# *Laser micromachining in azopolymers*


**M. R. Cardoso, V. Tribuzi, D. T. Balogh,**

**L. Misoguti and C. R. Mendonça**

***Departamento de Física e Ciência dos Materiais, Instituto de Física de São Carlos / USP, SP, Brasil, +55 (16) 3373-8085, crmendon@ifsc.usp.br***

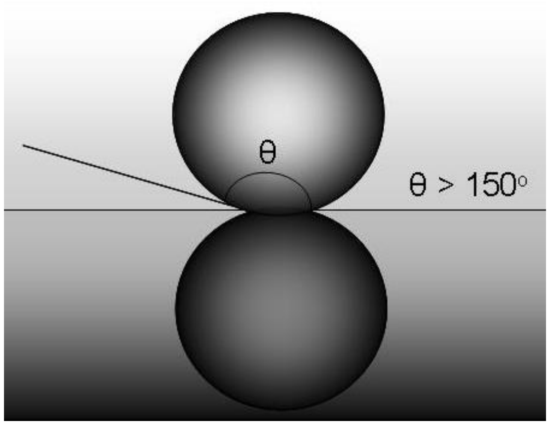
**http://www.fotonica.ifsc.usp.br**

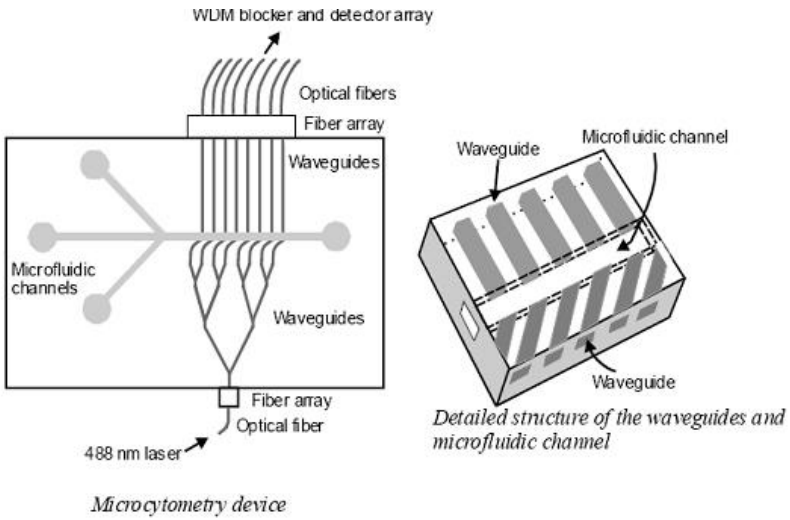
# Abstract

Picosecond laser micromachining of Poly(1-methoxy-4-(O-disperse Red1)-2,5-bis(2-methoxyethyl)benzene) films are investigated using pulses from a frequency doubled (532nm) Q-switched and mode-locked Nd:YAG laser, operating at a repetition rate of 850Hz, aiming to produce superhydrophobic surfaces. Our results revealed a contact angle of 120º on the flat surface, while an angle of 160º was obtained on the microstructured surface.

# Introduction

Superhydrophobic surfaces exhibit contact angles with water that are greater than 150° and insignificant hysteresis. The wettability of a surface depends on its chemical nature and topology.



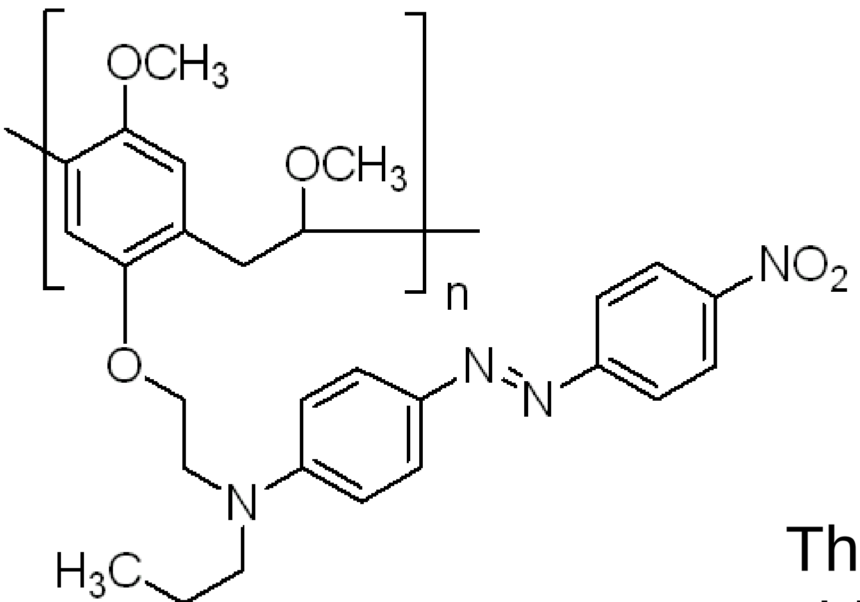



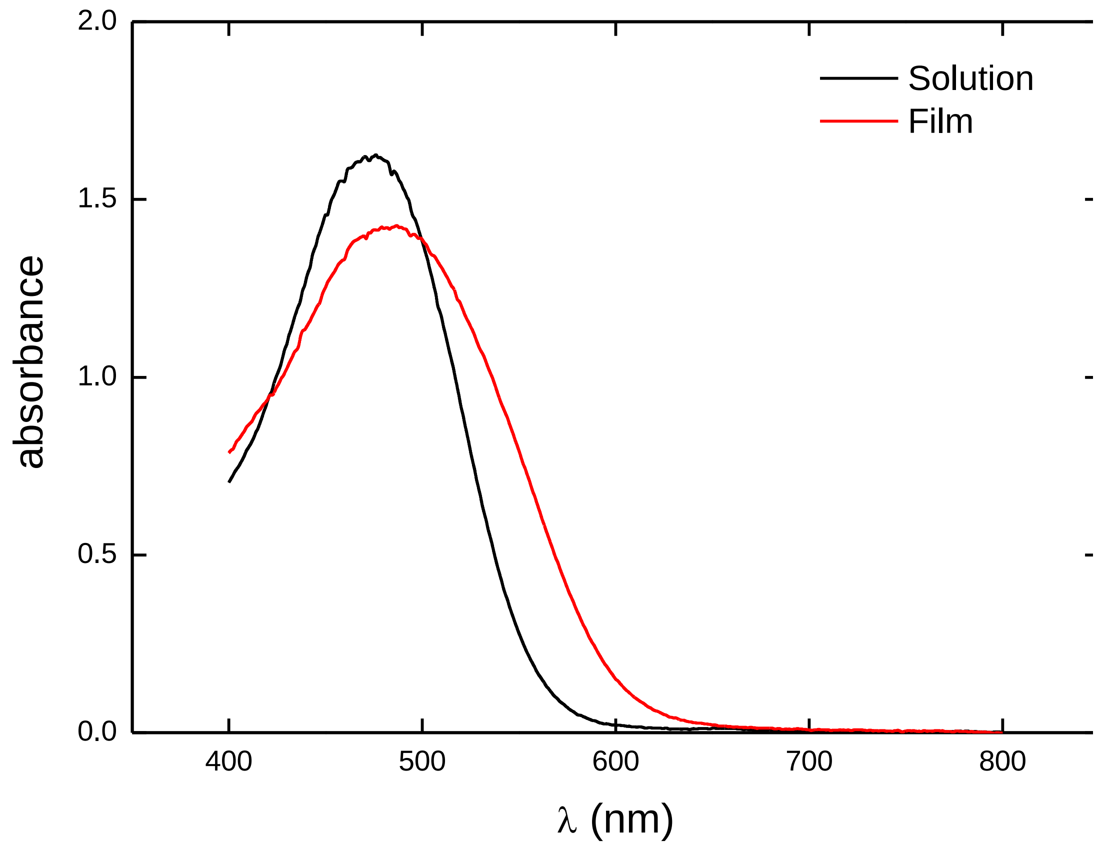

Flow cytometry (Dr. Chang-qing Xu McMaster University)
http://www.cpfr.ca/Projects/ProjectSummary10.aspx

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

# Sample Studied

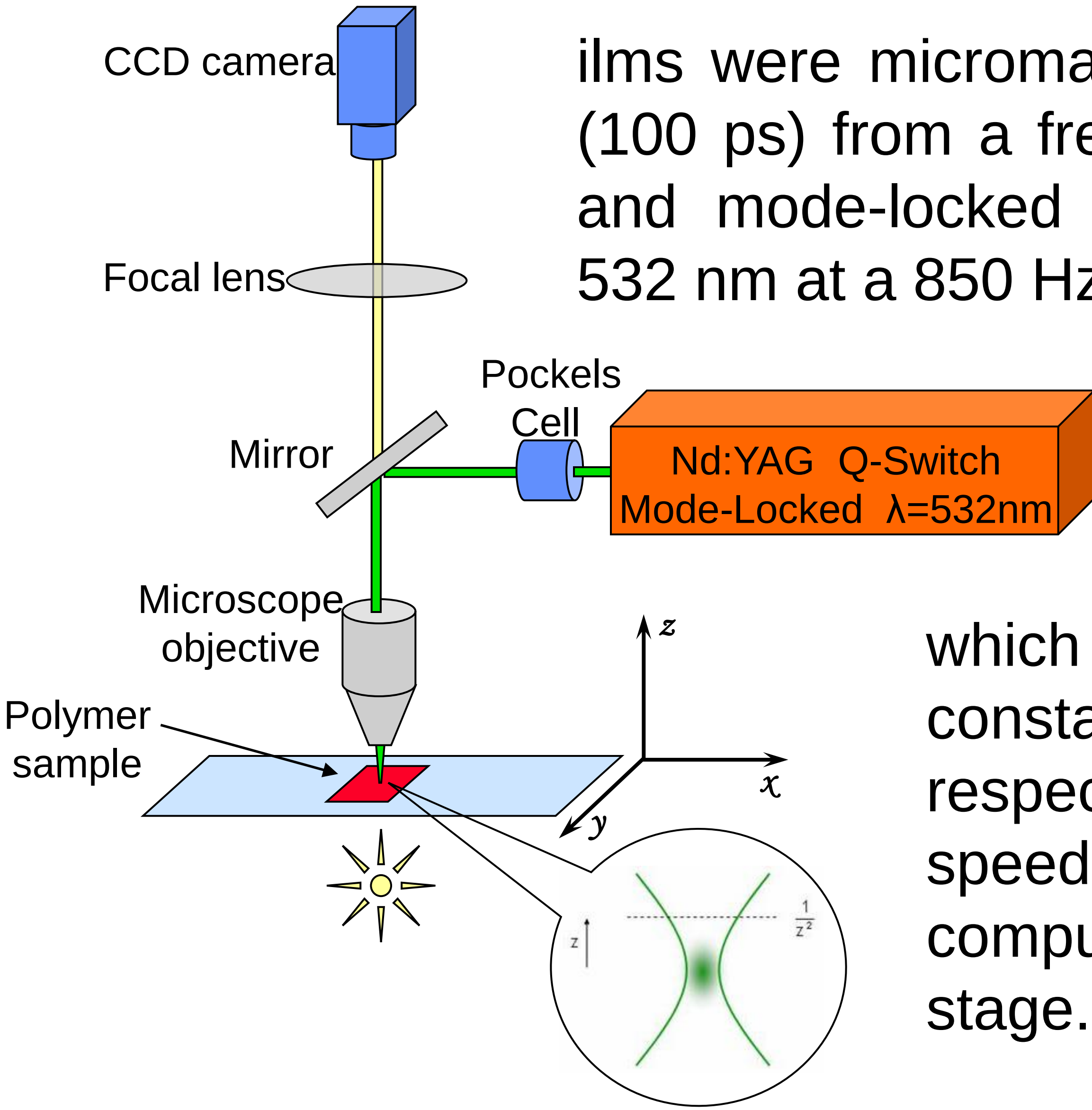
Poly(1-methoxy-4-(O-disperse Red 1)-2,5-bis(2-methoxyethyl)benzene),




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

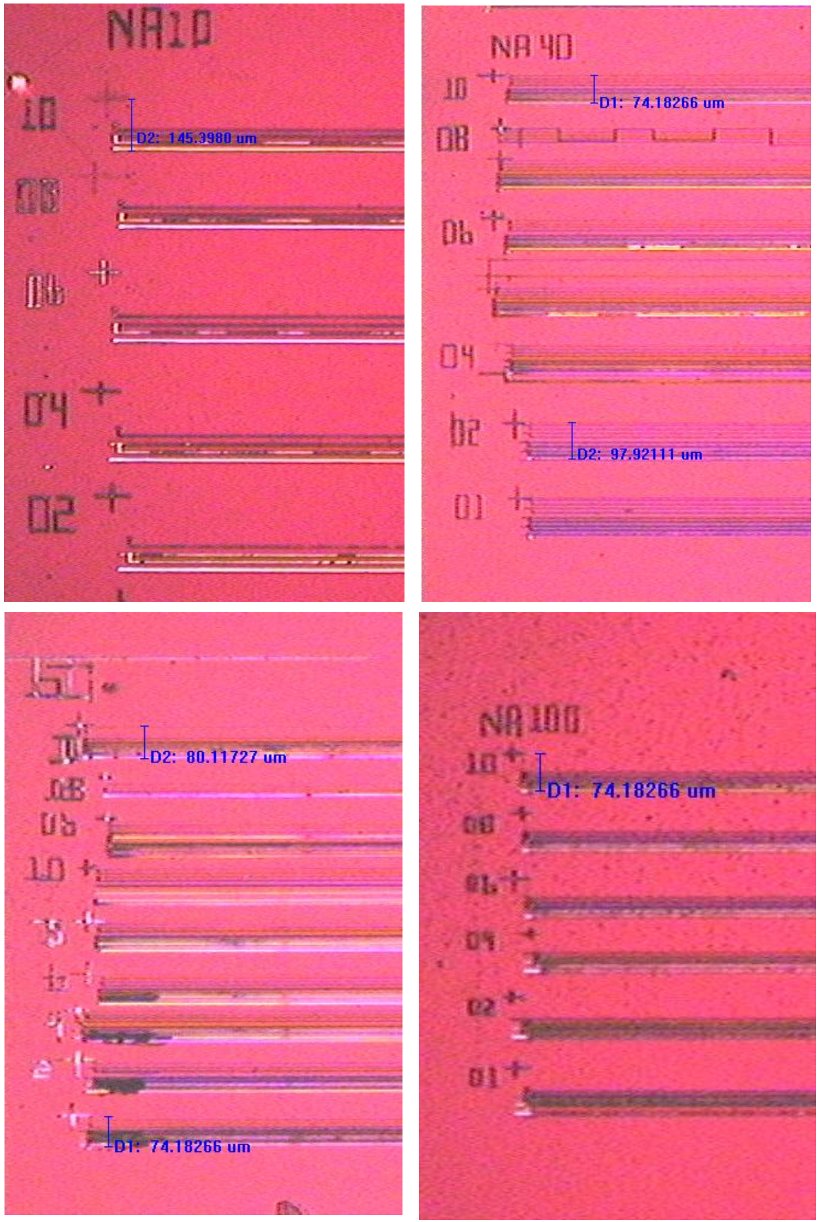
# *Methodology*



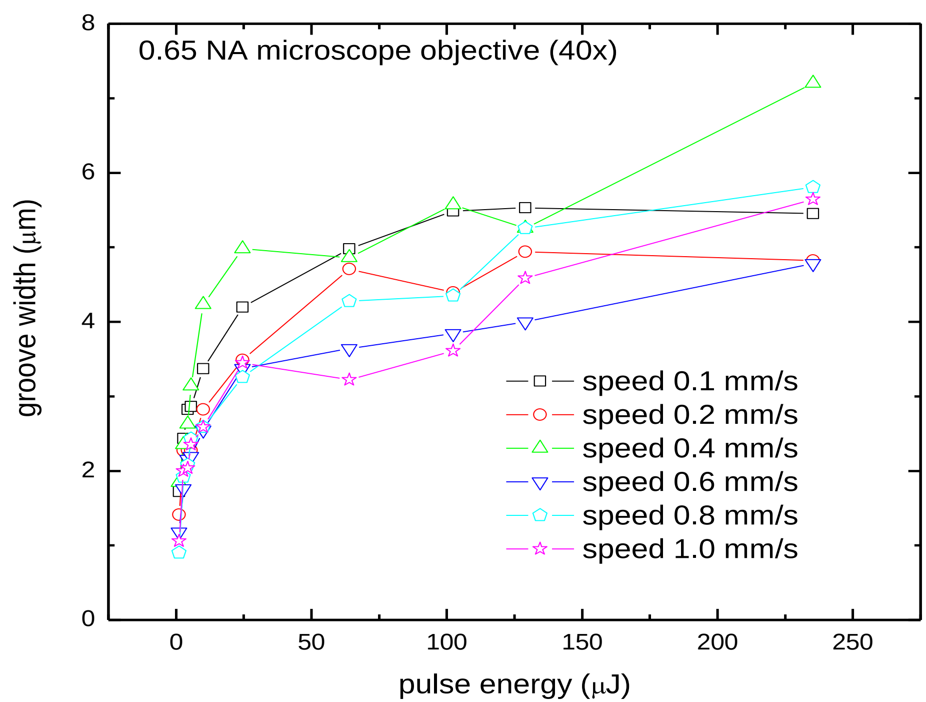

ilms were micromachined using a single pulse (100 ps) from a frequency-doubled Q-switched and mode-locked Nd:YAG laser operating at 532 nm at a 850 Hz repetition rate.

The pulses were focused through 0.65 NA microscope objective onto the sample surface, which was translated at a constant speed (1mm/s) with respect to the laser beam. The speed was maintained by a computer controlled translation stage.

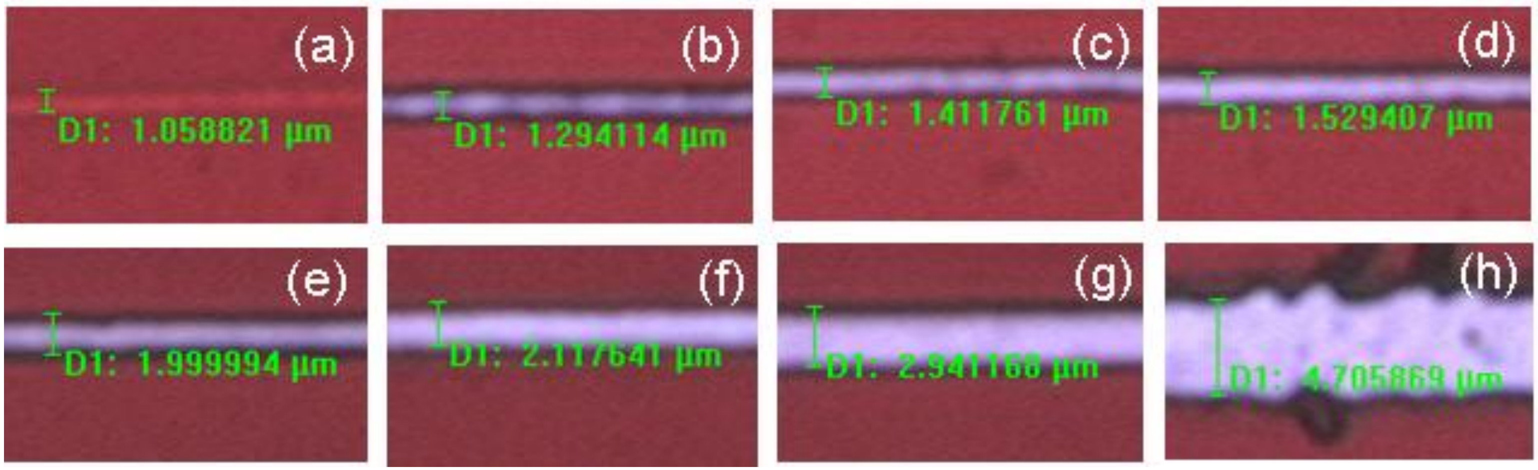
# Results




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



# Results

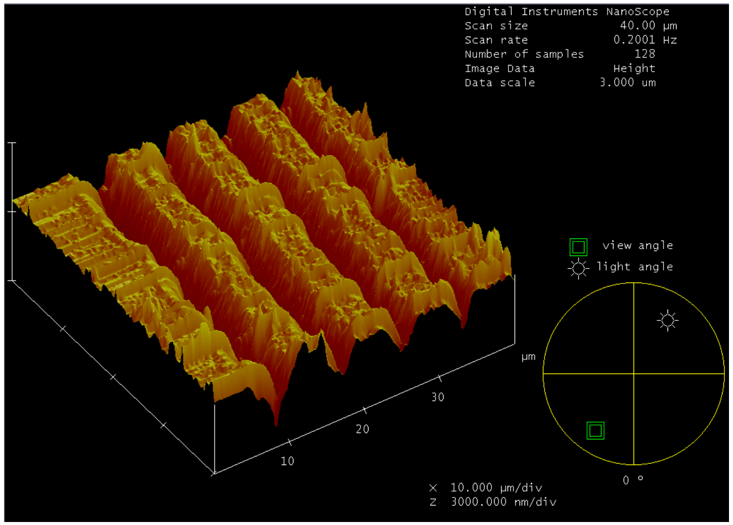


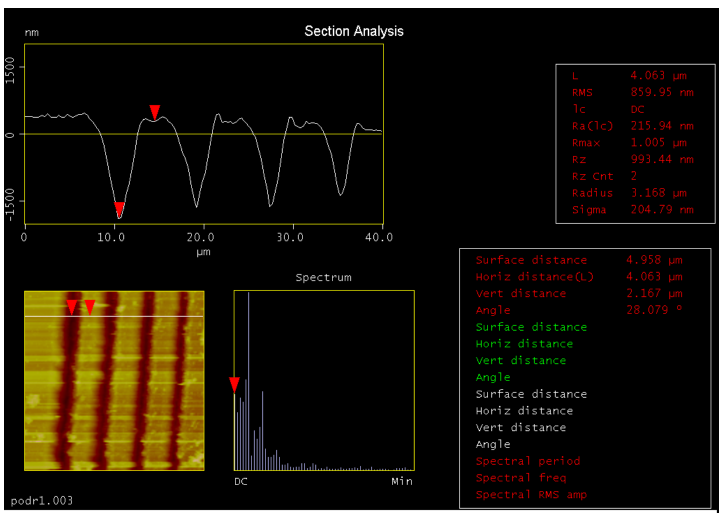

(a) E=0.7 µJ
(b) E=1.9 µJ
(c) E=2.6 µJ
(d) E=4.0 µJ
(e) E=6.5 µJ
(f) E=14.7 µJ
(g) E=31.1 µJ
(h) E=130 µJ

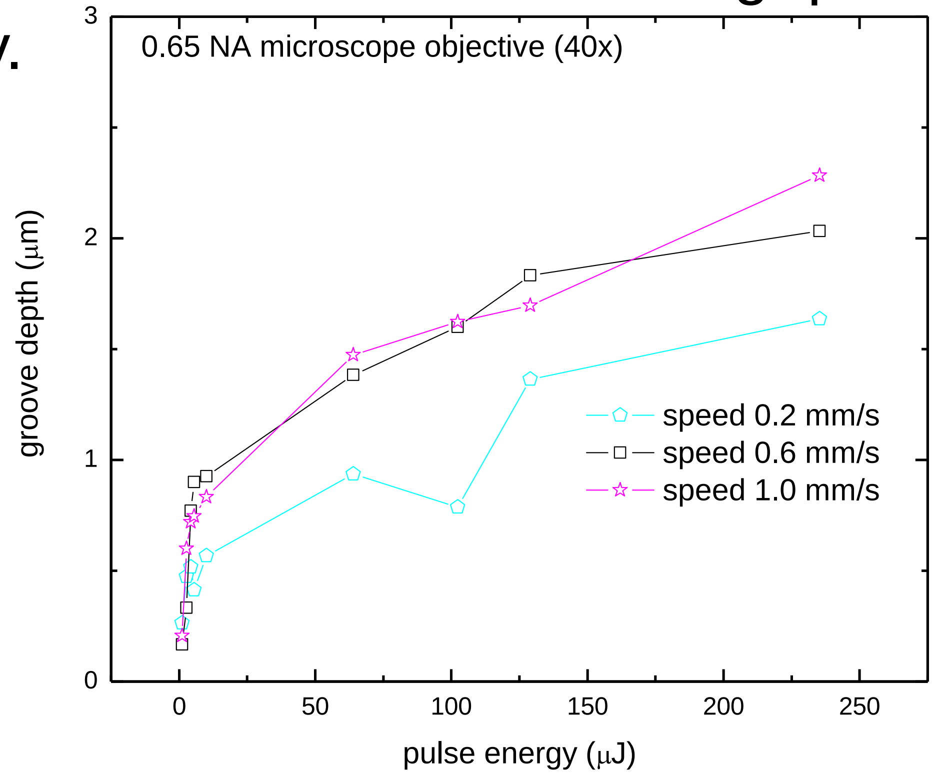
This figure shows optical microscope images of grooves produced on the sample at a translation speed of 1 mm/s and various pulse energies. The widths of the grooves vary from 1 to 4.7 µm when the pulse energy is increased from 0.7 to 130 µJ.

# 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.

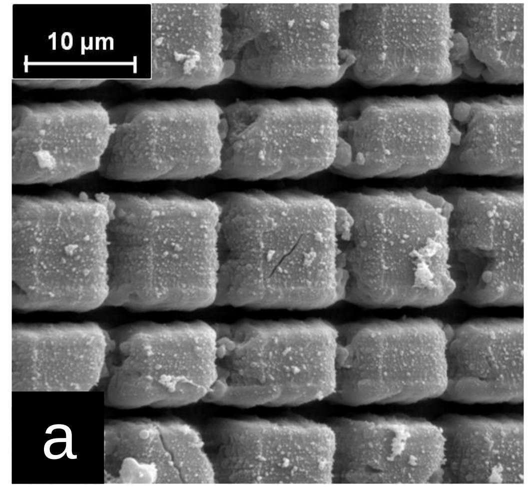


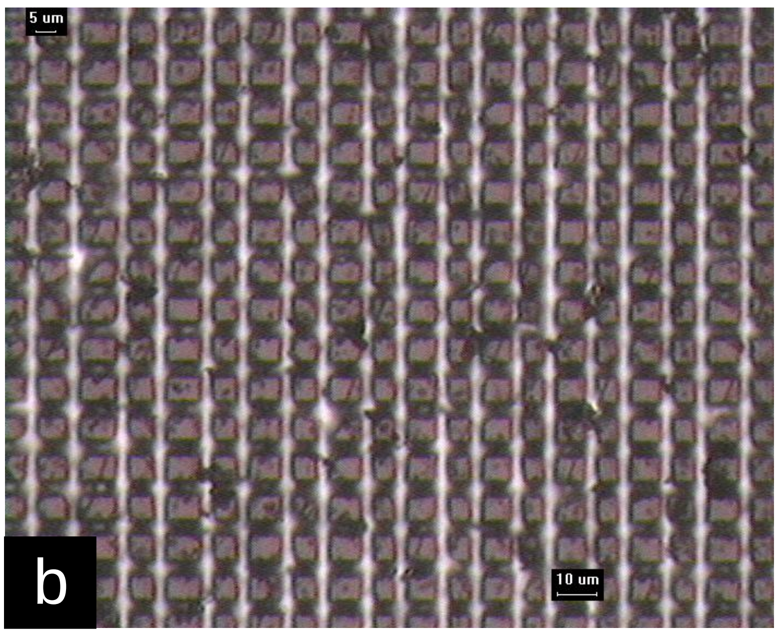



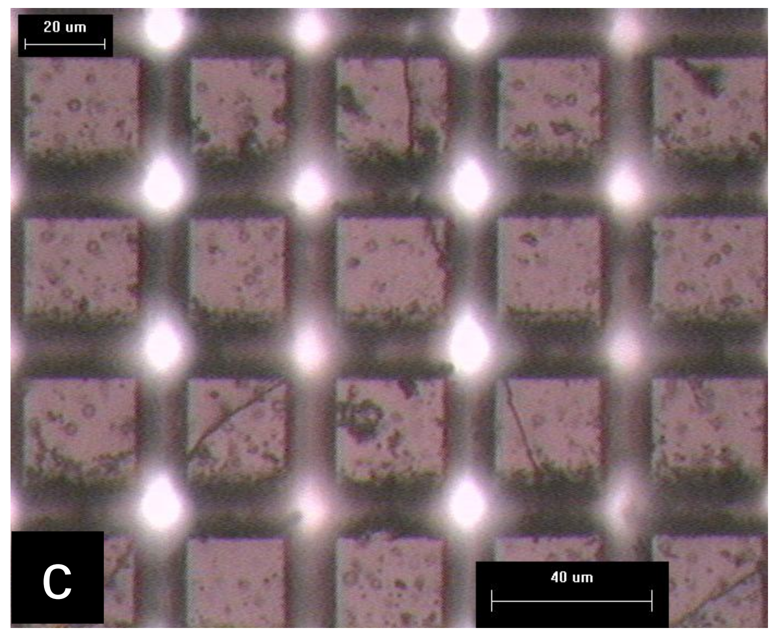



# Results

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.

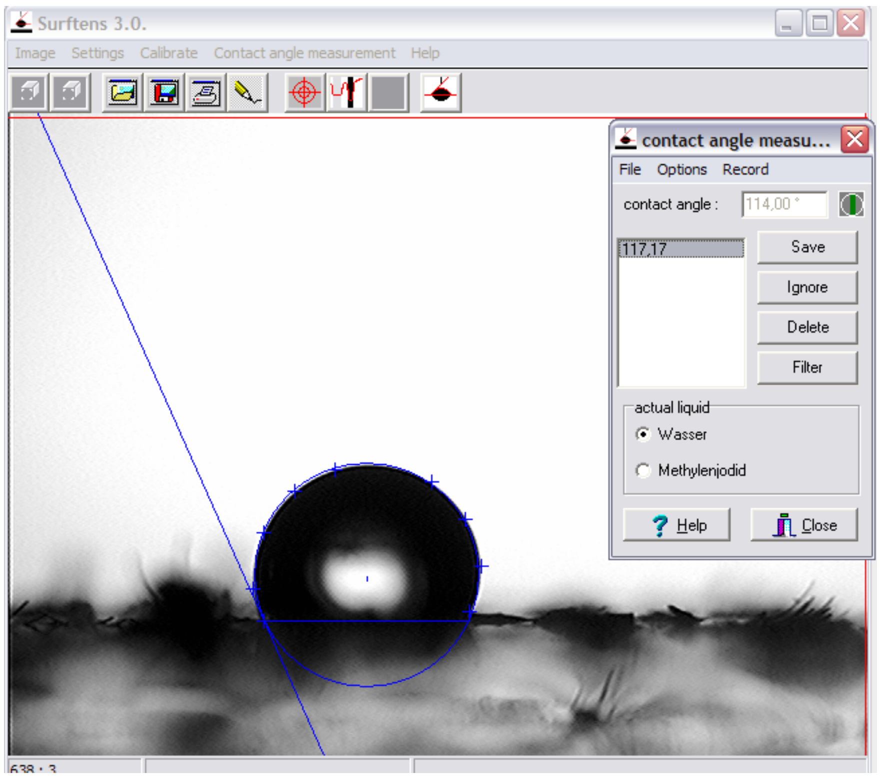


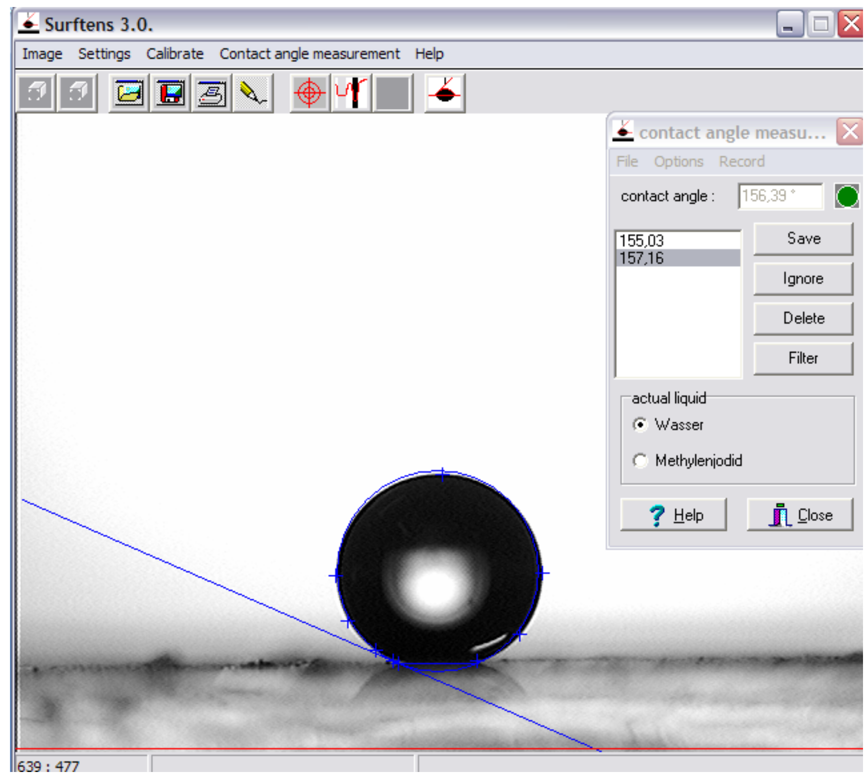



# Results

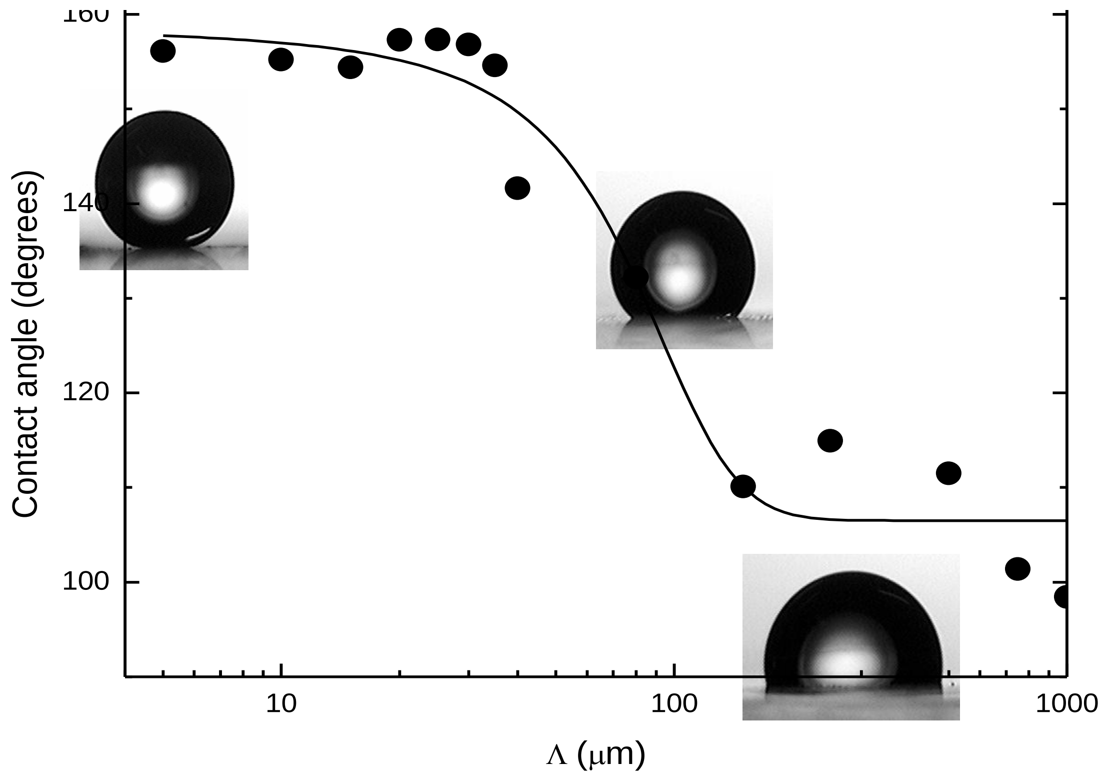
The sample is coated with a layer of (heptadecafluoro-1,1,2,2-tetrahydrodecyl)trichlorosilane to increase its natural hydrophobicity. The contact angle of the water droplet on the flat surface is 115°, while on the microstructured surface the contact angle is 156°.



# 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.



# 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.

**Acknowledgement:** The authors acknowledge FAPESP, CNPq and CAPES for financial support, and are grateful to André L. S. Romero for his assistance.

**http://www.fotonica.ifsc.usp.br**