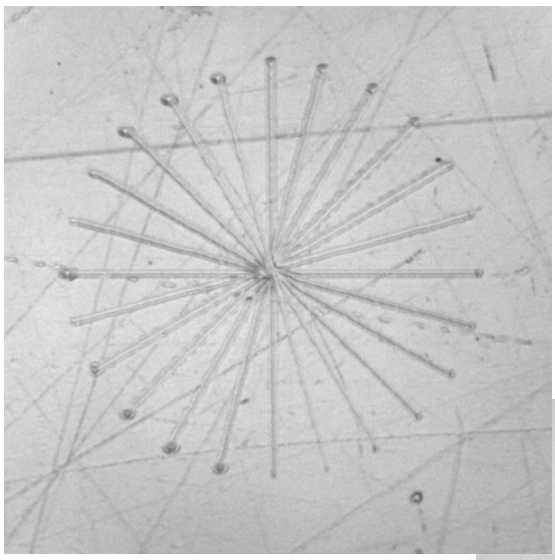
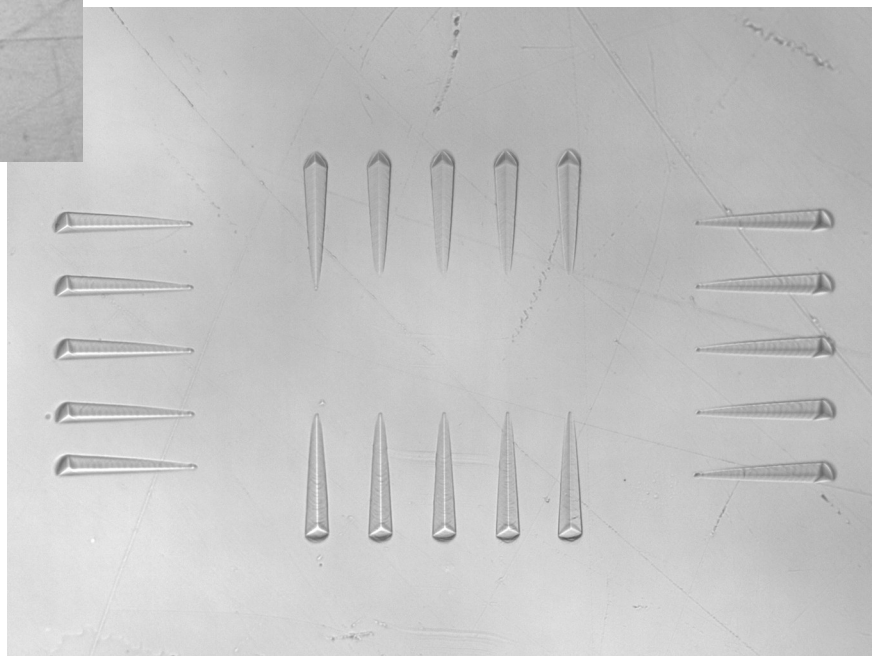
Application note

Scratch testing of SAN

The lateral force stage for sm@rt 500 nanoindenter:

- Lateral force sensors for x- and y-axis integrated into the stage
- Sensor range: 10 µN – 250 mN
- Heatable sample holder with height adjustment
- Temperature range up to 500°C with cooling water and inert gas supply
- Compatible to sm@rt active tip heating
- Lateral forces generated by moving the stage using XY motors with minimum step size 20 of nm
- Motor coordinates, lateral force sensor data and indenter head data captured by real-time sm@rt controller
- Software suite for all combinations of scratching and profiling





Patterns of scratches in styrol acryl nitril (SAN) using a Berkovich type indenter in x-axis, y-axis and combined to demonstrate accuracy and repeatability.

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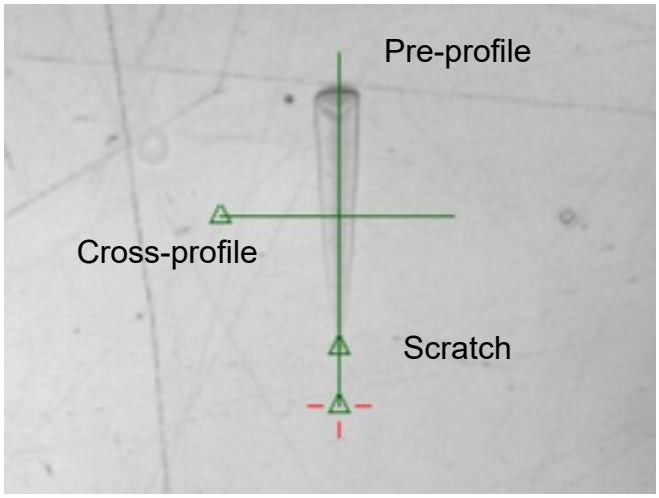
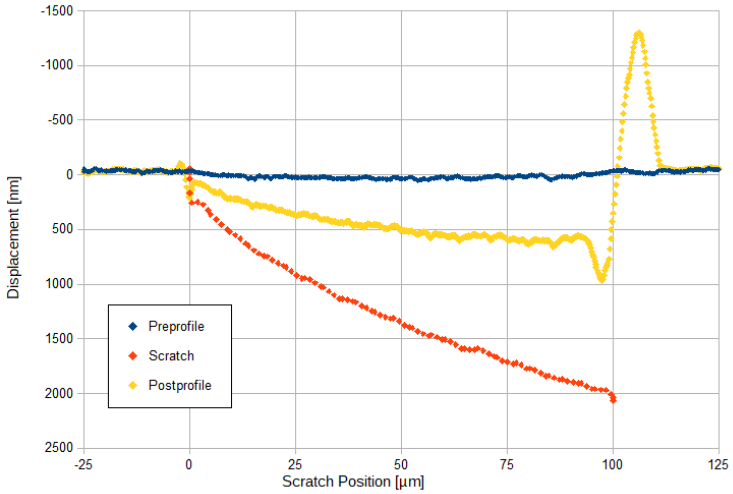
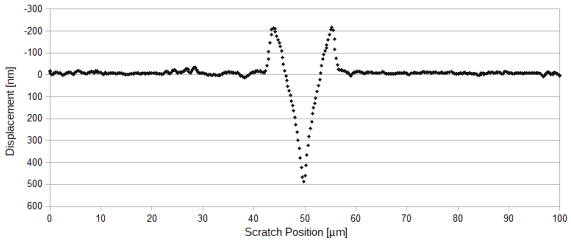
The standard 4-step scratch test:

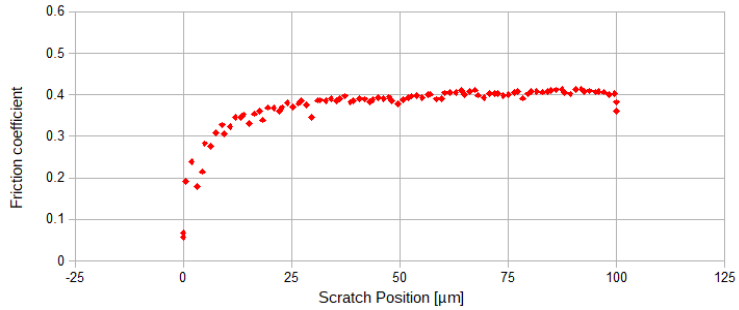


1) Pre-profile: Profiling with minimum load along the designated scratch path, the starting and end position of the pre-profile are placed ahead and after the scratch path.
2) Scratch: The scratch is starting with a small preload, then the load is increased linearly to the maximum load along the scratch path.
3) Post-profile: Repeating of the pre-profile reveals the permanent deformation due to the scratch load.
4) Cross-profile: The cross-profile can be used to determine the scratch depth, width and the pile-up of material.





Different profiles after leveling. The leveled pre-profile is used as reference height along the scratch to calculate the scratch depth during scratching and afterwards.



The measured lateral force is derived from the x- and y-sensors. The ratio between actual lateral force to normal force is reported as friction coefficient.

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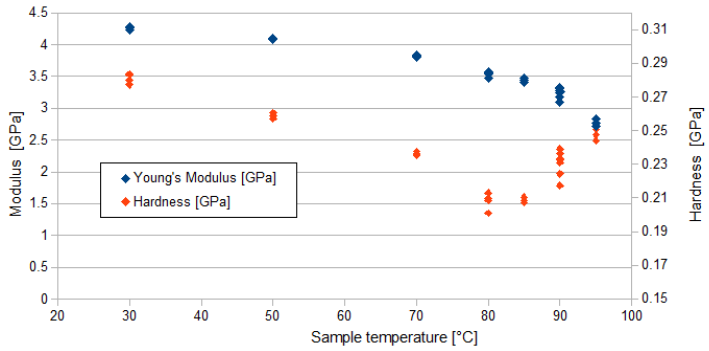
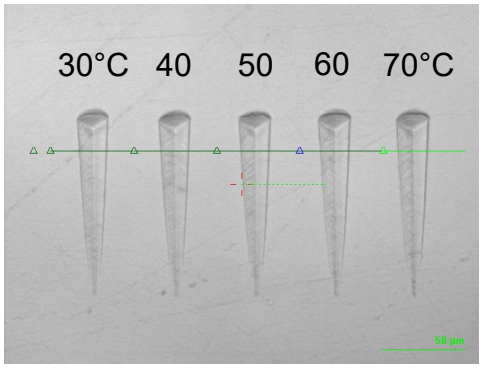
Application note

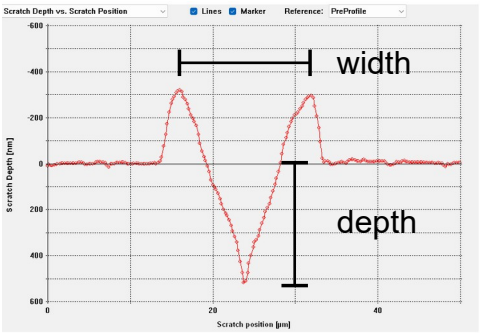
Nanoindentation and scratch testing of SAN at elevated temperatures:



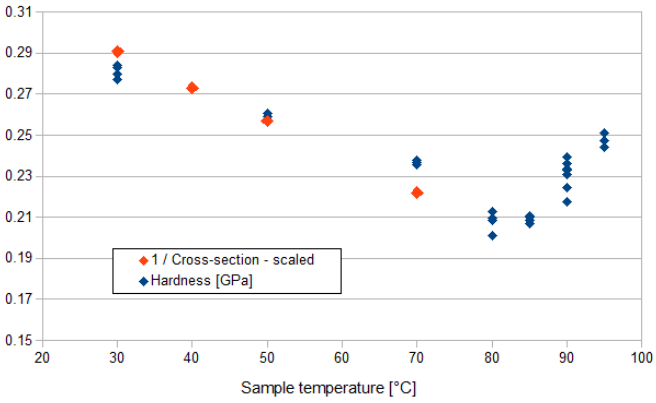
Hardness and modulus at test temperature, obtained from nanoindentation tests. The lateral force stage is used as heating stage during these tests. The SAN polymer shows a moderate decrease in hardness up to 80°C sample temperature. At higher temperatures the sample changes irreversible.



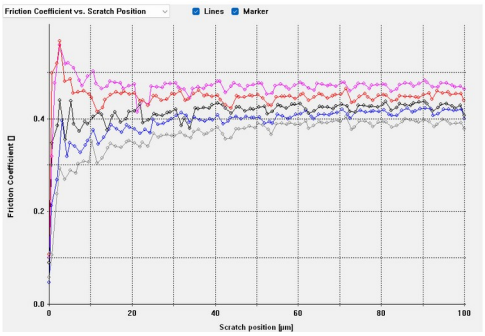
Scratches up to 20 mN in SAN performed at the indicated temperatures. The green lines mark the location of cross-profiles that were made afterwards at room temperature. Qualitatively these scratches appear quite similar.



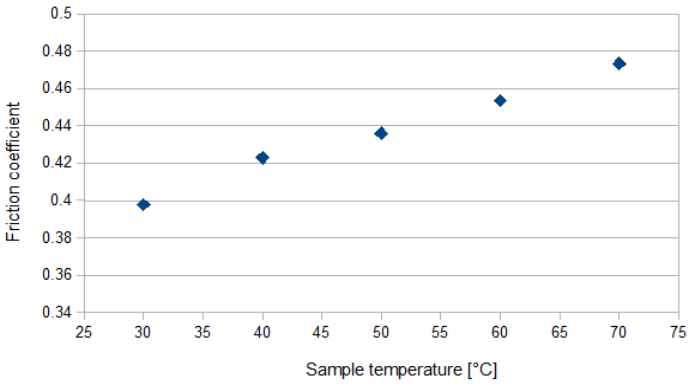
Cross profile of a scratch made at 50°C. The depth and the width are measured as indicated above. The scratch depth and the scratch width both increase only slightly with increasing temperature.



If we scale the quantity 1 / [width * depth] using a constant with the dimension force, we get a similar trend as the decrease of the hardness.



The friction coefficient becomes constant after a scratch distance of approx. 20 µm.



The friction coefficient increases almost linearly with temperature.

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