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Friction between Indenter and Sample → Can it be ignored? A simulation with FilmDoctor®

More at www.siomec.de/pub.

1. Material definition and intrinsic stress simulation

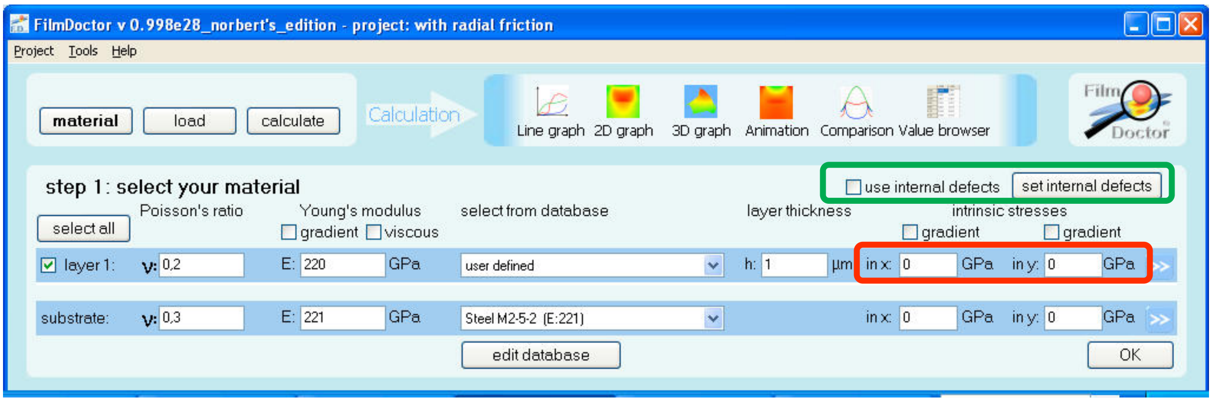


Fig. 1: **Defining your material structure. Here a rubberlike DLC-coating on steel-substrate is assumed. Even intrinsic stresses could be added and correctly taken into account.**

2. Modeling a contact situation with friction between indenter and sample surface

Next step is to find the loading conditions simulating the later application and / or surface test method. Here we assume a spherical diamond indenter with 5µm radius of curvature.

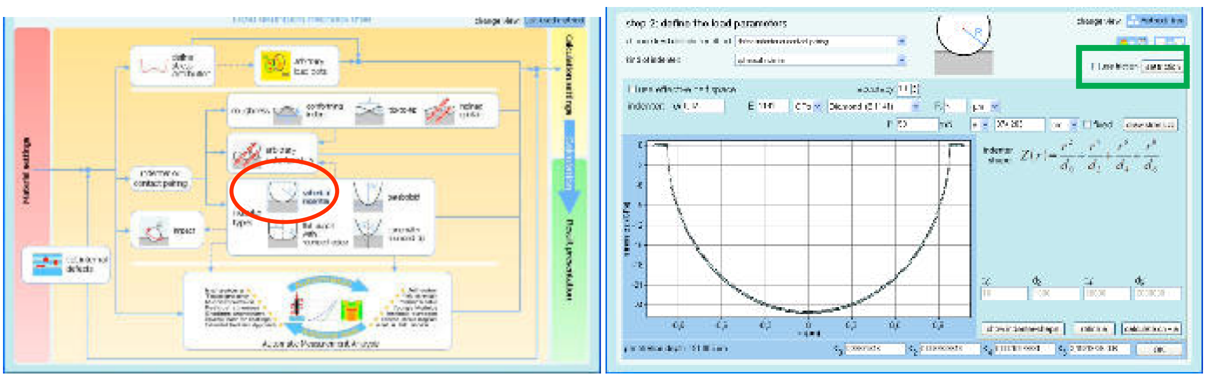


Fig. 2: **Choosing a load method (left). Here (red ellipse) it is the spherical indenter. By clicking on this symbol the program jumps directly to the load dot page (right). Here a 50mN load is assumed and we investigate the contact situation with and without friction between sample and indenter (green rectangle).**

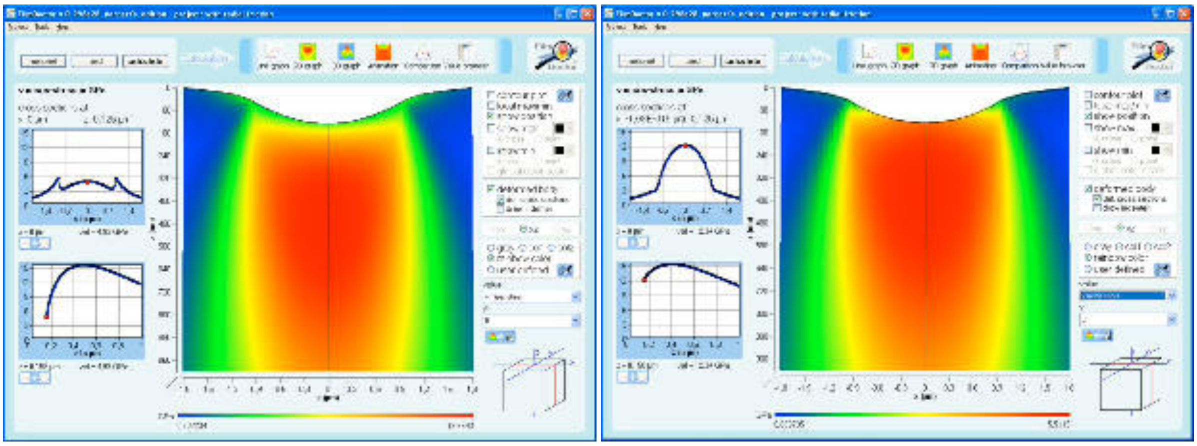


Fig. 3: **von Mises stress, giving the likelihood of plastic flow in either coating-system or substrate or both. Left without friction, right with friction between sample and indenter**

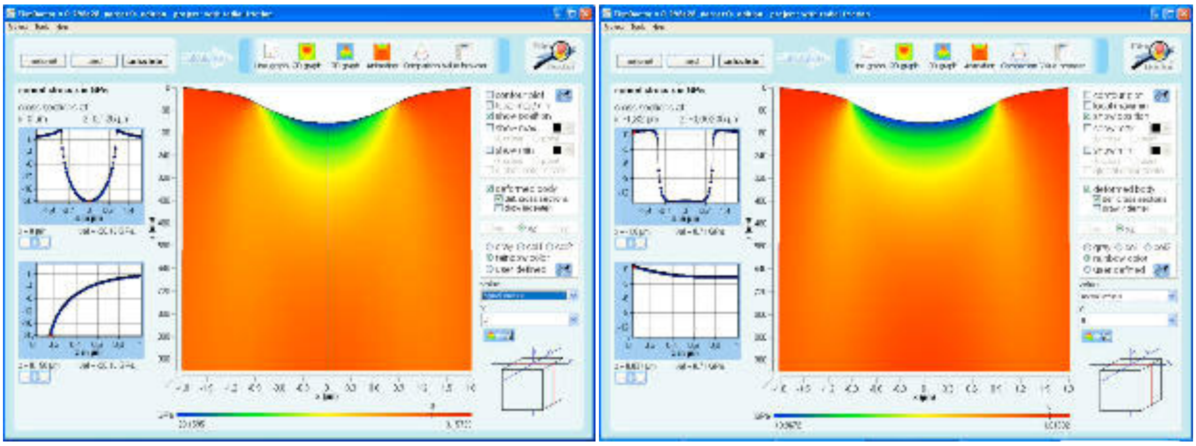
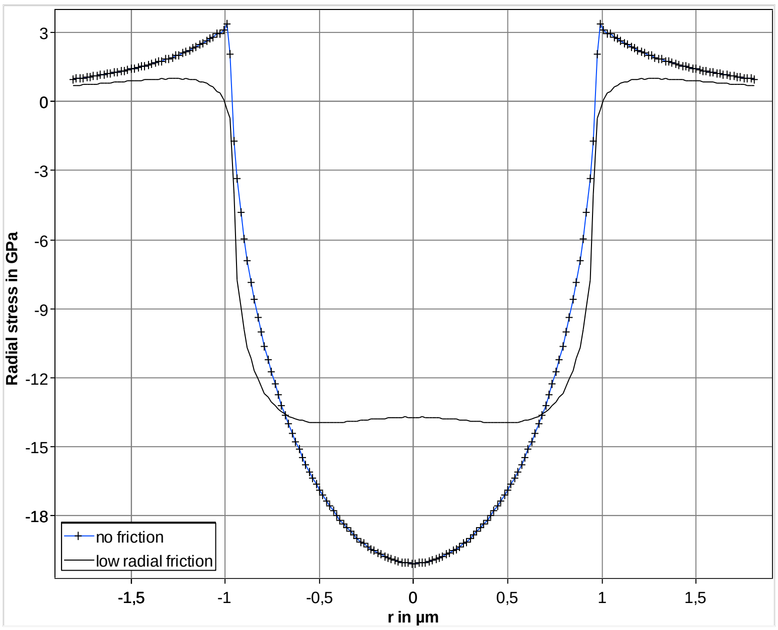


Fig. 4: **Radial stress, giving the likelihood of Mode I tensile fracture on the surface of the coating. Left without friction, right with friction between sample and indenter**

3. Now → Does radial friction compromise nanoindentation results?



For our example from above:

`No friction:`
`Penetration depth h=191.885nm;`
`contact radius a=974.203nm`

`With low friction:`
`Penetration depth -> 190.171nm;`
`contact radius a=956.692nm`

Thus, effect on penetration depth and contact radius is relatively low. However, effect on radial stresses can be dramatic (see figure on the left). Friction might be the explanation for Hertzian cone cracks being more likely to occur outside the contact zone instead at its rim as the classical Hertzian theory would predict.