Picosecond laser micromachining of azopolymers aiming at superhydrophobic surfaces

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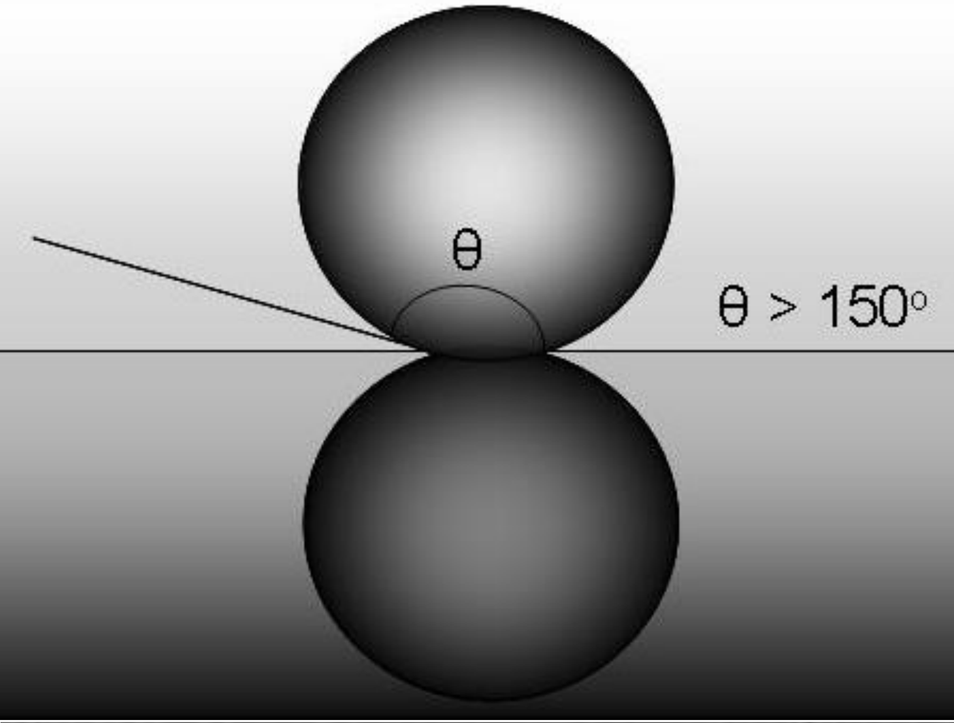
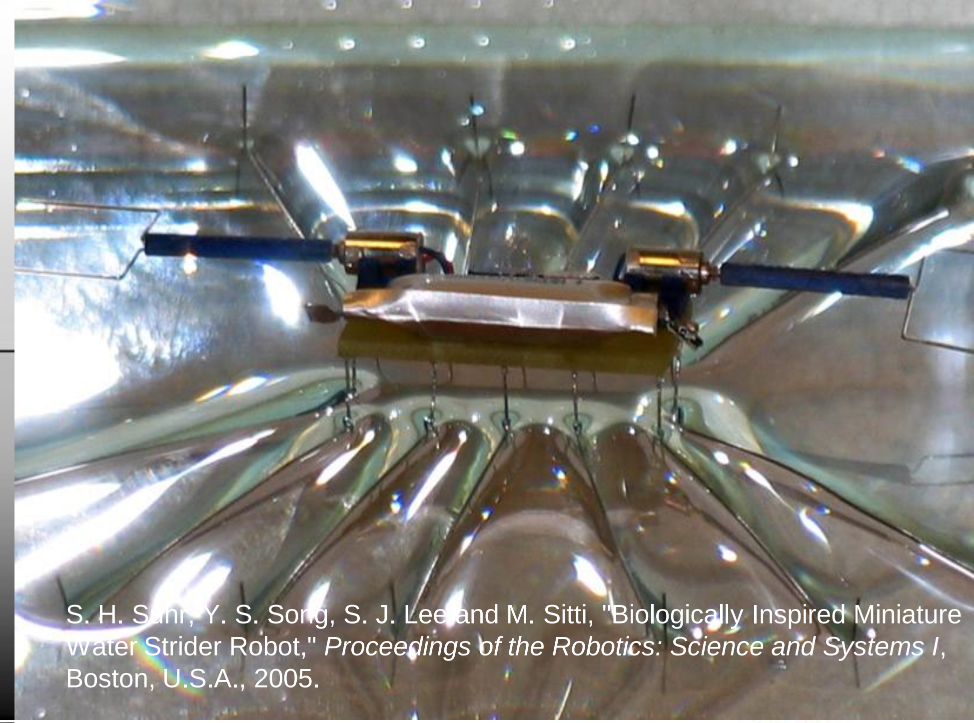
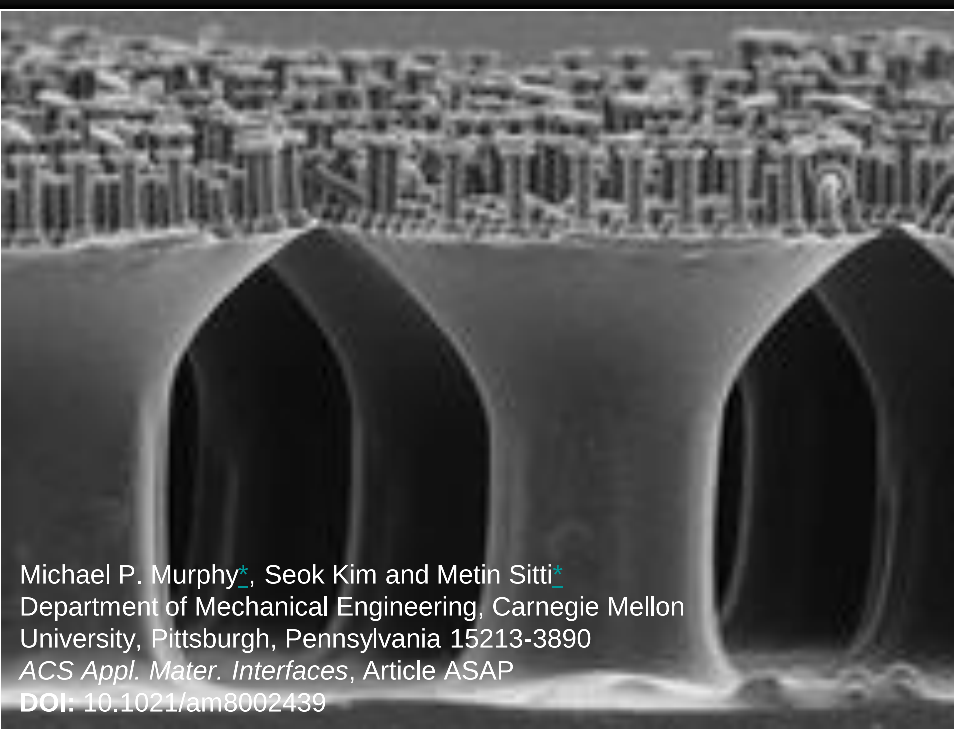
Introduction – Motivation

In nature some examples of superhydrophobic surfaces.





S. H. Suhr, Y. S. Song, S. J. Lee and M. Sitti, "Biologically Inspired Miniature Water Strider Robot," *Proceedings of the Robotics: Science and Systems I*, Boston, U.S.A., 2005.



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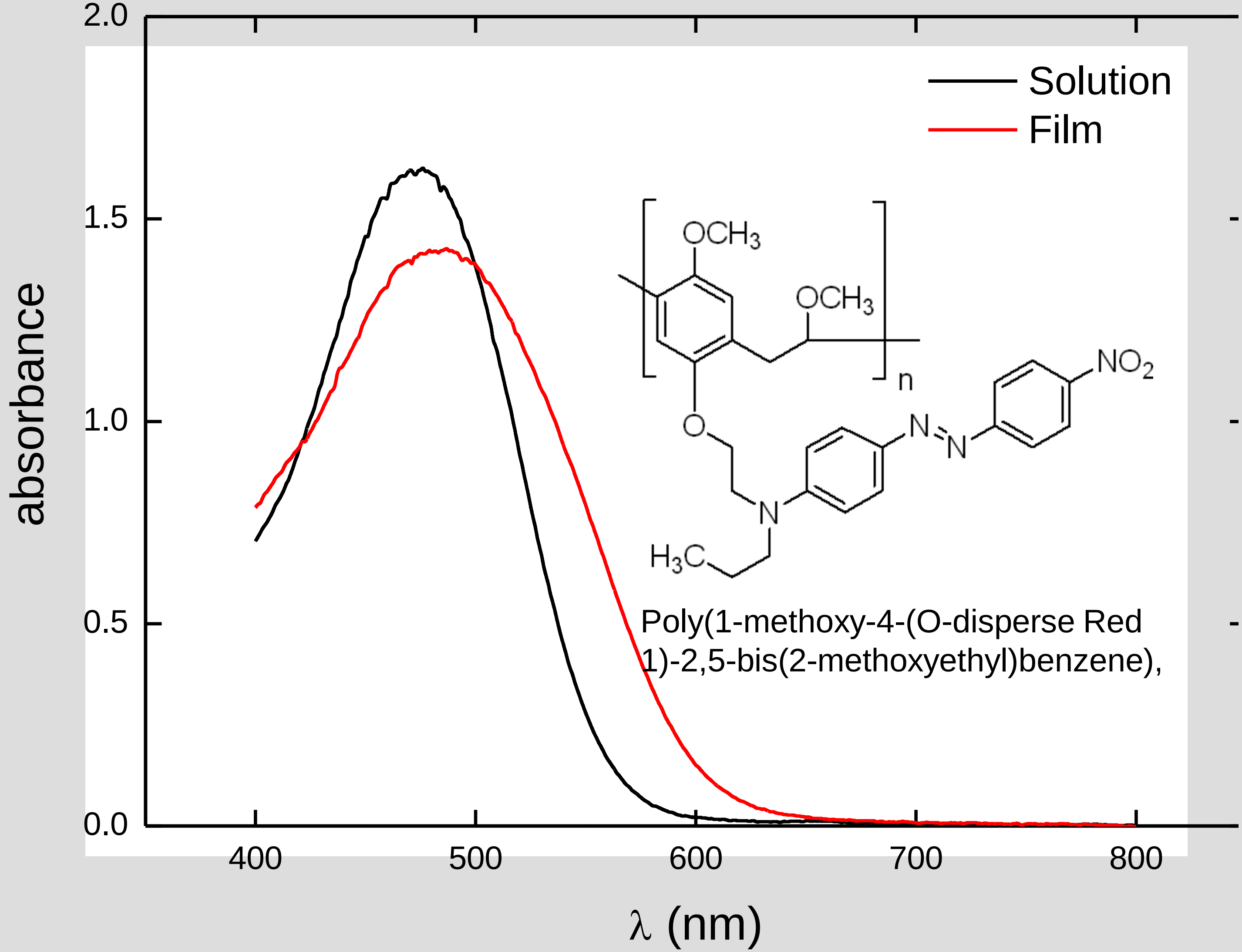
Nokia Morph Cellphone Rolls Up, Stretches, Cleans Itself
http://research.nokia.com/files/insight/NTI_Nanoscience_-_Dec_2008.pdf

Outline

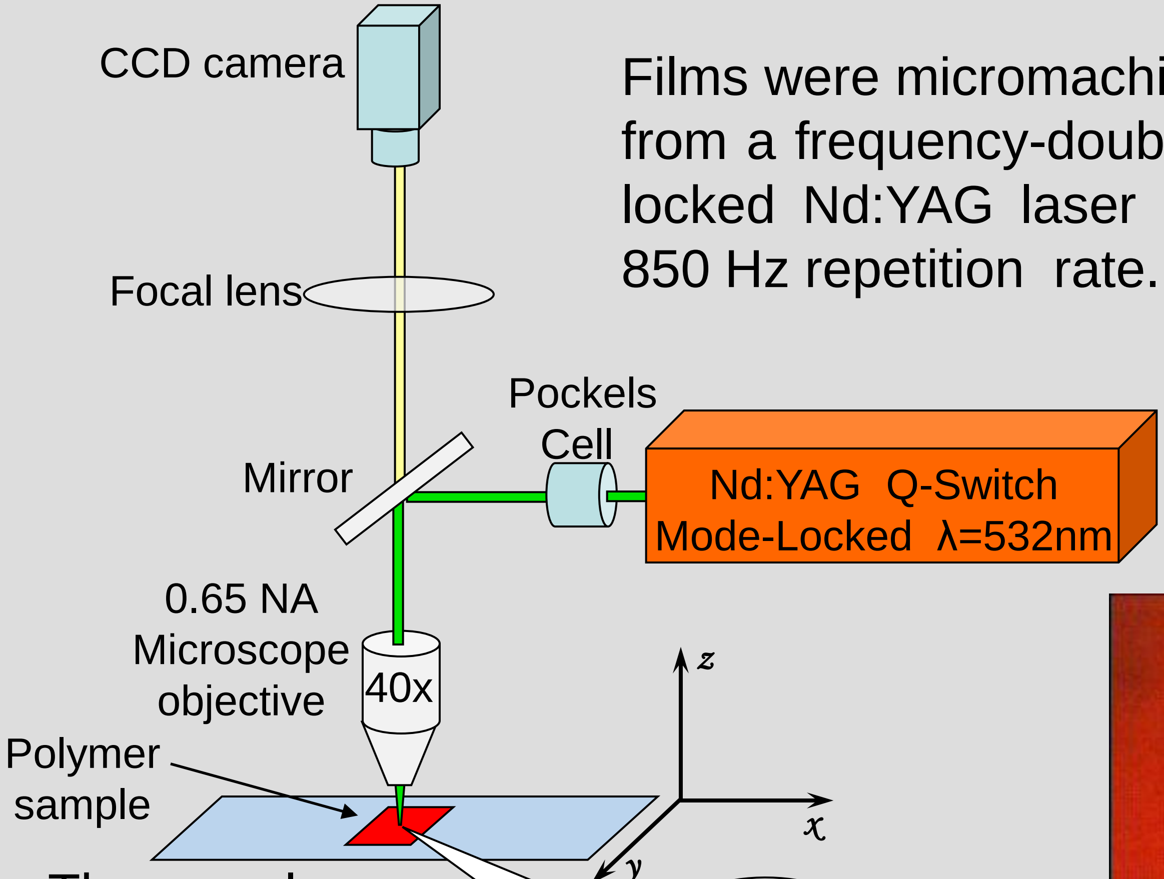
- Sample studied
- Methodology
- Results
- Summary
- Conclusion

Sample studied



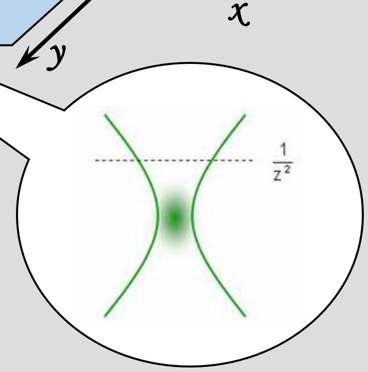
UV-Vis absorption spectra of a chloroform solution (black) and film (red)

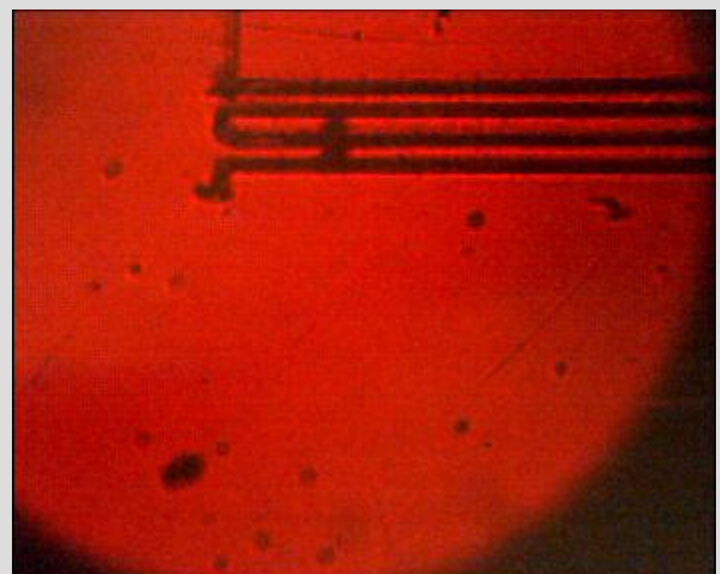
Methodology



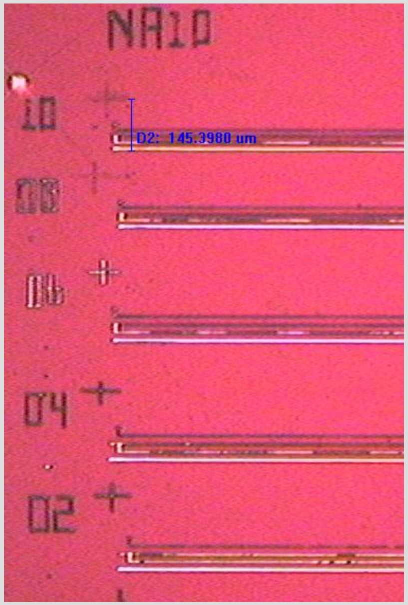
Films were micromachined using a pulse (100 ps) from a frequency-doubled Q-switched and mode-locked Nd:YAG laser operating at 532 nm at a 850 Hz repetition rate.

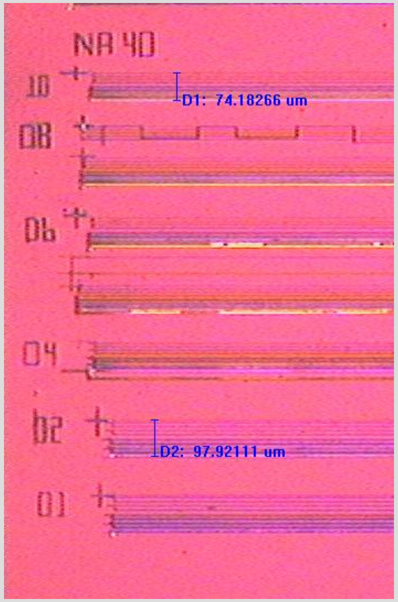
The sample was translated at a constant speed (1mm/s) with respect to the laser beam.

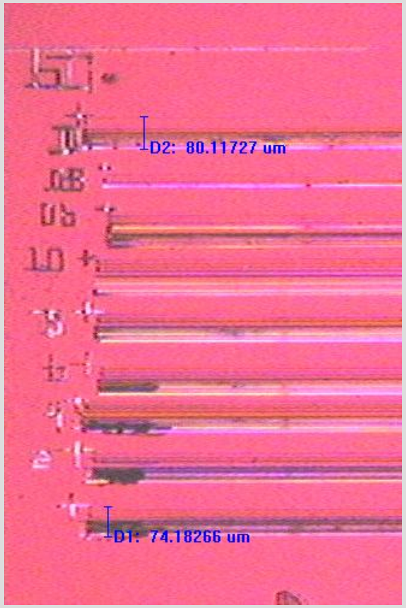


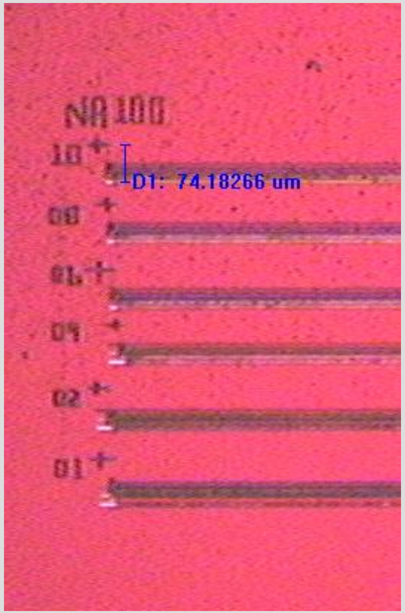


Results

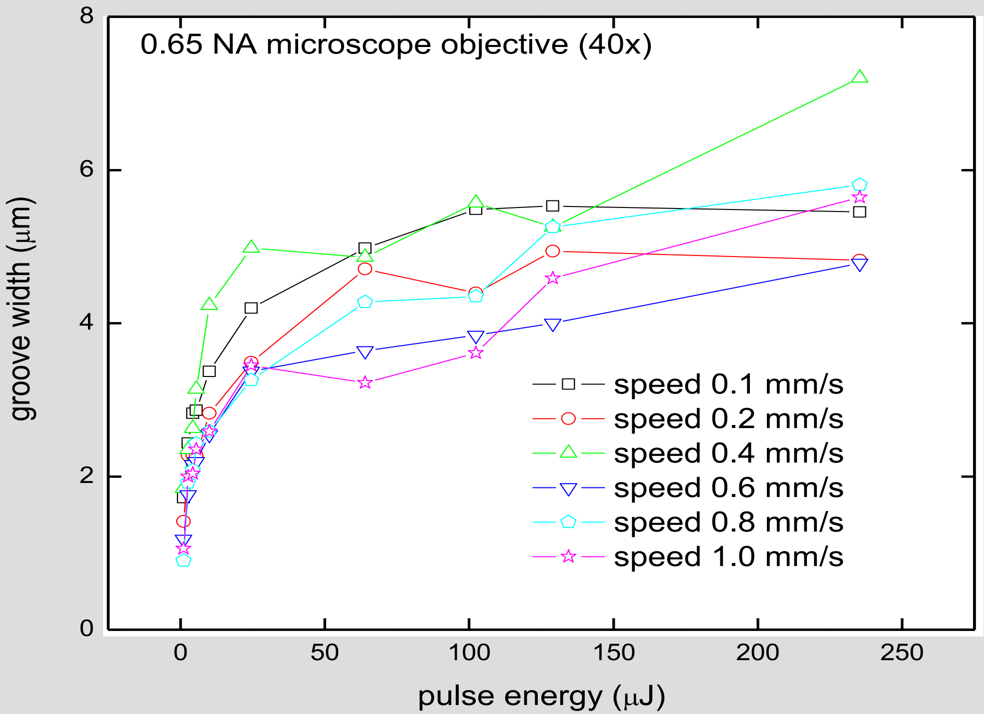




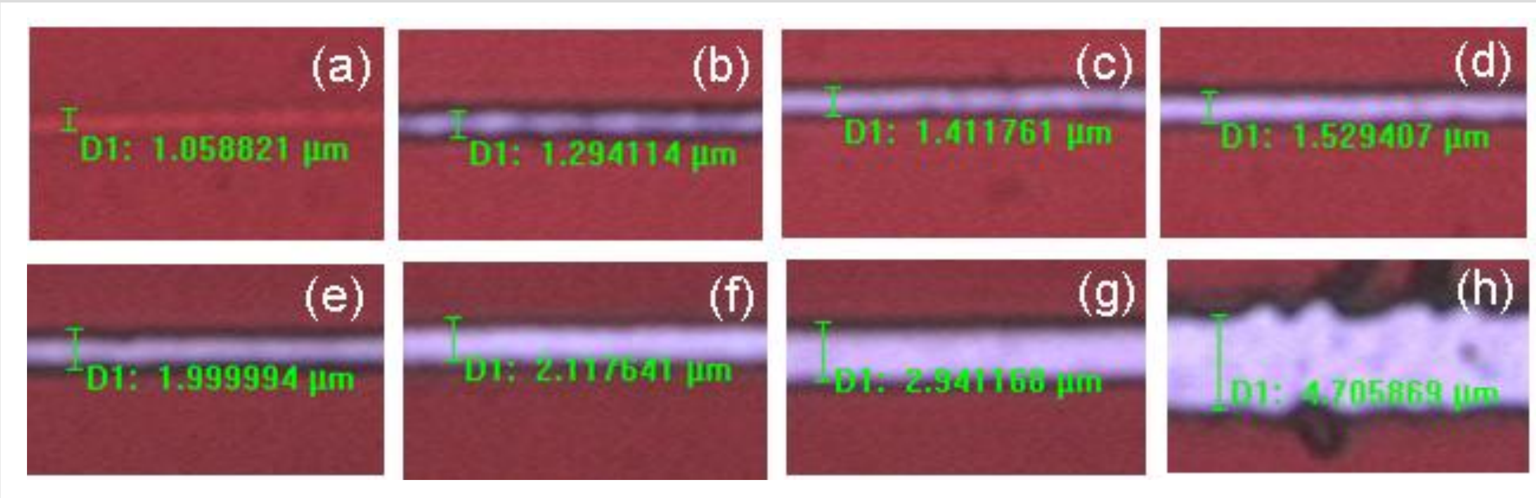




The influence of pulse energy and translation speed on the micromachining was studied using optical and atomic force microscopy.



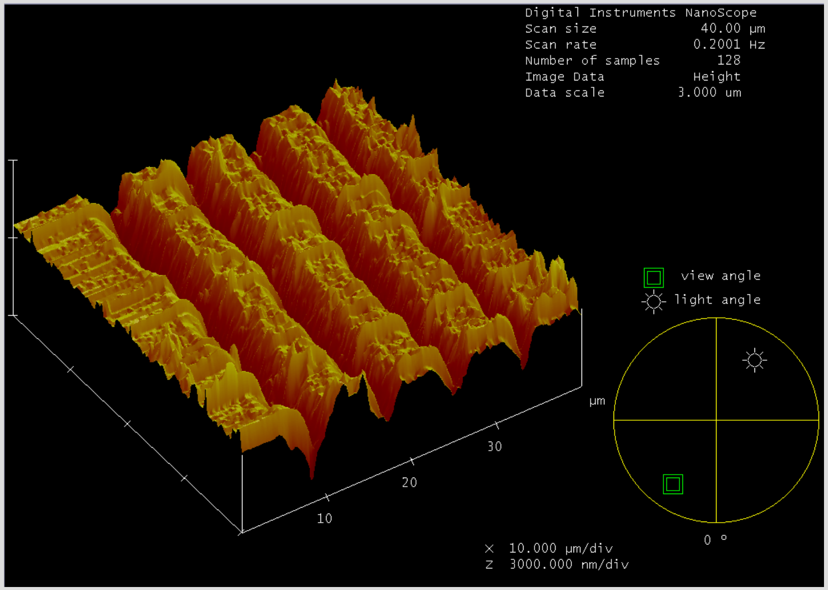
Results

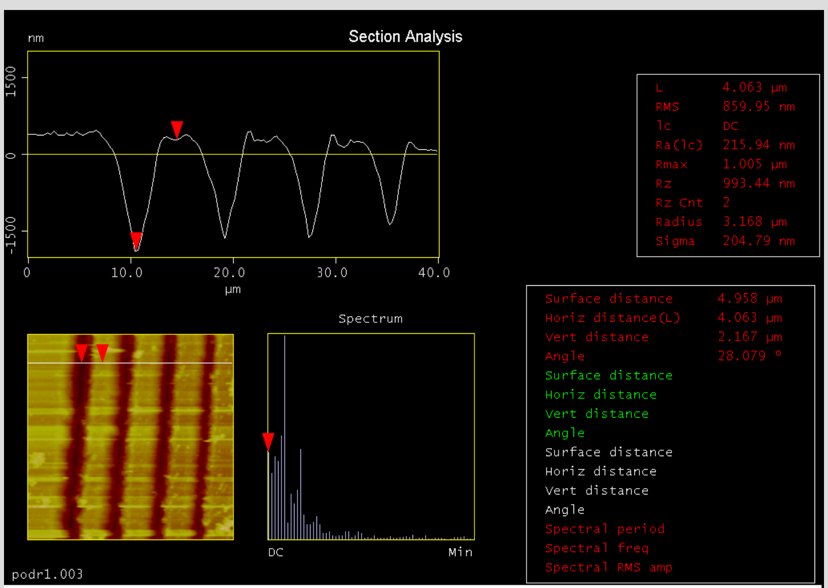


(a) E=0.7 µJ
(b) E=1.9 µJ
(c) E=2.6 µJ
(d) E=4.0 µJ
(e) E=6.5 µJ
(f) E=14.7 µJ
(g) E=31.1 µJ
(h) E=130 µJ

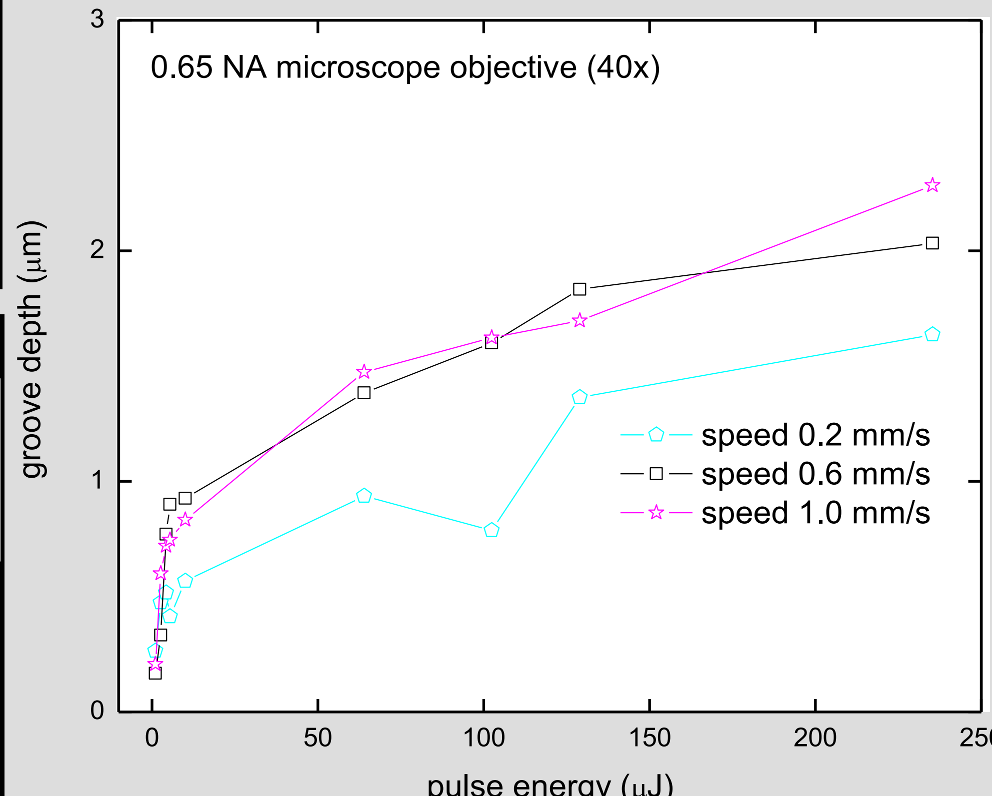
Optical microscope images of grooves produced on the sample at a translation speed of 1 mm/s and various pulse energies. The widths of the grooves vary from 1 to 4.7 µm when the pulse energy is increased from 0.7 to 130 µJ.

Results



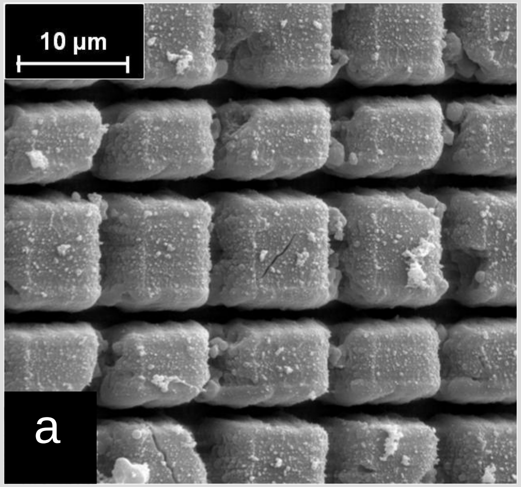


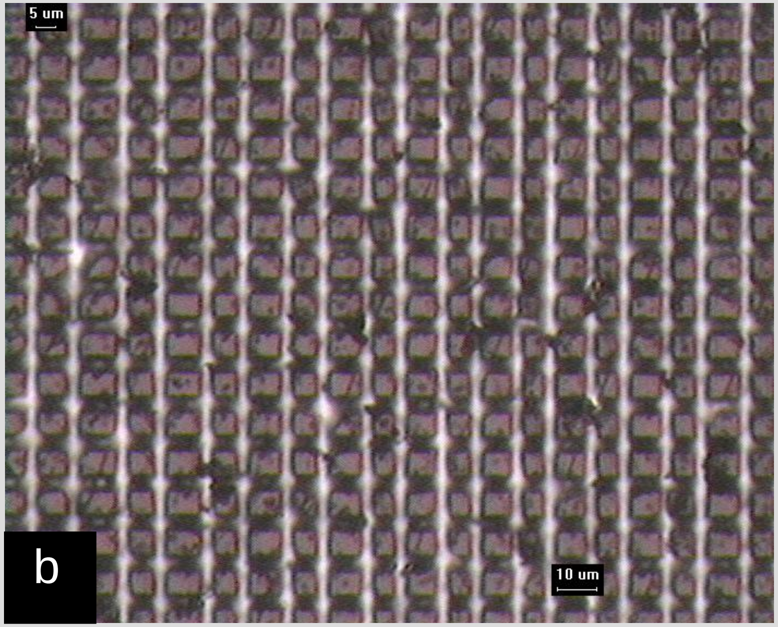
The depths of the grooves were determined using atomic force micrographs, and are plotted as a function of pulse energy. The groove depth increases with increasing pulse energy.

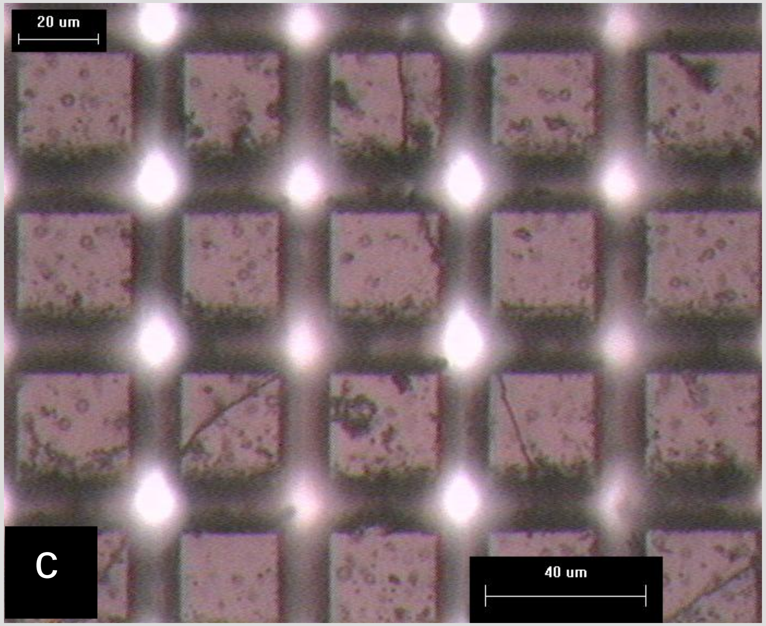


Results

Figure (a) shows a scanning electron microscopy of the microstructured film surface with a periodicity 10 μm. Figures (b) and (c) show optical microscope images of the sample´s surface microstructured with periodicities of 10 and 40 μm, respectively.



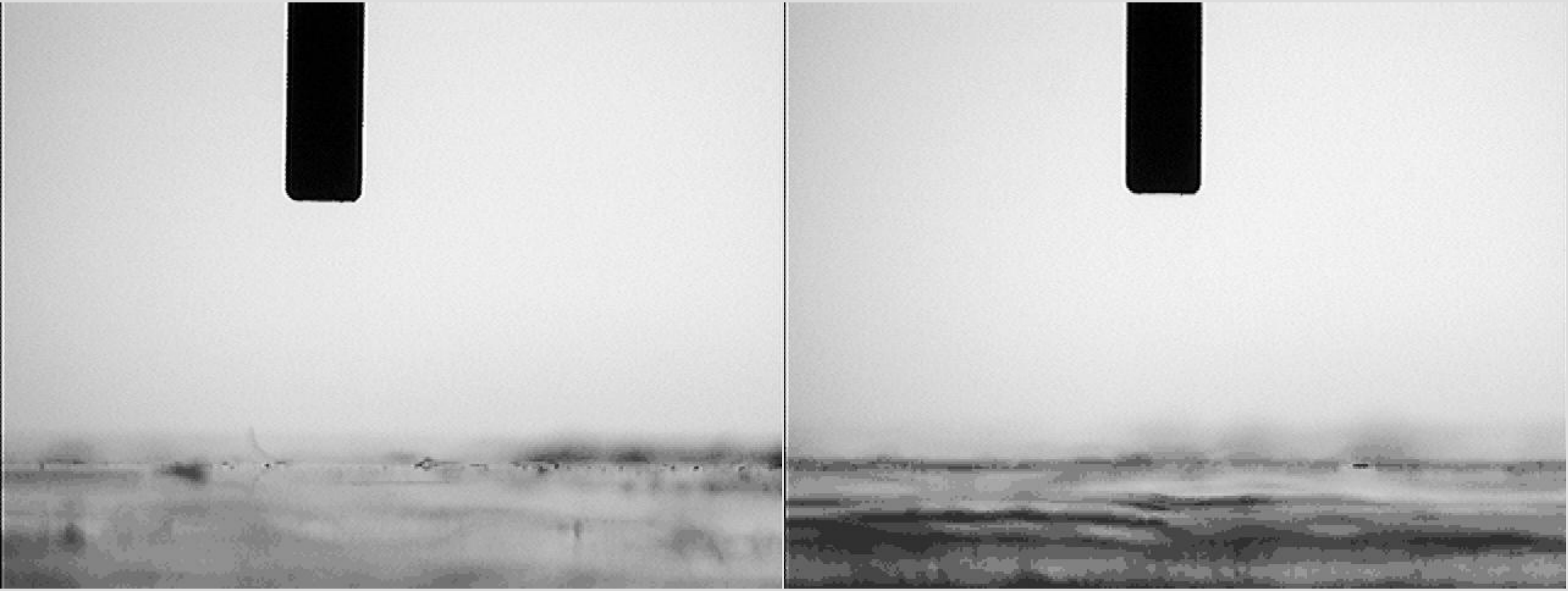




The sample is coated with a layer of (heptadecafluoro-1,1,2,2-tetrahydrodecyl)trichlorosilane

Results

The contact angle of the water droplet on the flat surface is 115°, while on the microstructured surface the contact angle is 156°.



Results

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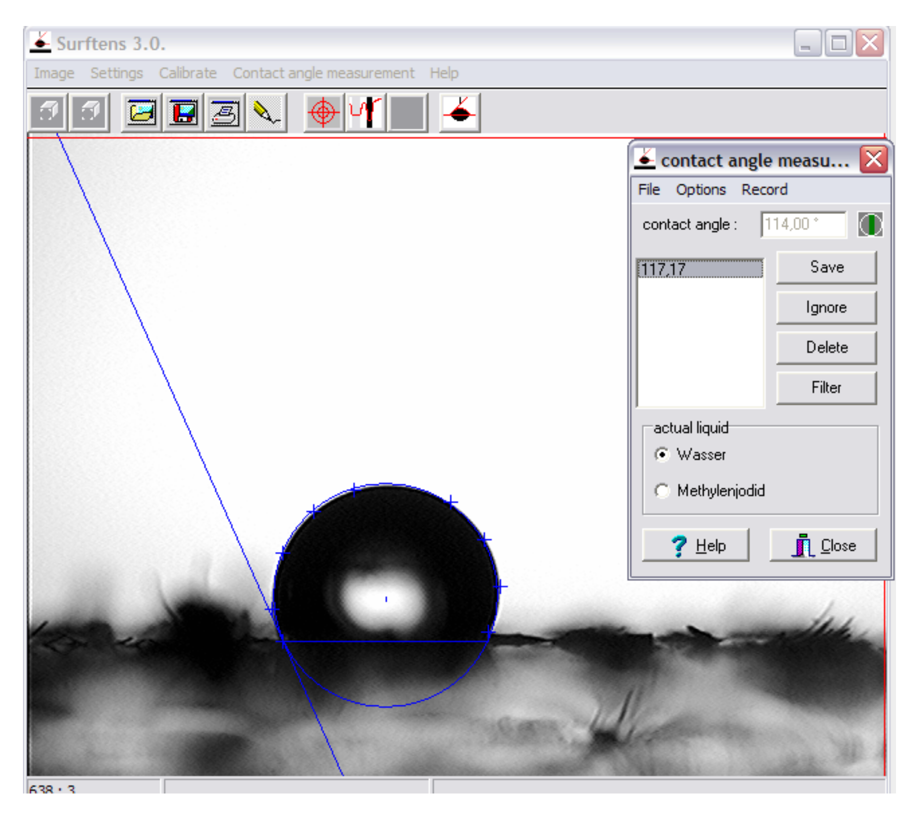
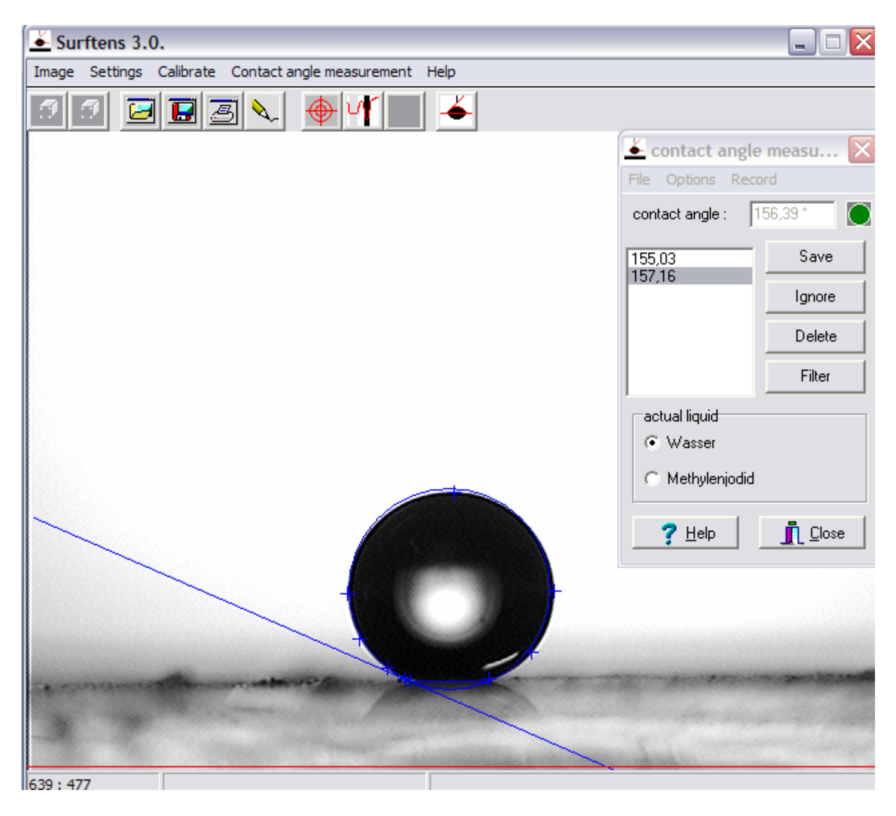
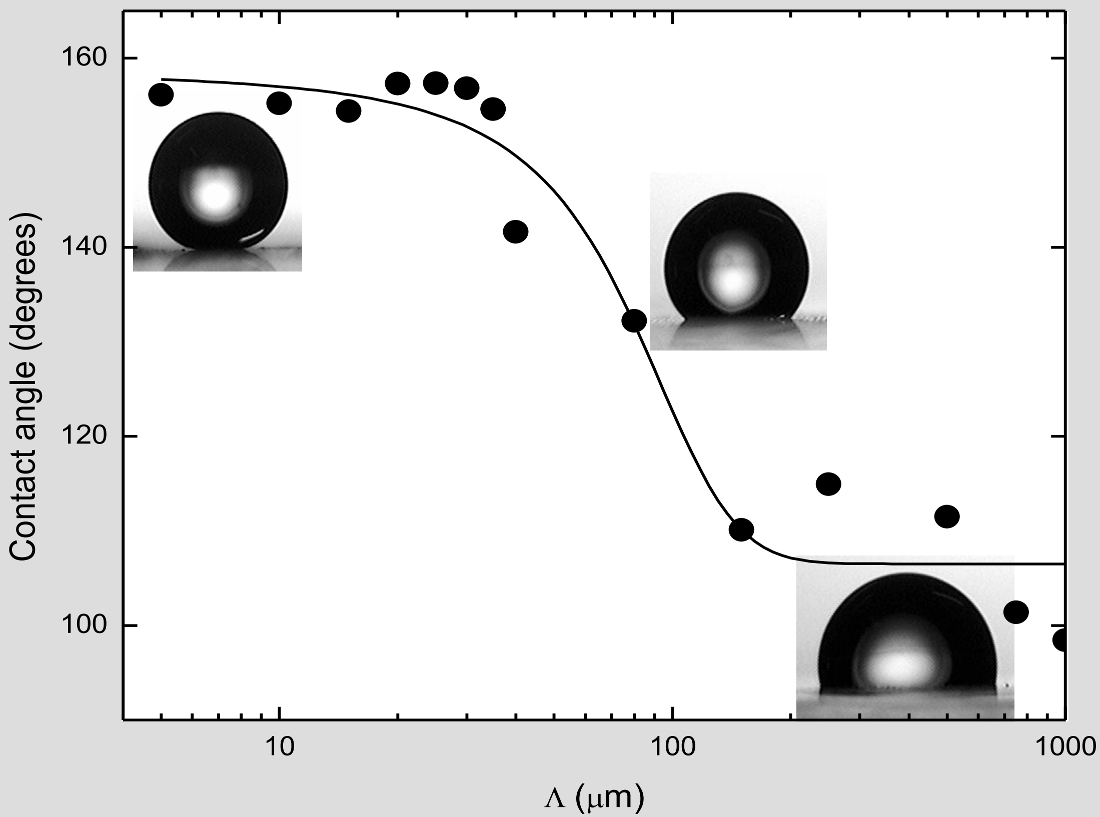




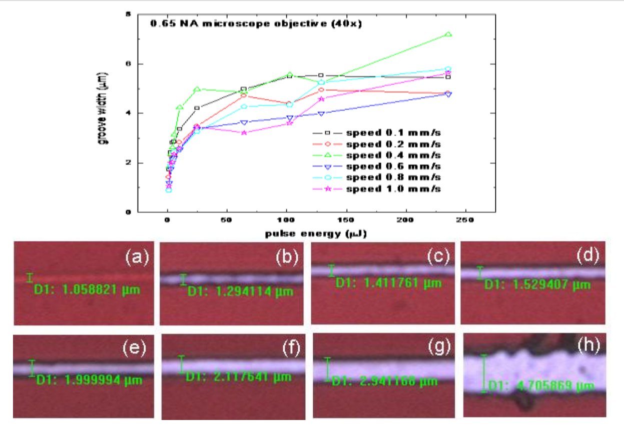
Results

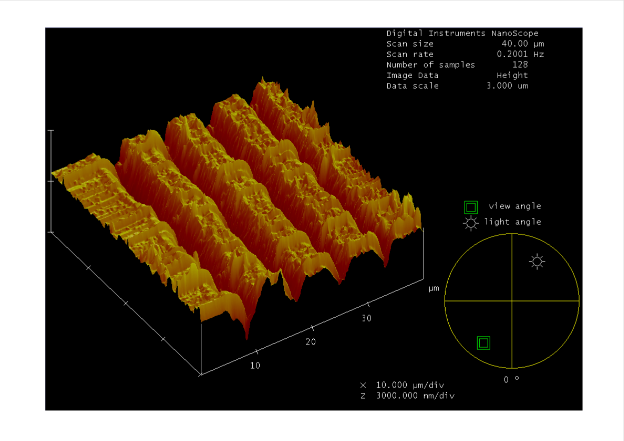
The contact angle of water on the microstructured surfaces as a function of the pattern periodicity is shown in the figure below. The wetting properties are very stable for the structure's periodicity until 35 µm, maintaining the same superhydrophobic characteristic.

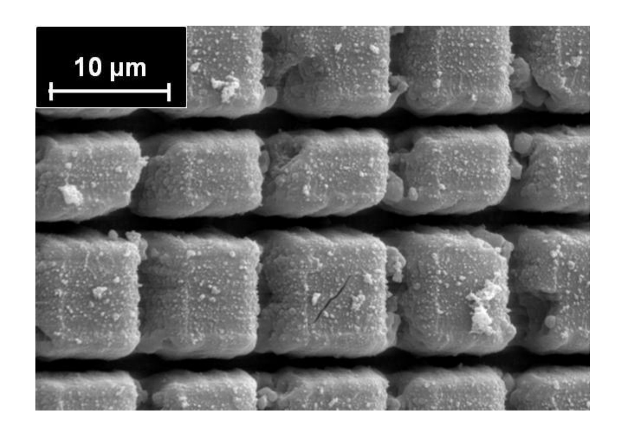


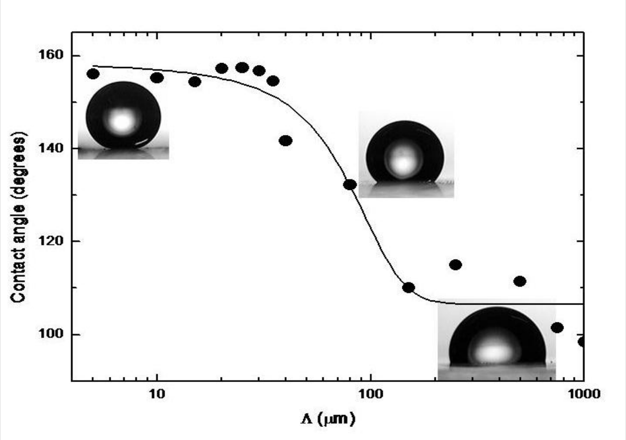
Summary

- Ablation threshold
  - Influence pulse energy
  - Translation speed
- Superhydrophobicity threshold
  - Width and space of grooves









Conclusion

We show that it is possible to increase the hydrophobicity of polymeric surfaces by ps-laser micromachining. Our results revealed an increase of 36% in the contact angle for water in the microstructured surface, reaching superhydrophobicity.

Acknowledgments

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