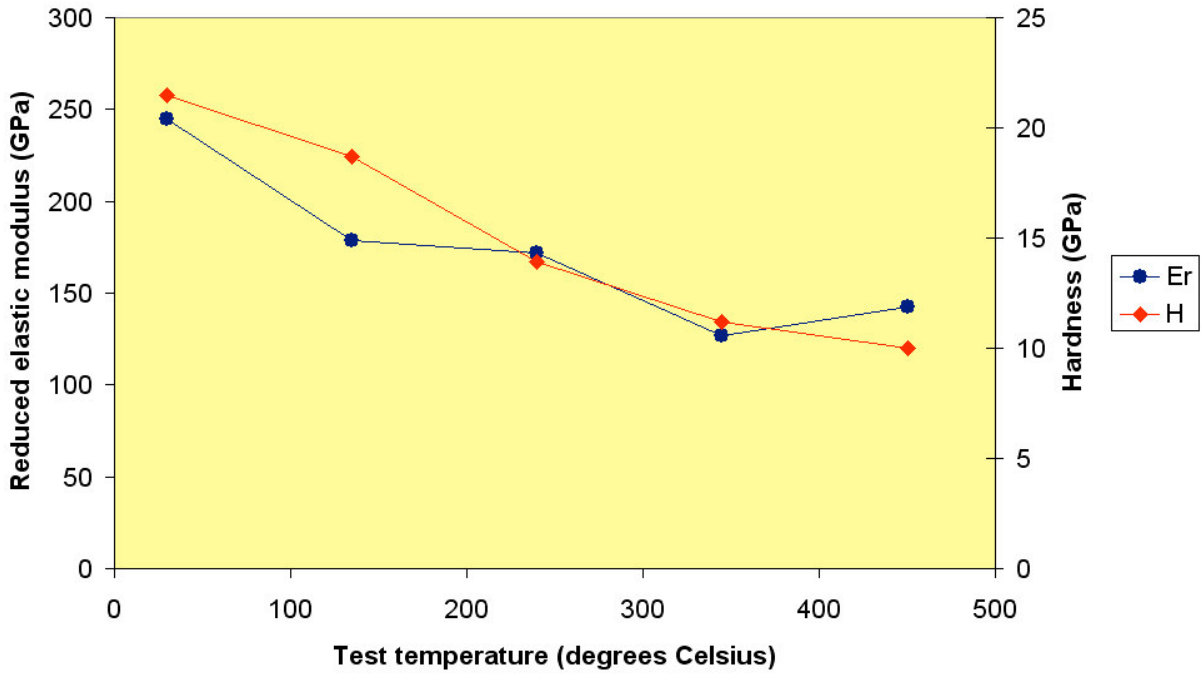
Dr. rer. nat. habil. Norbert Schwarzer
Sächsisches Institut für Oberflächenmechanik SIO
Tankow 1
18569 Ummanz auf Rügen
Germany
E-Mail: n.schwarzer@siomec.de
Internet: www.siomec.de

Temperature Dependent Mechanical Properties - A FilmDoctor® Application

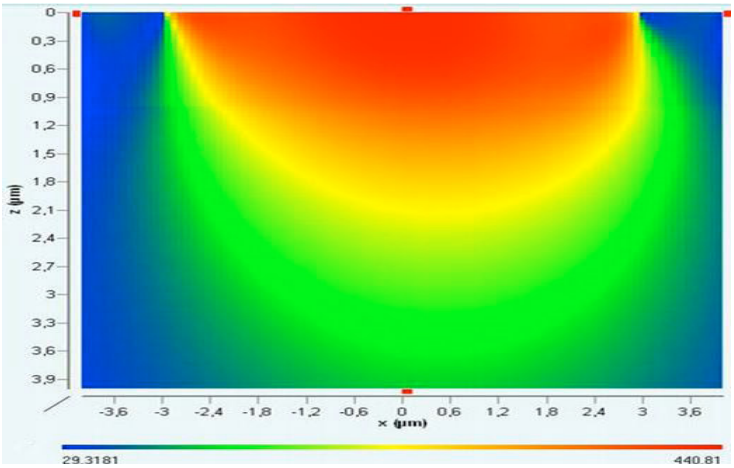
Full story at www.siomec.de/pub.

1st Step: Determination of mechanical coating properties as function of temperature using Micromaterial's NanoTest® courtesy Wilfried Helle, LOT-Oriel



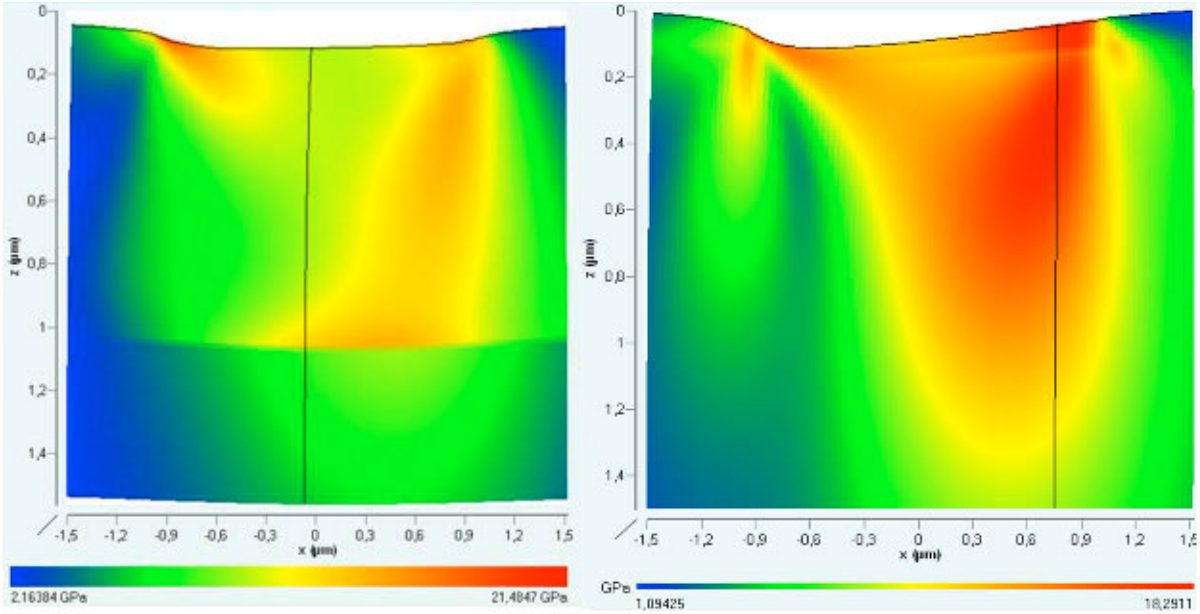
2nd Step: Evaluation of temperature field of typical application for the coating-substrate-system in question

The next figure shows the temperature field within the operational state of the material for which we have determined the Young's modulus as function of temperature. The heat on the surface is either produced by a rather high frictional load or simply comes from the heated contacting counterpart directly. In short, it is the applicational worst case assumption with this temperature field. The other side of the coated sample is to be cooled, so we have a temperature gradient and as the indenter (frictional area) moves to the left, the field is asymmetric, too.
The coating thickness was assumed to be 1µm (special hard coating on steel).



Temperature field of worst case application scenario in °C

3rd Step: Modeling worst case contact situation



Temperature field **not** taken into account

With Temperature field

As one can see, the two cases, meaning the two resulting mechanical fields, are completely different. So, if the temperature effect on the mechanical parameters is ignored, then completely inadequate stability and reliability or life time predictions might be the result.

BTW: Interesting fact in the figure on the right hand side → Because the Young's modulus of coating drops more than that of the substrate, we obtain a smoother transition at the interface, meaning the differences of Young's modulus between substrate and coating is smaller at the interface if compared to the case where temperature gradient is not taken into account.

To conclude → measuring the mechanical properties at different temperatures (also for coatings) is very important wherever either the application itself or friction might lead to temperature gradients and / or temperature fields.