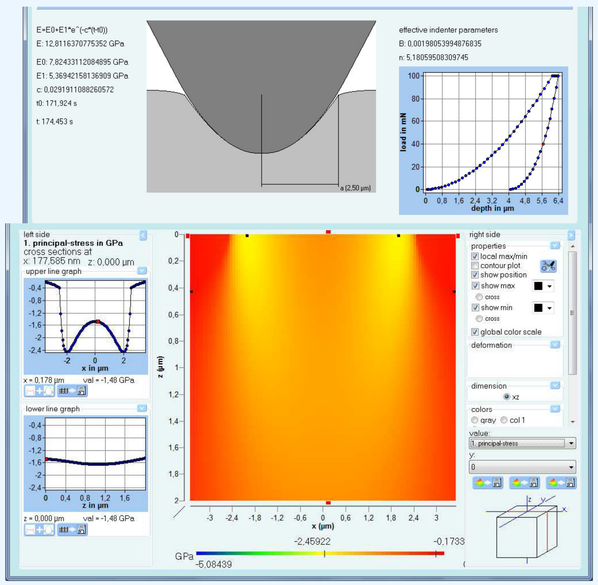
end of holding period—begin of unloading



middle of unloading



end of unloading



References - time dependent option in

[1] See www.siomec.de/OPfC

[2] See www.siomec.de/SSA

[3] See www.siomec.de/ISA

[4] See www.siomec.de/FilmDoctor

* due to NDA absolut values changed

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Major Benefits

- ✓ Meaningful exponents, allowing further evaluation of complete stress and strain field under indenter (no singularities)
- ✓ Extendable to layered materials
- ✓ Completely invertable for parameter identification of viscous materials