

Replication of nanotextures using UV nanoimprint lithography

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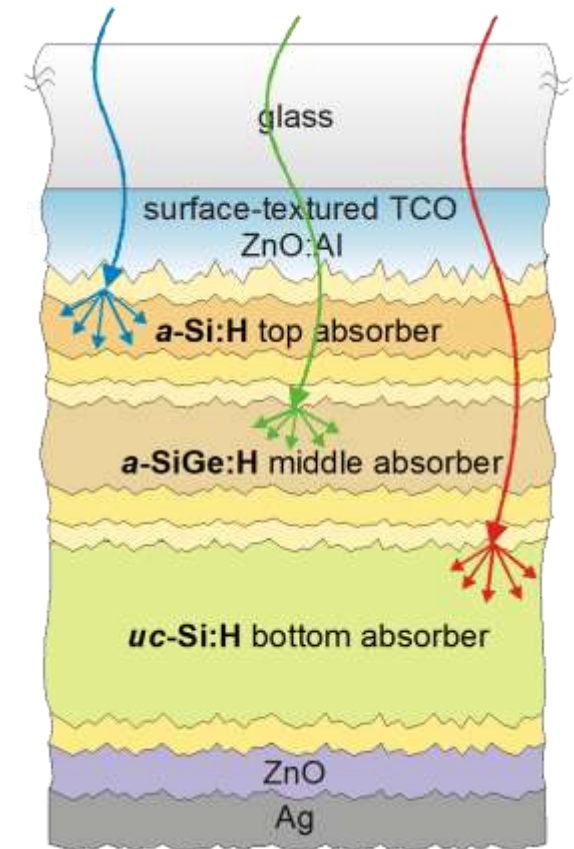
Introduction

■ Increasing the conversion efficiency in thin film solar cell

- › Light scattering at textured surface
- › Longer optical path

■ Texturization

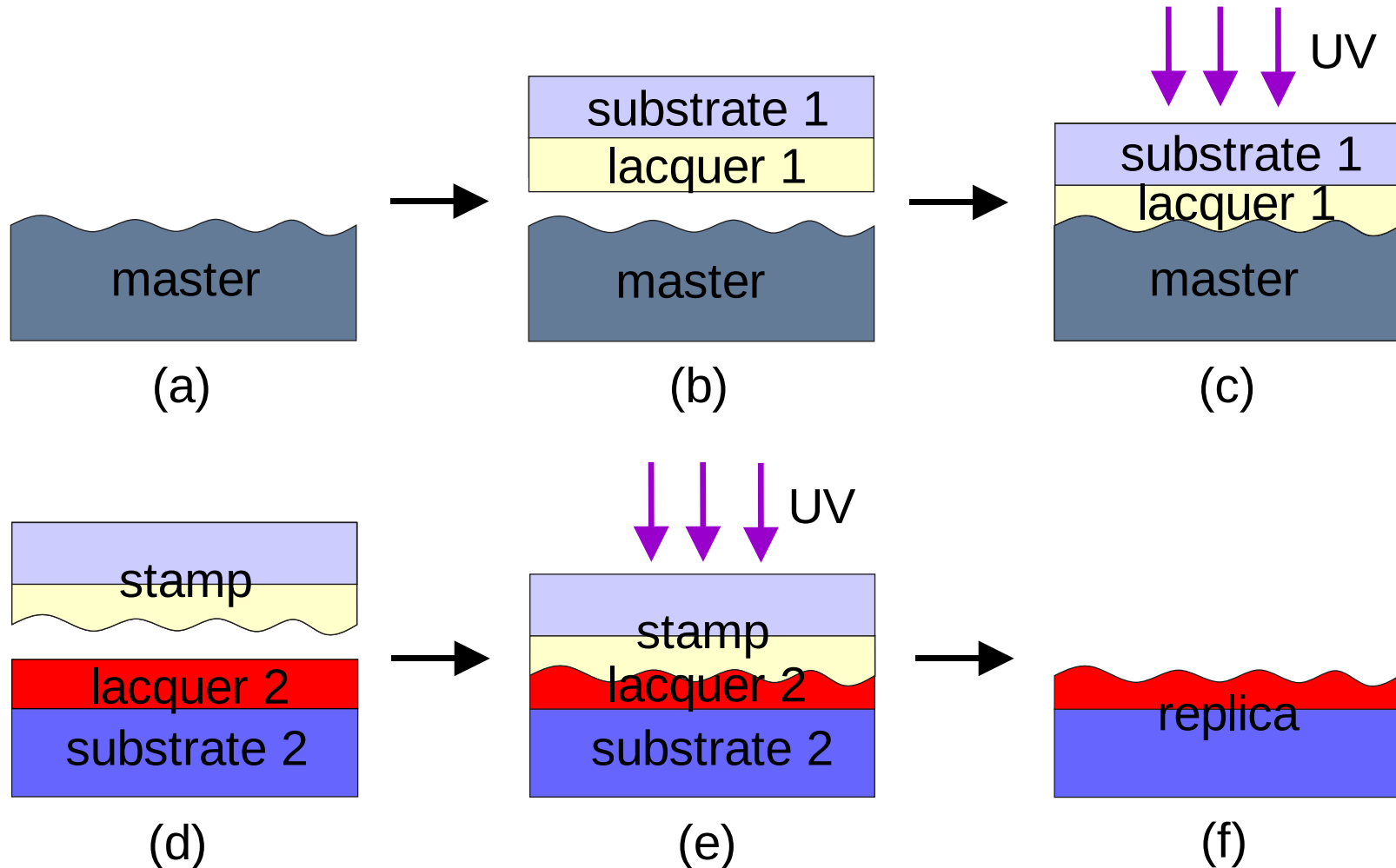
- › Natural growth
 - LPCVD ZnO
- › Etching existing layers
 - Magnetron sputtered ZnO etched in HCl
- › Pre-fabricated textures
 - Nanoimprint lithography
 - Thermal NIL
 - UV NIL



UV NIL

- Replicating the master texture with the help of an intermediate stamp
- Imprint under UV light – UV sensitive lacquers harden and adopt the structure of the master
- Accurate in nanometer scale
- Fast and suitable for roll-to-roll manufacturing
- Stamp can be used several times
- Needs further processing - layer deposition – for thin-film solar cell applications

Schematic procedure of the UV NIL imprint



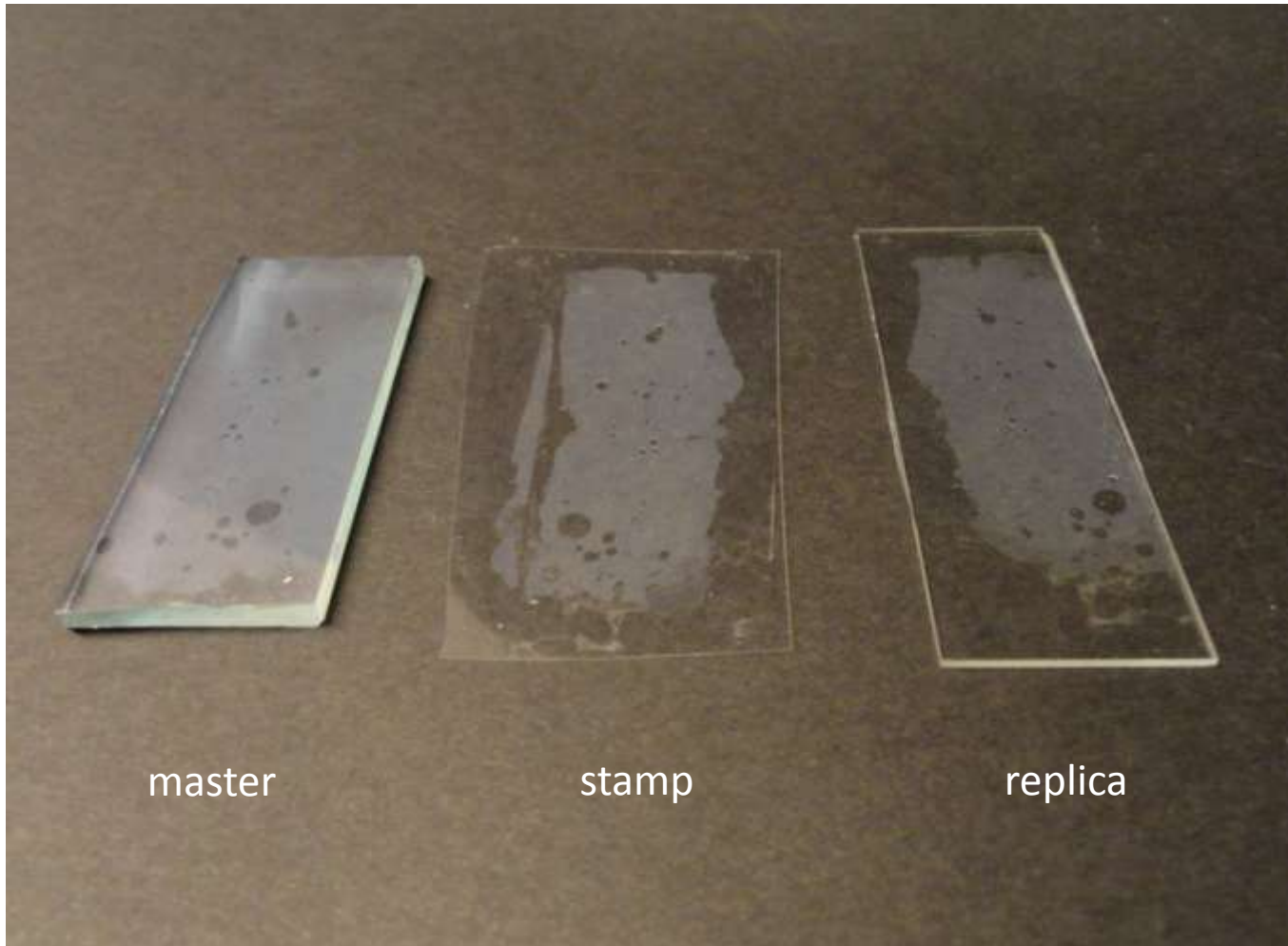
Experimental 1

- Master: TCO $\text{SnO}_2\text{:F}$ solaronix 30/8
 - › Randomly textured

- Stamp
 - › Substrate: PET film
 - › Stamp lacquer
 - › Deposition technique: dr. blade
 - › Illumination time: ~10 min

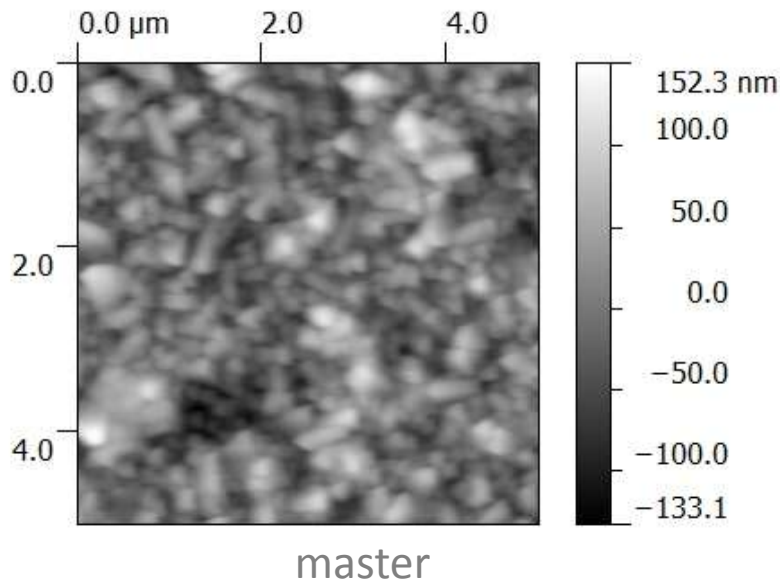
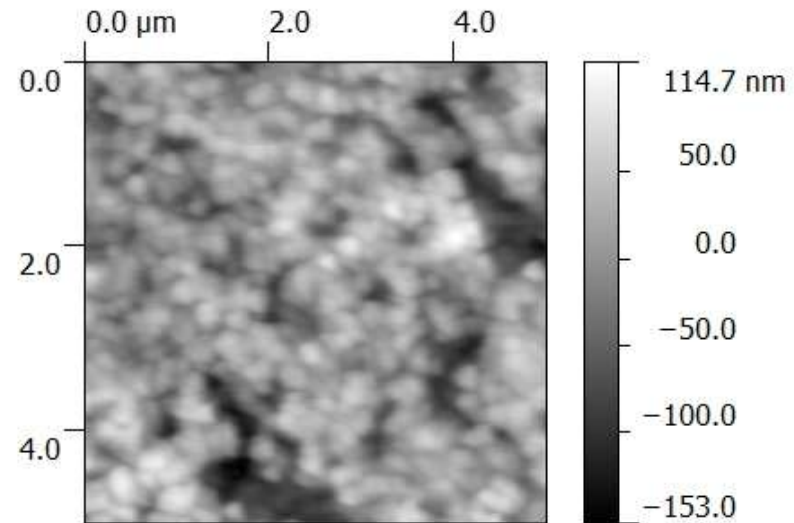
- Replica
 - › Substrate: glass slide
 - › Replica lacquer and adhesion lacquer for better adhesion to the glass
 - › Deposition technique: dr. blade
 - › Illumination time: ~15 min

Samples 1

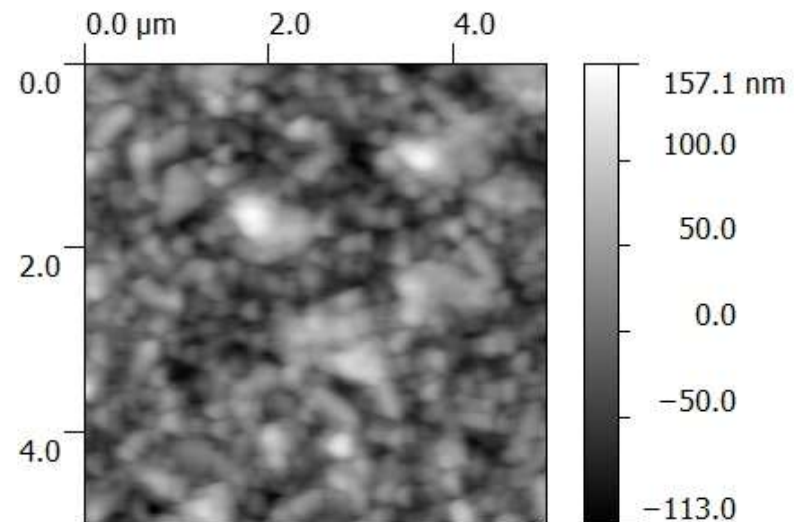


AFM measurements 1

2D surface view



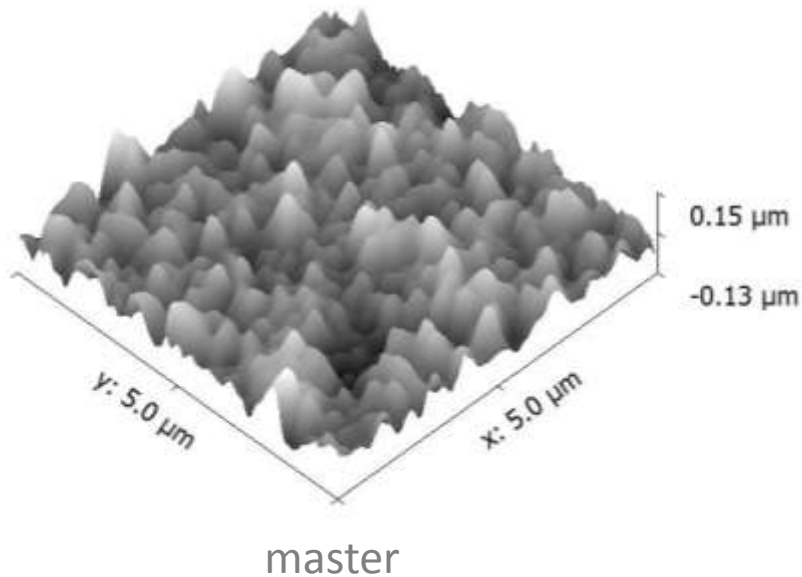
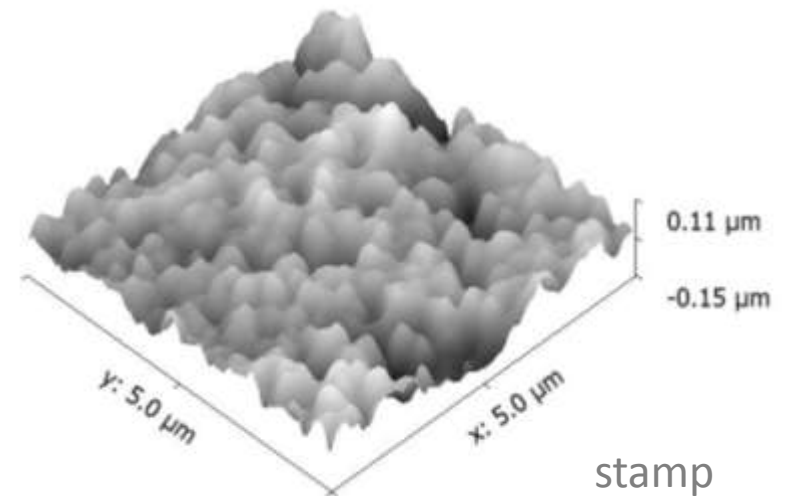
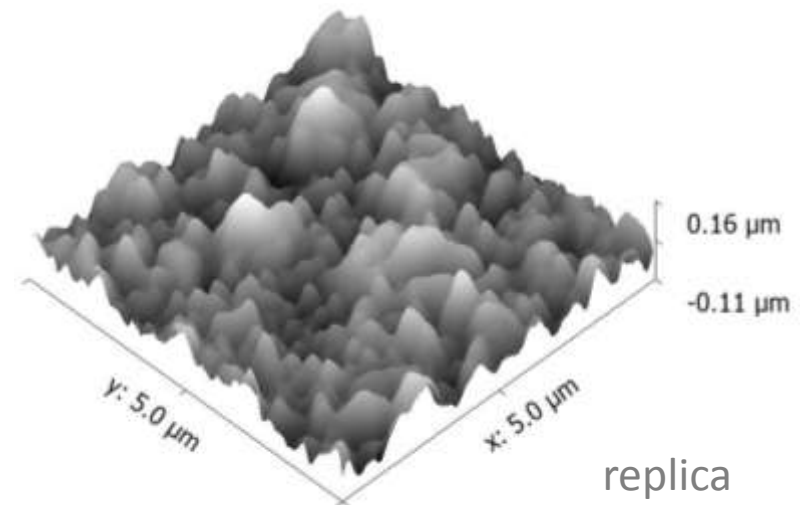
stamp



replica

AFM measurements 1

3D surface view



AFM measurements 1

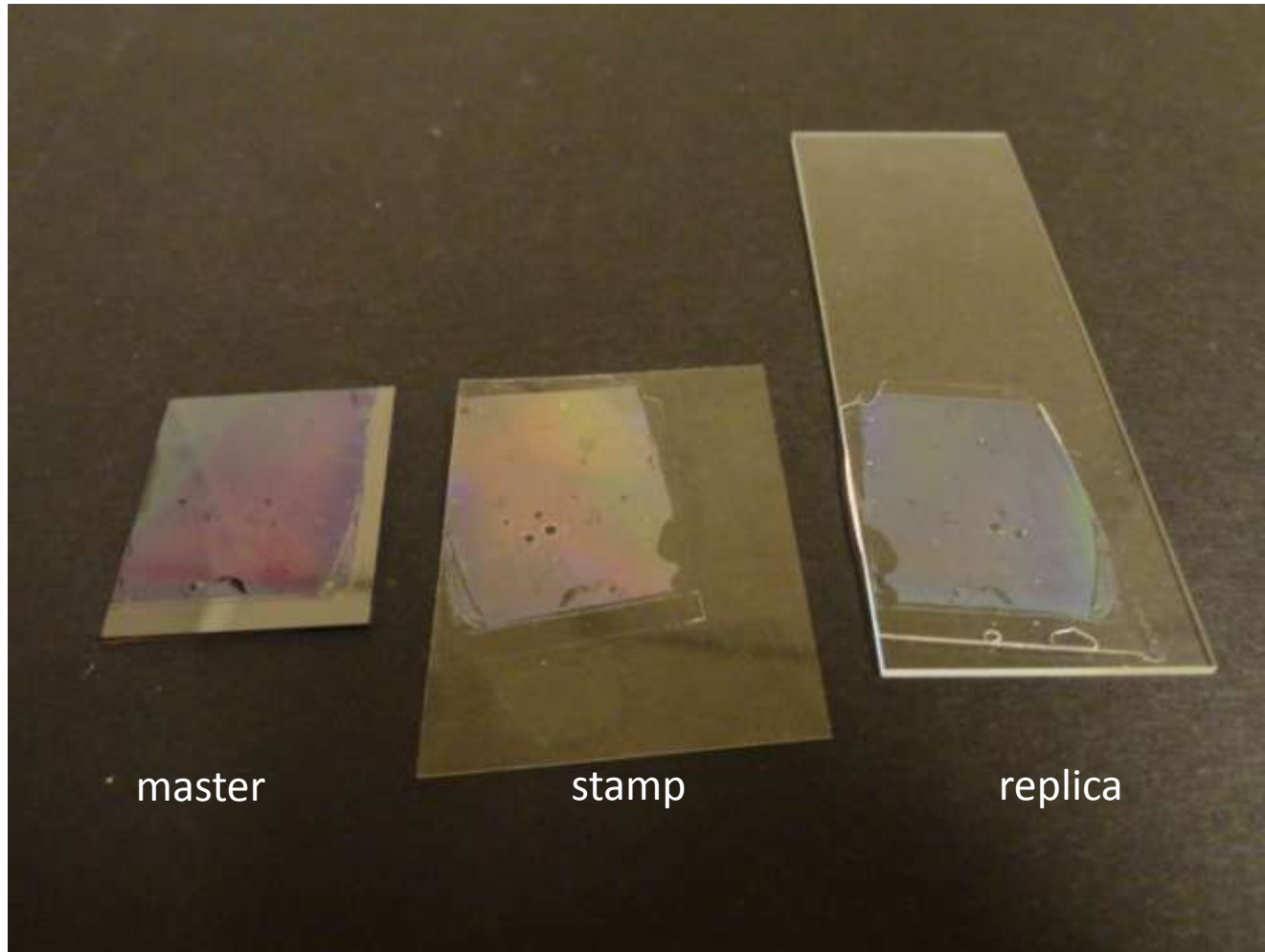
Results of root-mean-square roughness σ_{RMS} and correlation length l

	σ_{RMS} (nm)			Correlation length l (nm)		
	Area 1	Area 2	Area 3	Area 1	Area 2	Area 3
Master	39.4	38.1	39.7	250	240	260
Stamp	43.1	48.3	40.6	250	260	280
replica	39.3	40	38.5	320	250	250

Experimental 2

- Master: inverted pyramids on a silicon substrate
 - › Periodically textured, 900 nm
 - › Master sample made at IMEC, Belgium 
- Stamp
 - › Substrate: PET film
 - › Stamp lacquer
 - › Deposition technique: dr. blade
 - › Illumination time: ~10 min
- Replica
 - › Substrate: glass slide
 - › Replica lacquer and adhesion lacquer for better adhesion to the glass
 - › Deposition technique: dr. blade
 - › Illumination time: ~15 min

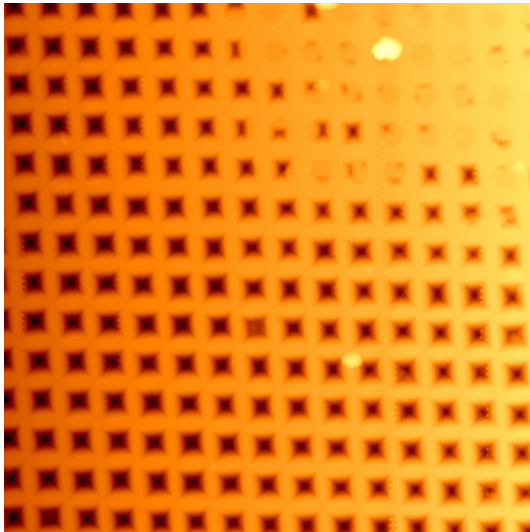
Samples 2



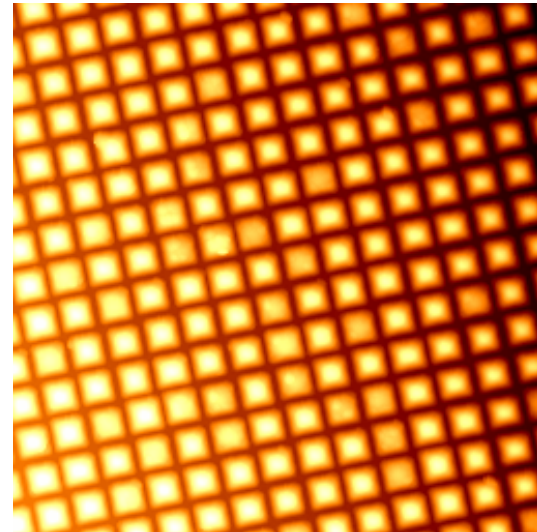
AFM measurements 2

2D surface view - 12 μm scan size

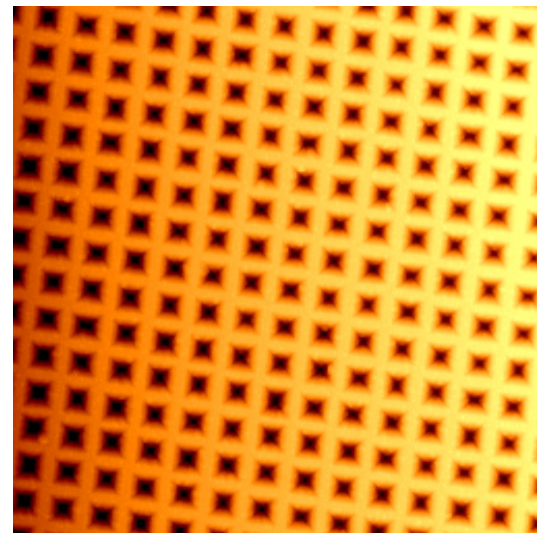
master



stamp



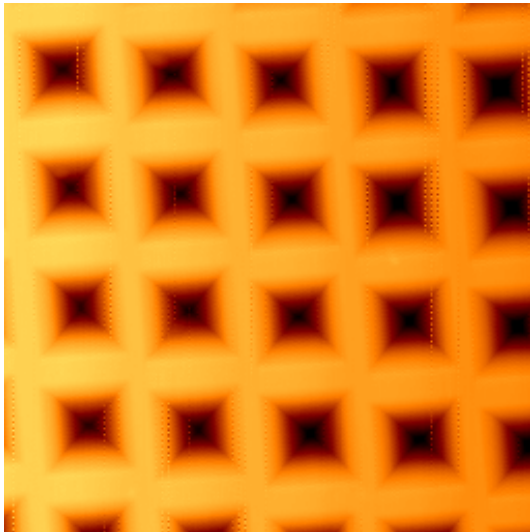
replica



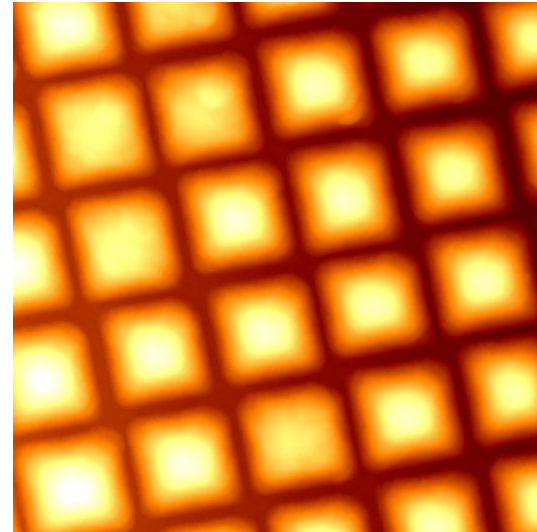
AFM measurements 2

2D surface view - 4 μm scan size

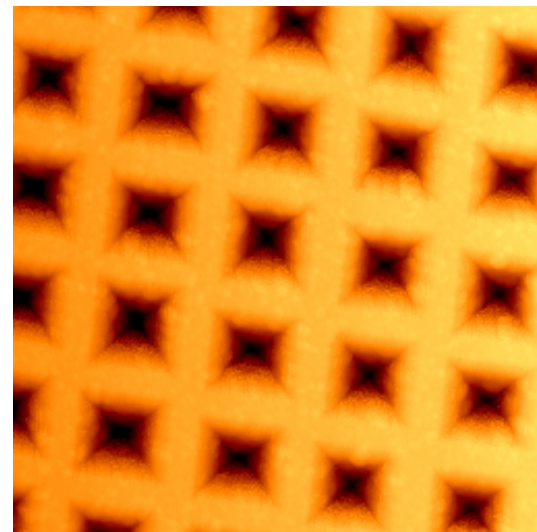
master



stamp



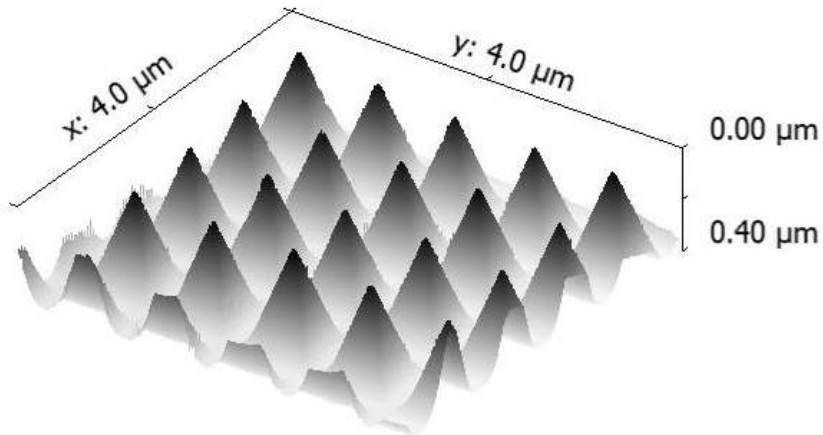
replica



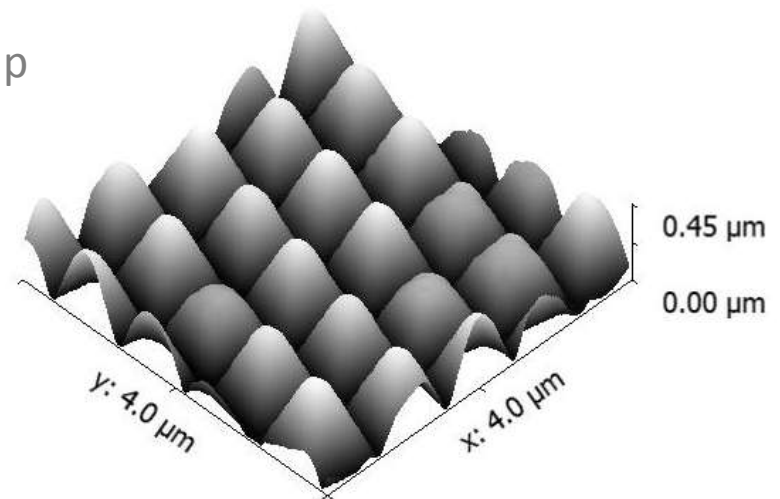
AFM measurements 2

3D surface view – 4 μm

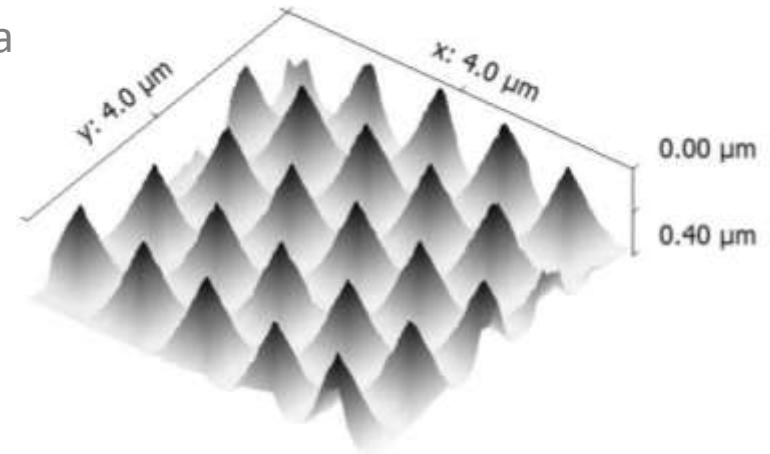
master



stamp

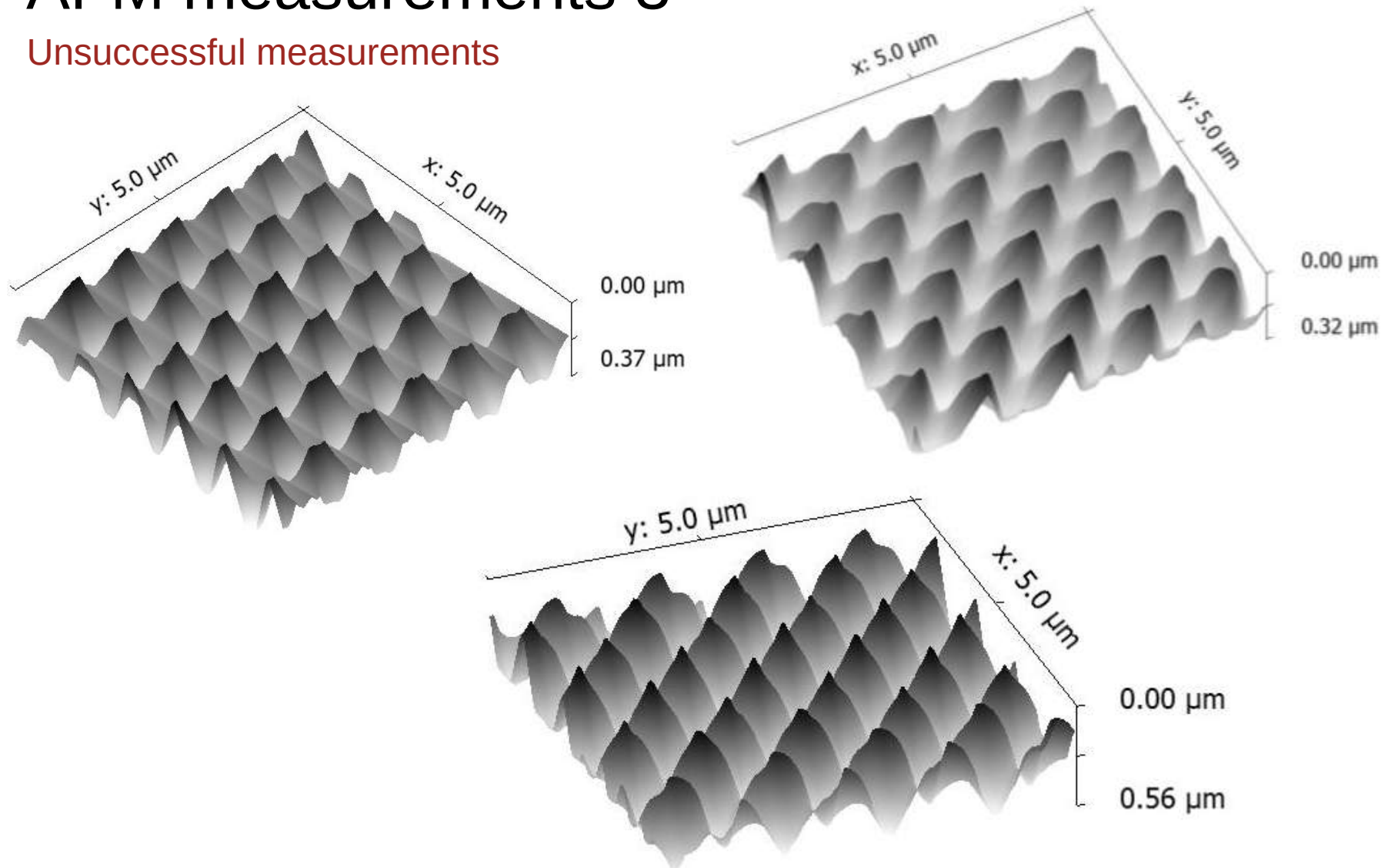


replica



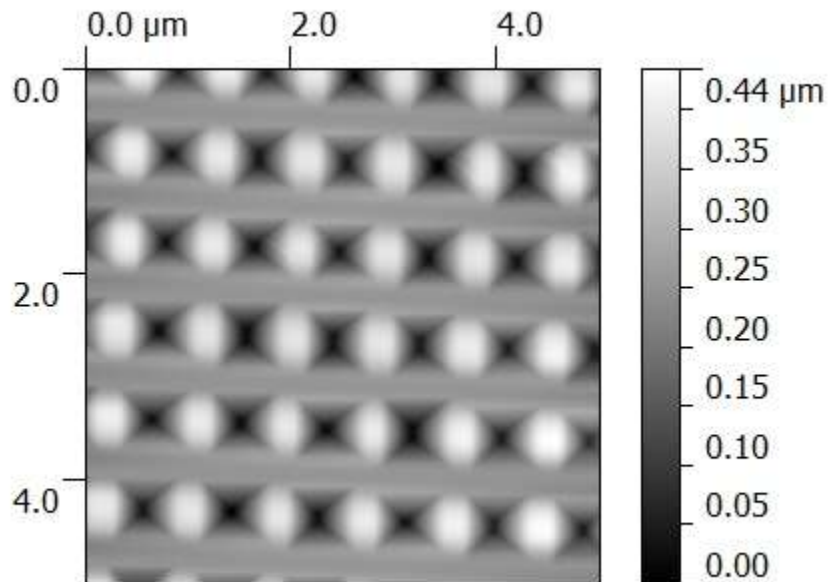
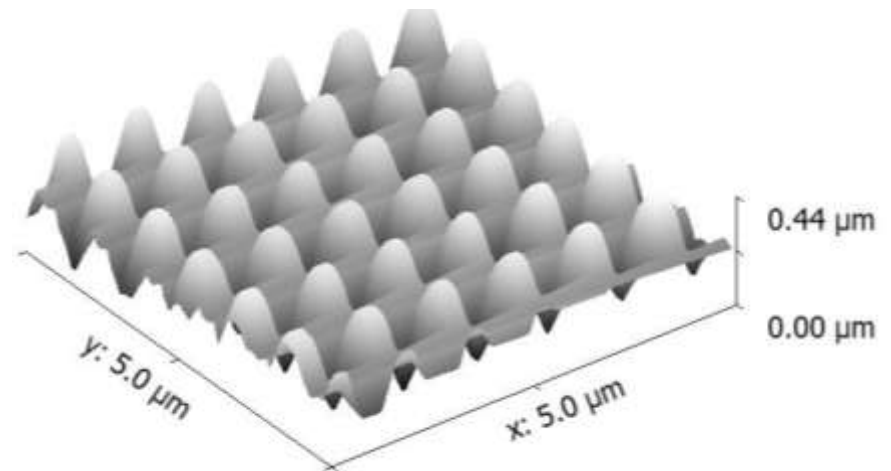
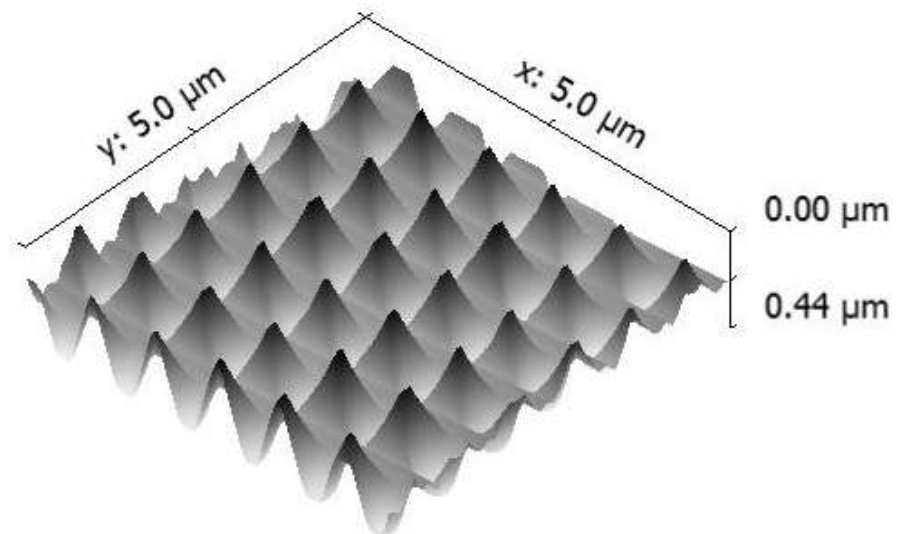
AFM measurements 3

Unsuccessful measurements



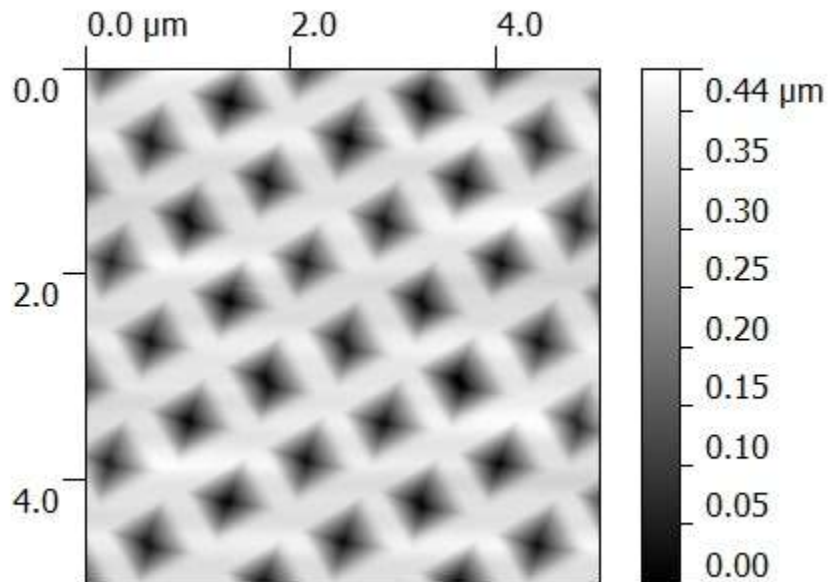
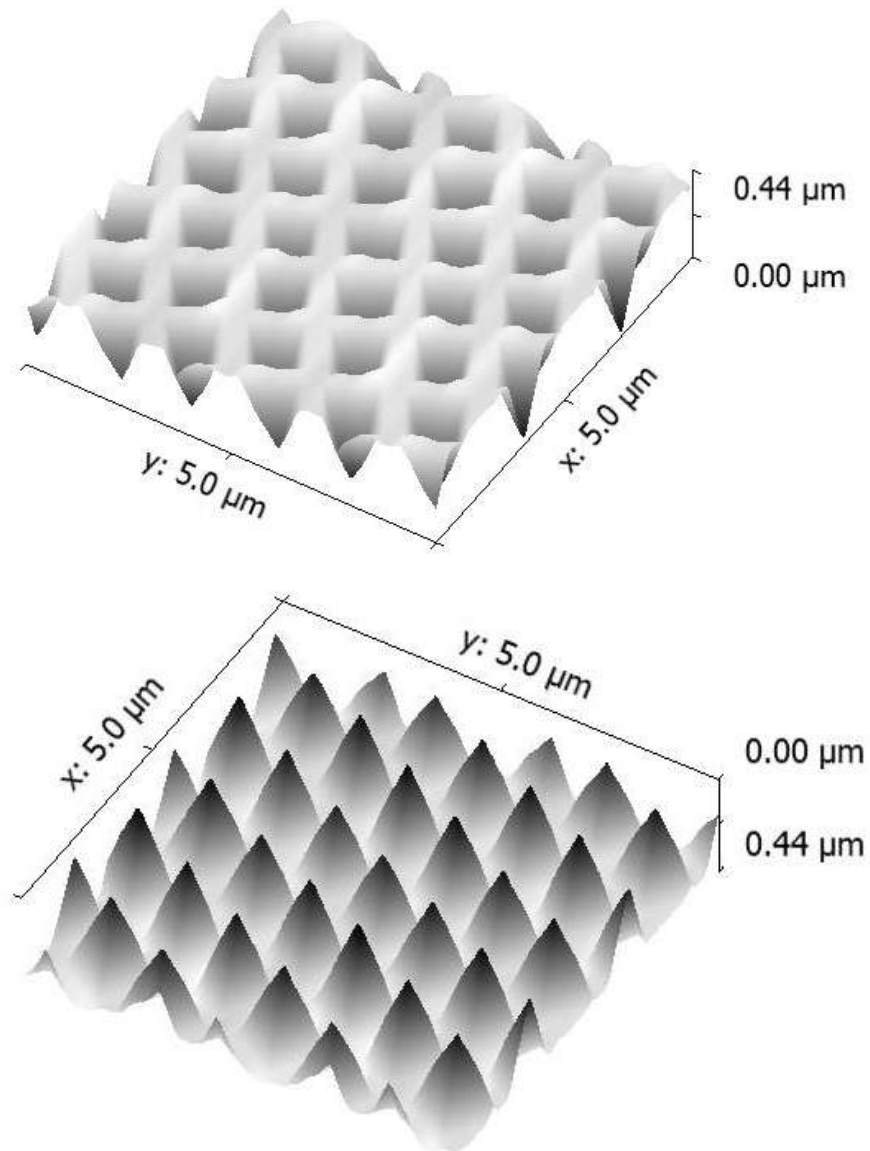
AFM measurements 3

Scanning direction 0°



AFM measurements 3

Scanning direction 30°



Conclusions

- UV NIL procedure explained and presented on one randomly and one periodically textured sample
- AFM measurements confirmed the fidelity of the transfer
- Good matching between structures on master, stamp and replica
- AFM measurements not to always be trusted!

Acknowledgement

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