

# Microtexturation of liquid silicone rubber surfaces by injection moulding

A decorative graphic consisting of five horizontal white lines with arrowheads pointing to the right. A white curved arrow starts from the left side of the lines and points upwards and to the right, crossing over the top line.

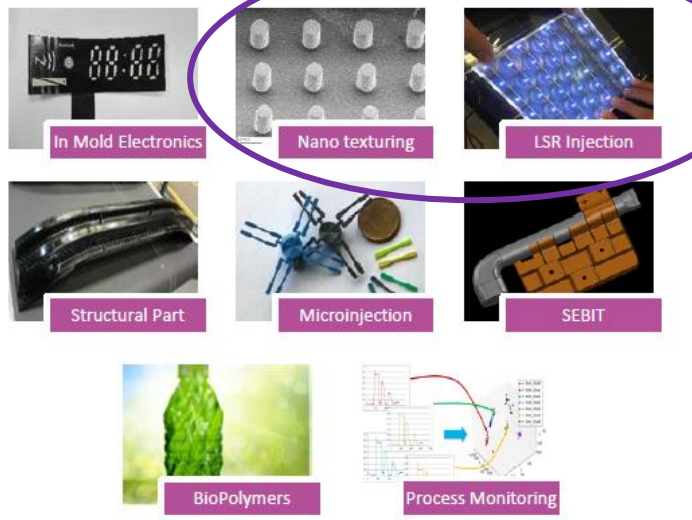
Nekane Lozano Hernández  
Polymer Replication on Nanoscale 2021, 28-29 May 2021

## Outline

- Eurecat
- Liquid silicone rubber: introduction and interest in replication of microfeatures
- Replication of textures: dependence of injection parameters and mould geometries
- Surface characterizations
- Conclusion and future work

# Innovation with an impact

## Unit of Polymeric materials



11

Work centres  
all over Catalonia



# Microtexturation of LSR surfaces by injection moulding

Liquid silicone rubber: introduction and interest in replication of microfeatures

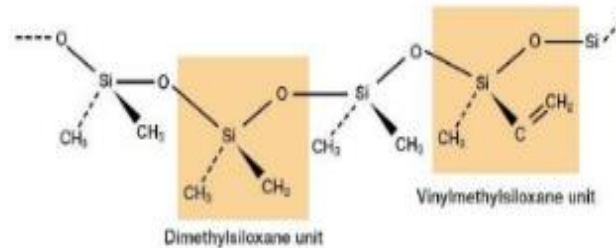
## LSR Properties

- Resistance to exposure and humidity
- High stress resistance
- Biocompatibility
- Low compression set
- Temperature resistance

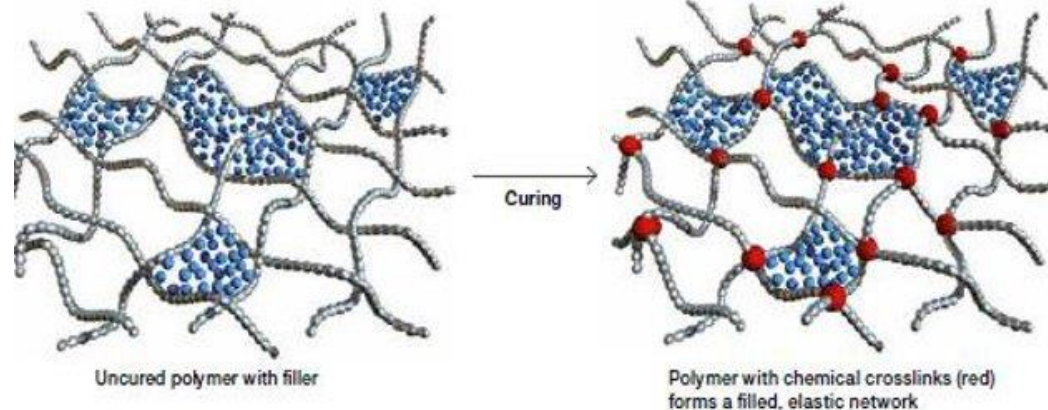
## Synergies with microtexturation

- Antibacterial, cell-alignment (biocompatibility, medical devices)
- Self-cleaning (resistance to exposure)

## Chemical structure:



- Central siloxane bonds
- Two components: base and activator
- Vulcanizes with temperature (120-200°C)

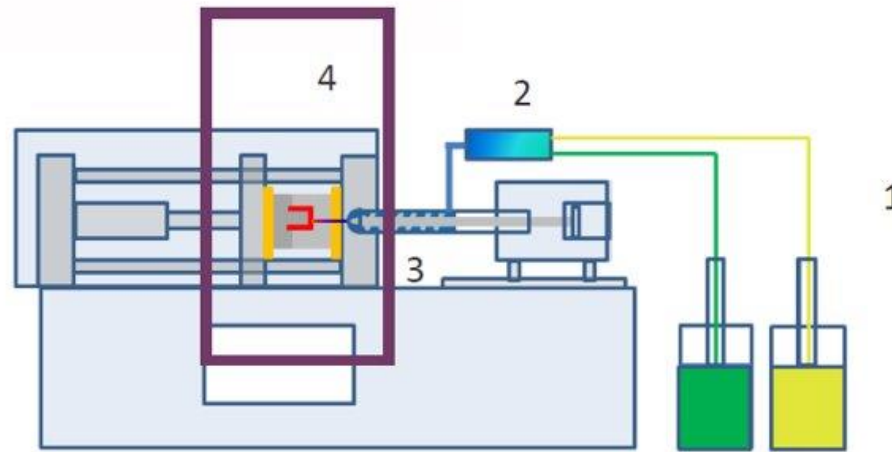


# Microtexturation of LSR surfaces by injection moulding

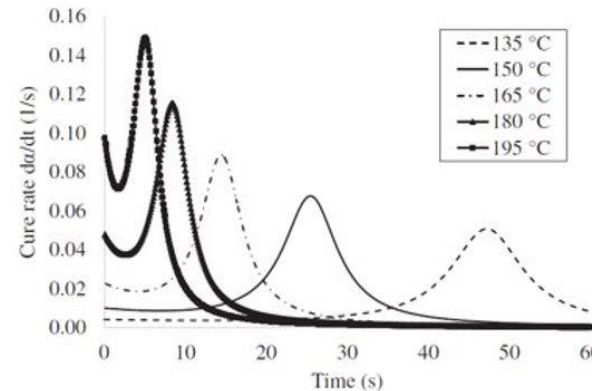
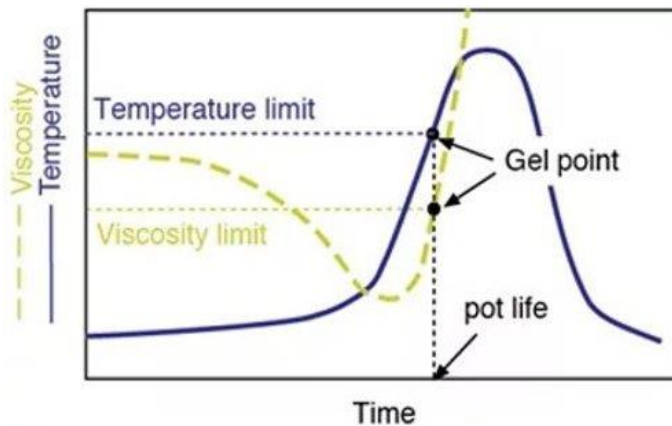
Liquid silicone rubber: introduction and interest in replication of microfeatures

## Injection moulding

High productivity replication technique



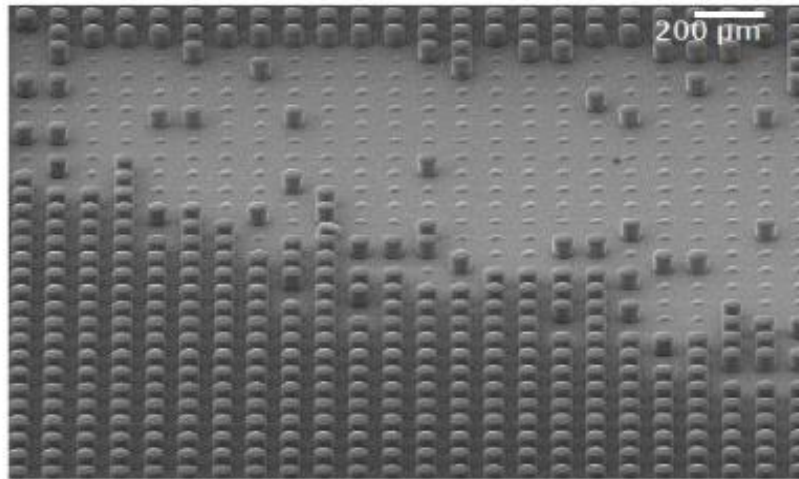
- 1-Dosing Unit
- 2- Mixing
- 3- Screw
- 4-Mould



Mould temperature can control the cure rate and viscosity -> better filling of microtextures

### Overmoulding metallic inserts

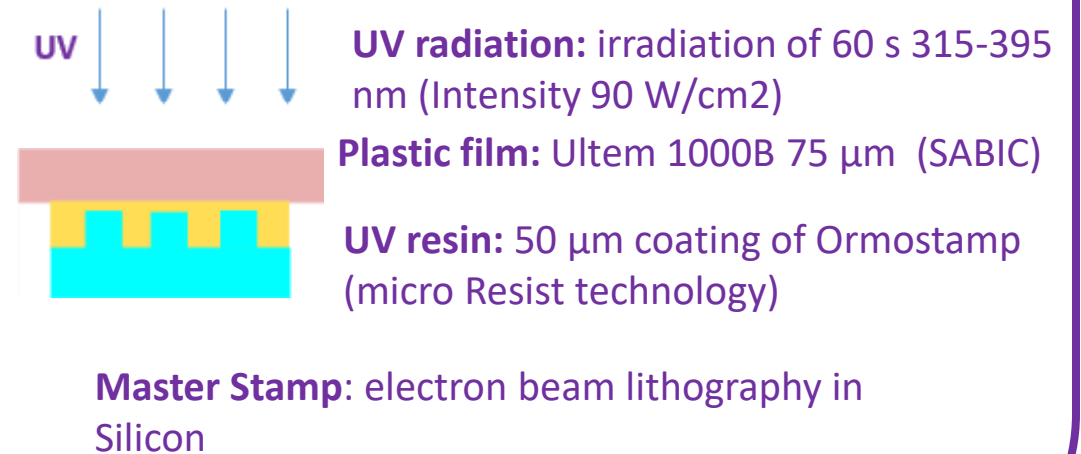
- Textures directly engraved on the mould
- Difficult demoulding step: breakage of textures, non-homogenous height
- Different elastic properties between metal and silicone



Carol Forance Barrie, University of Massachusetts Lowell, Smart Manufacturing seminar series "Injection Molding LSR Parts with Micro and Nanostructured Surfaces"

### Overmoulding plastic films

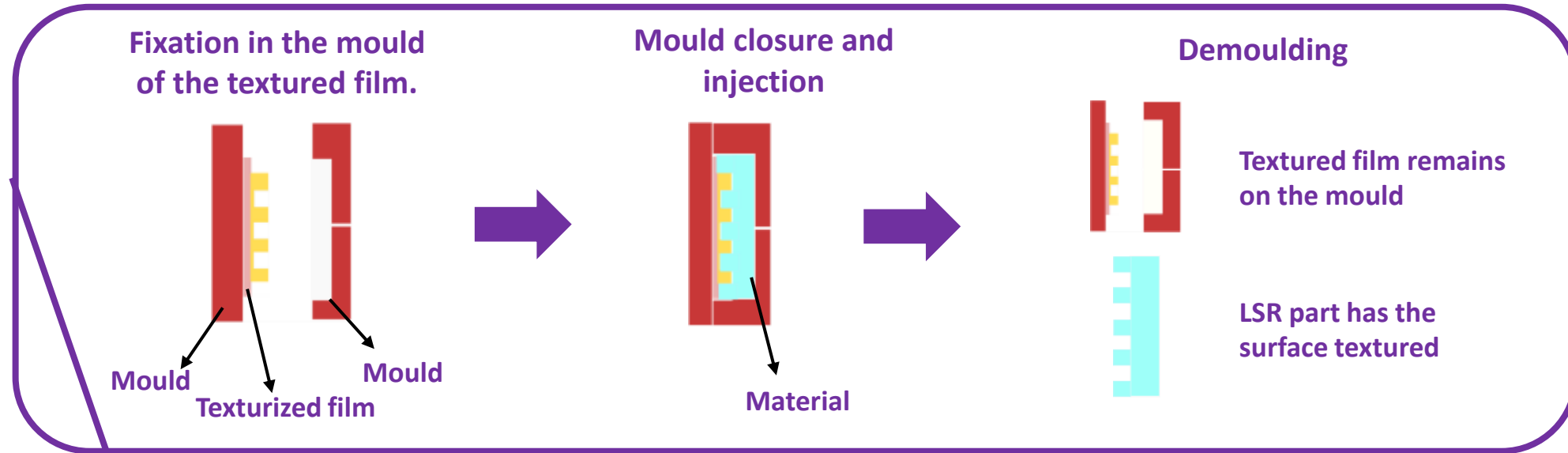
- Replicated by NIL from a metallic master
- Extend the useful life of the metallic stamp
- Similar elastic properties between plastic foils and silicone (avoid breakage?)





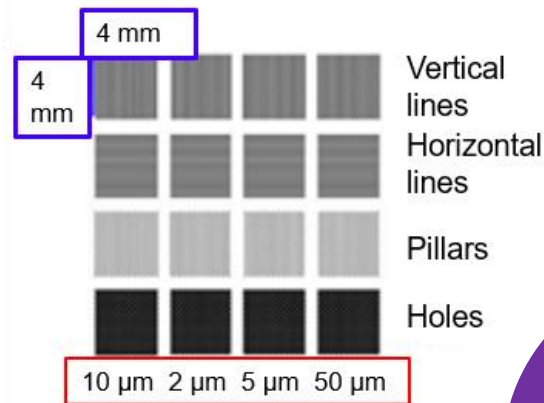
# Microtexturation of LSR surfaces by Injection Moulding

## Scheme of the overmoulding process



## Studied points

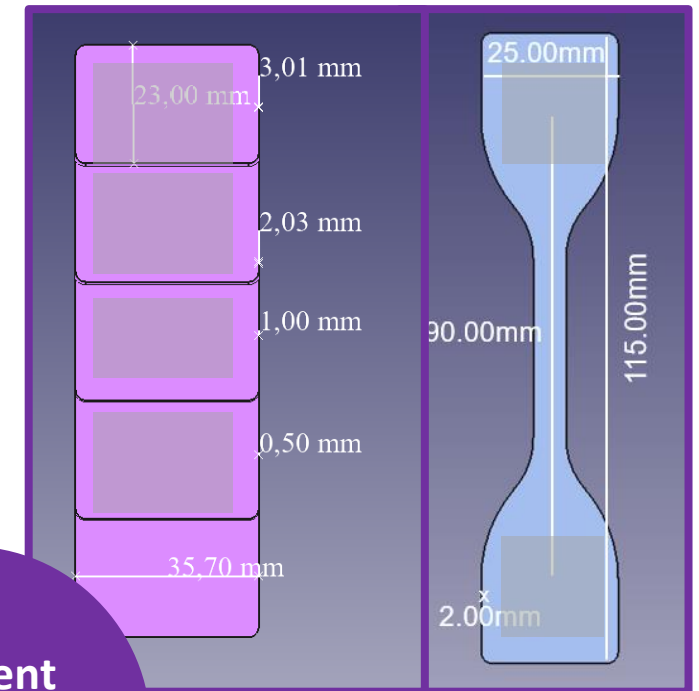
1. Optimization of injection parameters
2. Influence of the distance to the injection point in replication
3. Influence of the part thickness in the replication



Different geometries and scale resolution

The injected material is Elastosil LR 3003 70

Different mould geometries



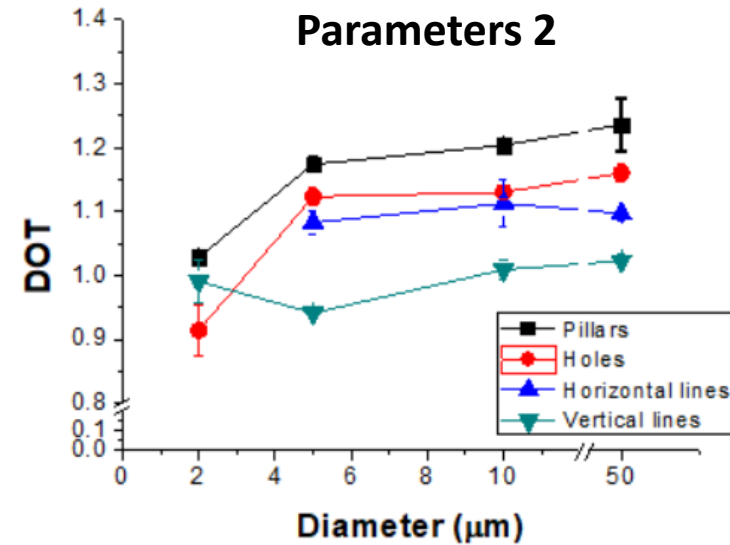


# Microtexturation of LSR surfaces by injection moulding

## 1- Optimization of injection parameters

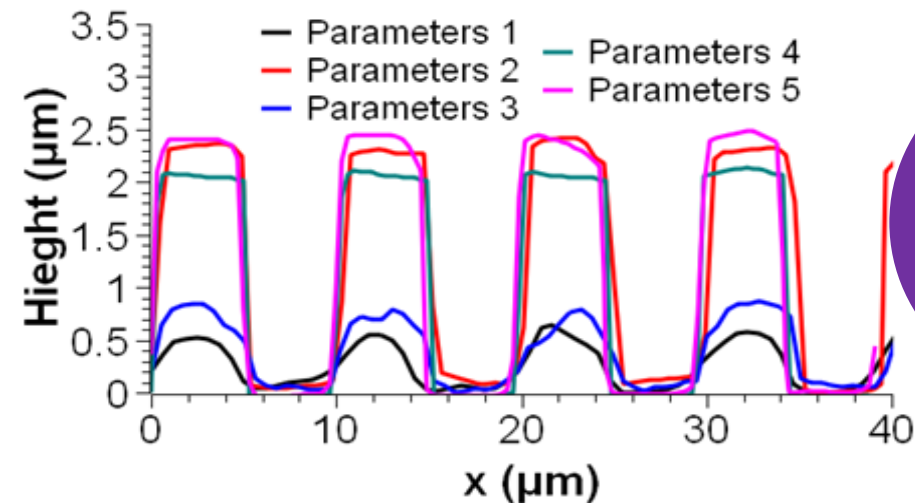
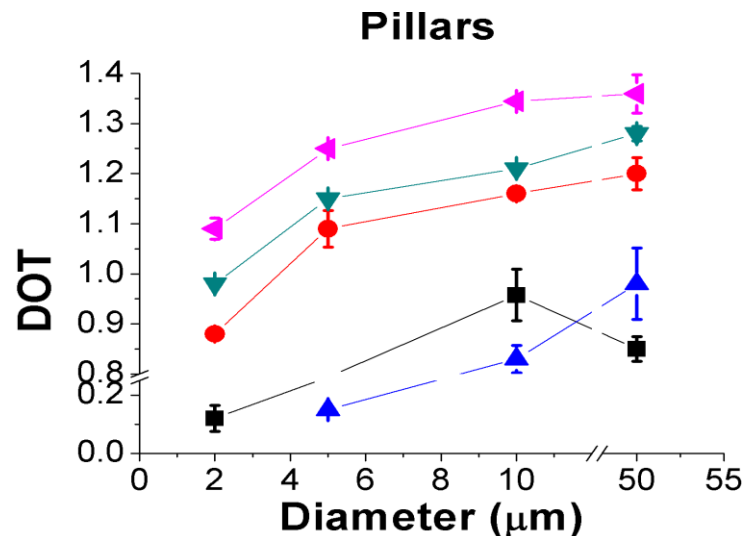
Set	T Mold (°C)	V inj (m/s)	t curing (s)
1	130	15	30
2	130	15	60
3	130	50	30
4	130	50	60
5	150	50	30

$$DOT = \frac{h_{replication}}{h_{master}}$$



Stretching of all textures depending on diameter

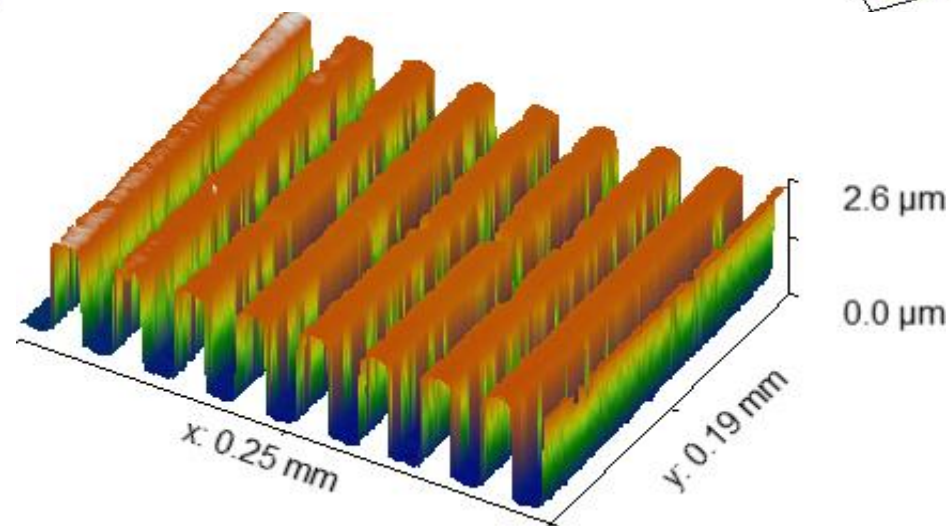
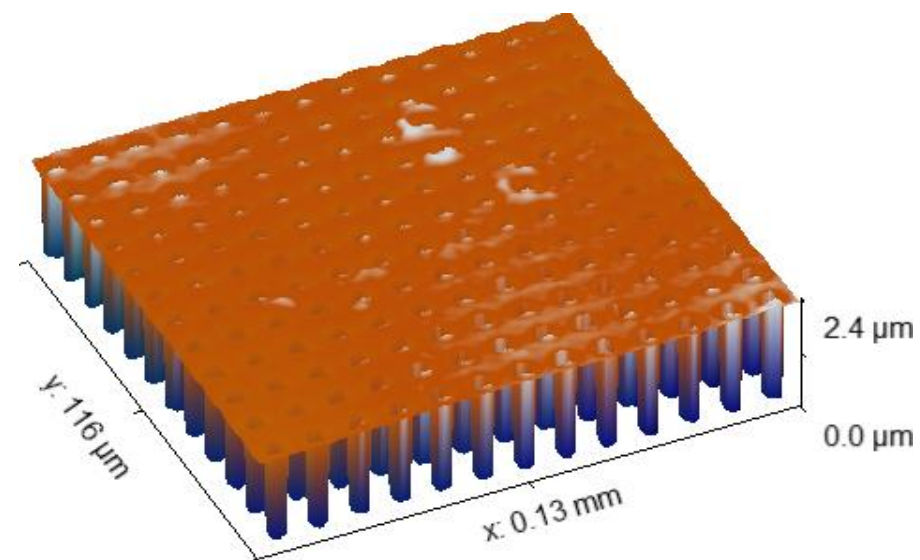
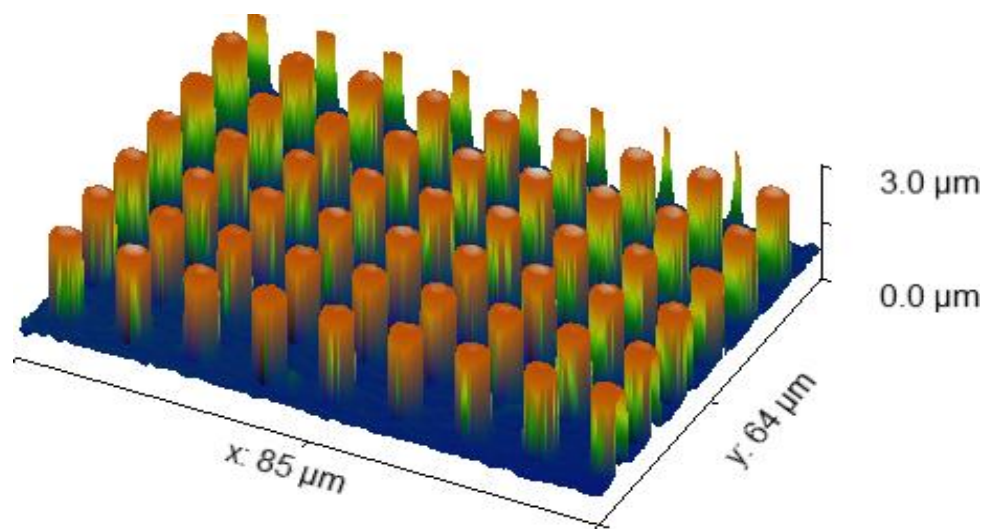
Pillars are the most influenced texture



Curing time must be enough for a good demoulding

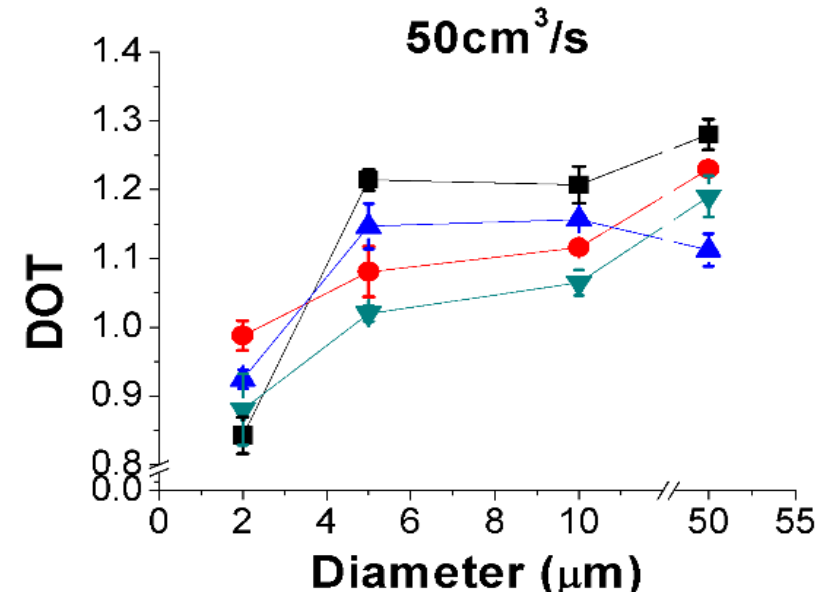
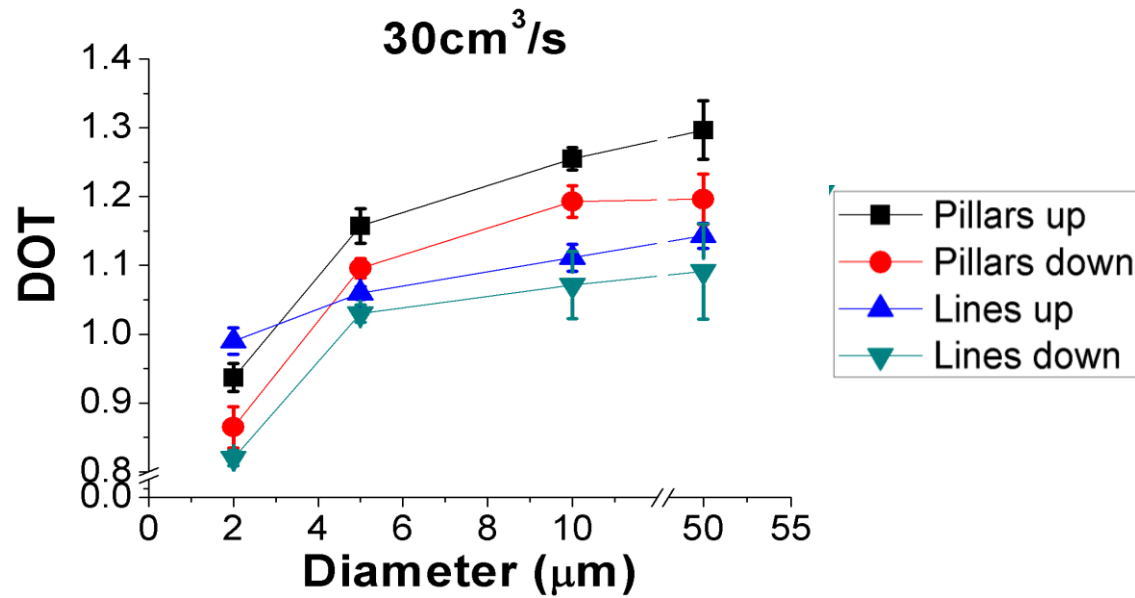
# Microtexturation of LSR surfaces by injection moulding

## 3D confocal scan of obtained surfaces



# Microtexturation of LSR surfaces by injection moulding

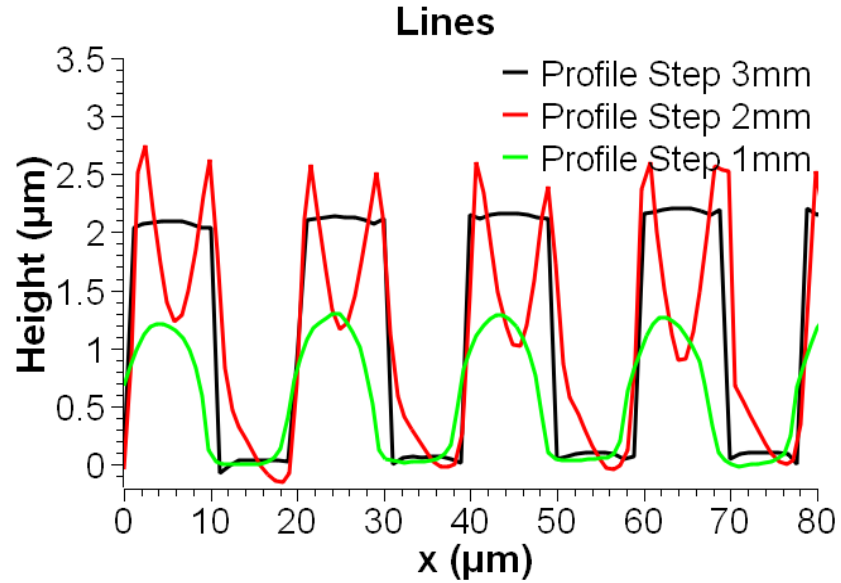
## 2-Dependence of replication with distance to the injection point



T mould = 130°C  
t curing = 60 s

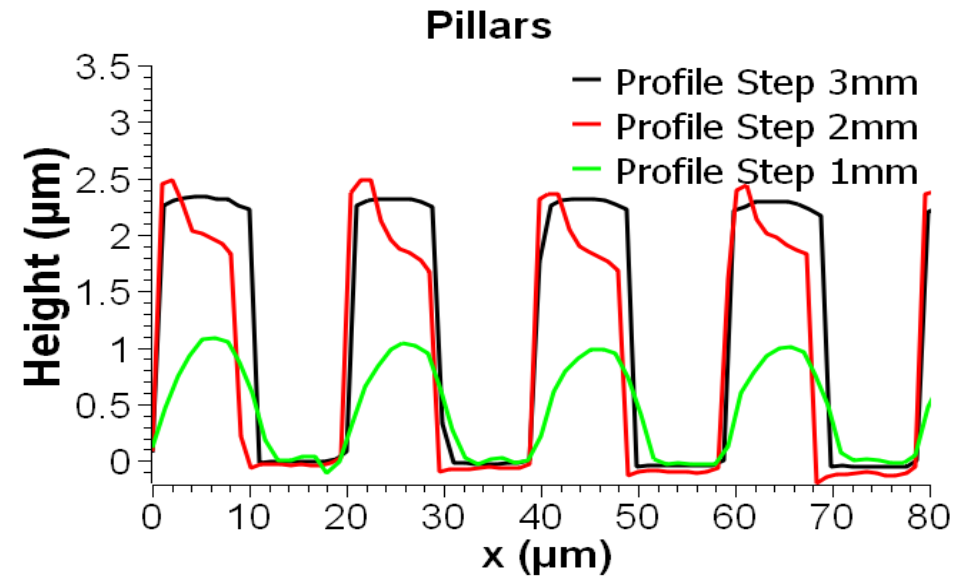
Similar results were  
obtained for both  
injection speed

## 3-Dependence of replication on the part thickness

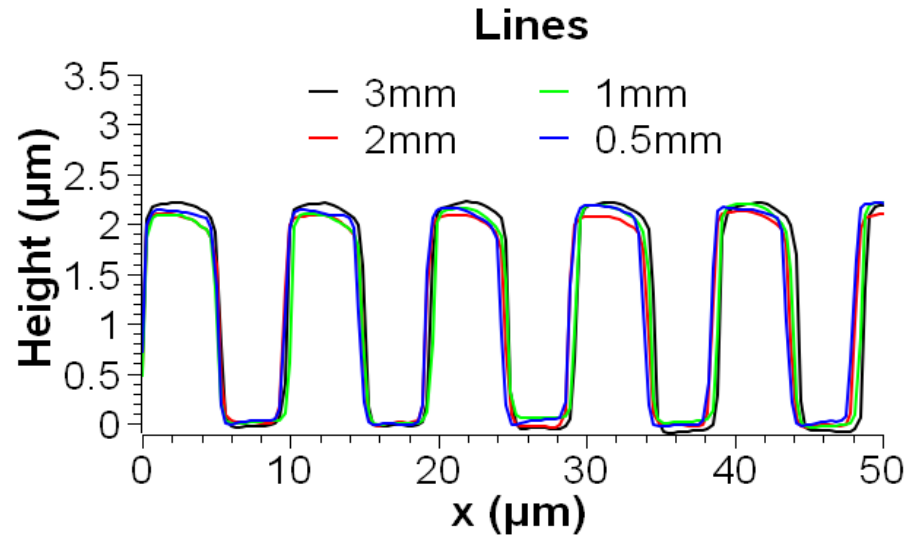


**T=150°C**  
**t= 60 s**  
**v =50m/s**

**Loss of replication and deformation of textures as thickness decreases**

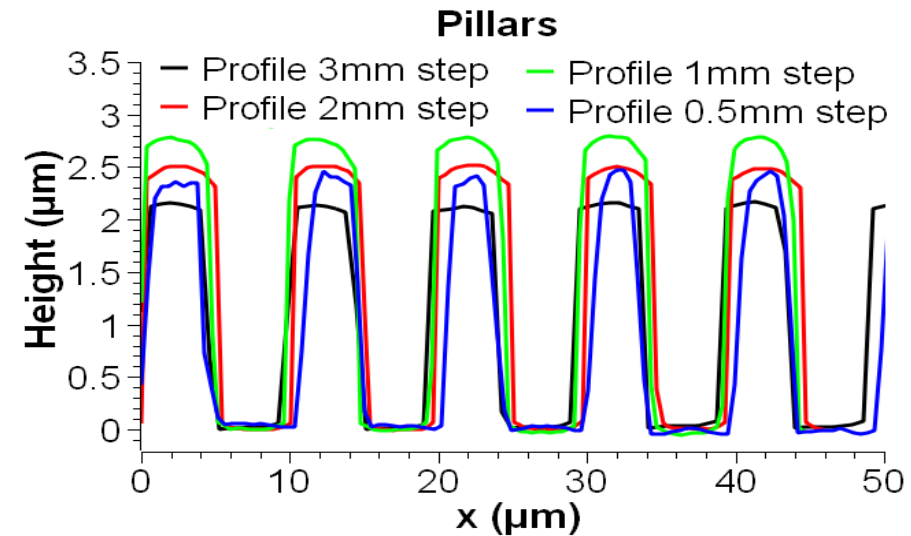


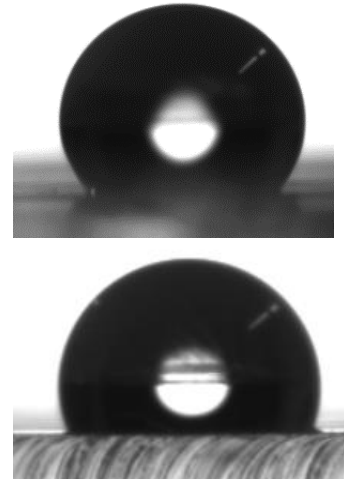
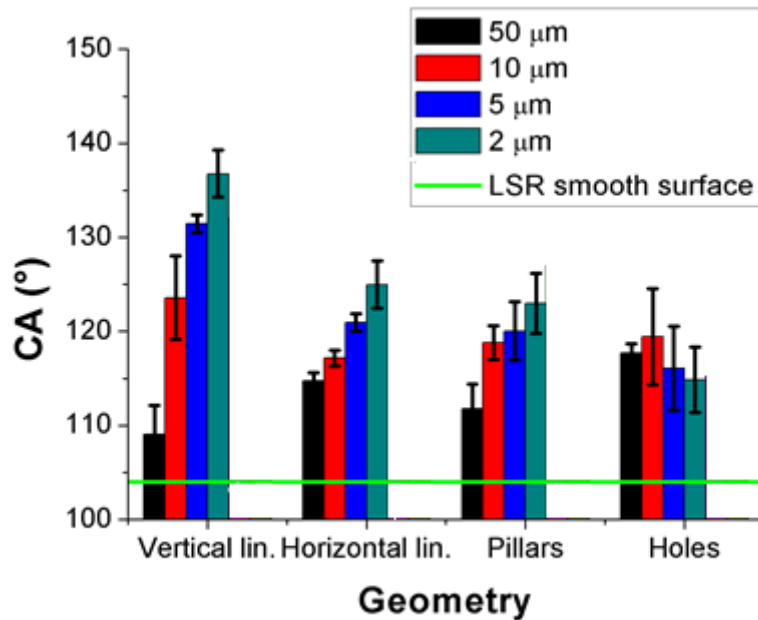
## 3-Dependence of replication of the part thickness



T=130°C  
t= 60 s  
v =50m/s

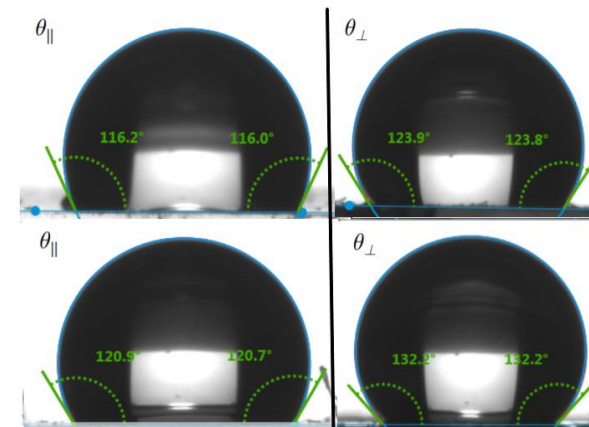
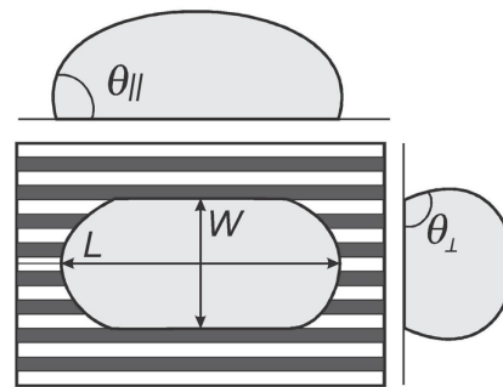
Change in height depending on thickness  
Good replication obtained  
The height is higher than 1 in all cases





- Increments in contact angle depends on geometry and diameters
- Increase of up to 33° for 2 μm lines
- Contact angle values are not influenced by holes diameter

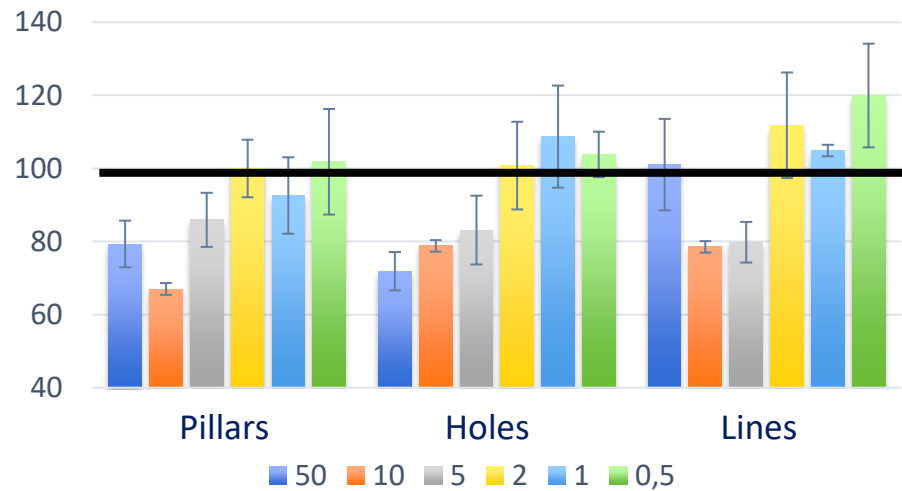
The difference in the values obtained for lines is due to the line orientation





## Bacterial adhesion

### Ecoli

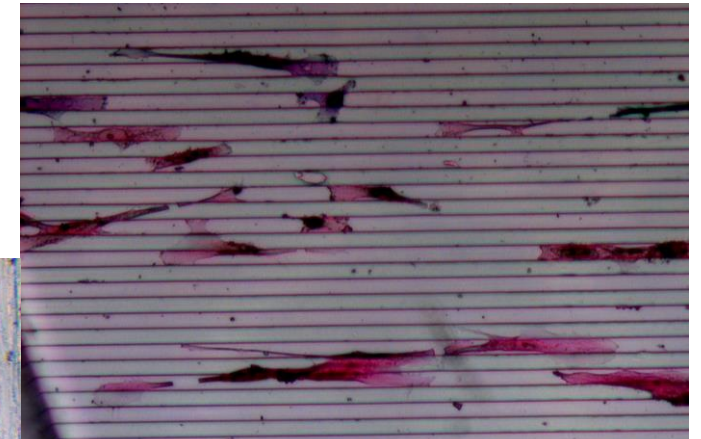
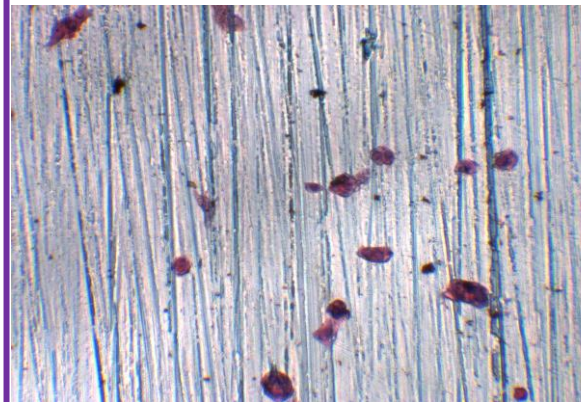


Decrease in bacteria adhesion until 30%

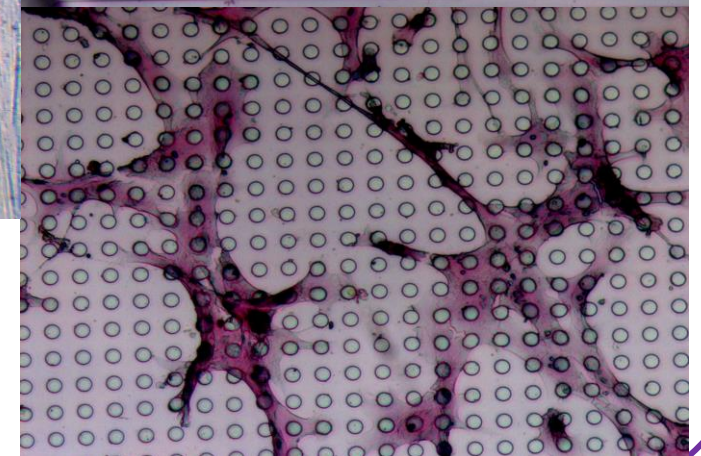
## Cell proliferation

Lines: growth oriented

Smooth Surface:  
contracted fibroblast



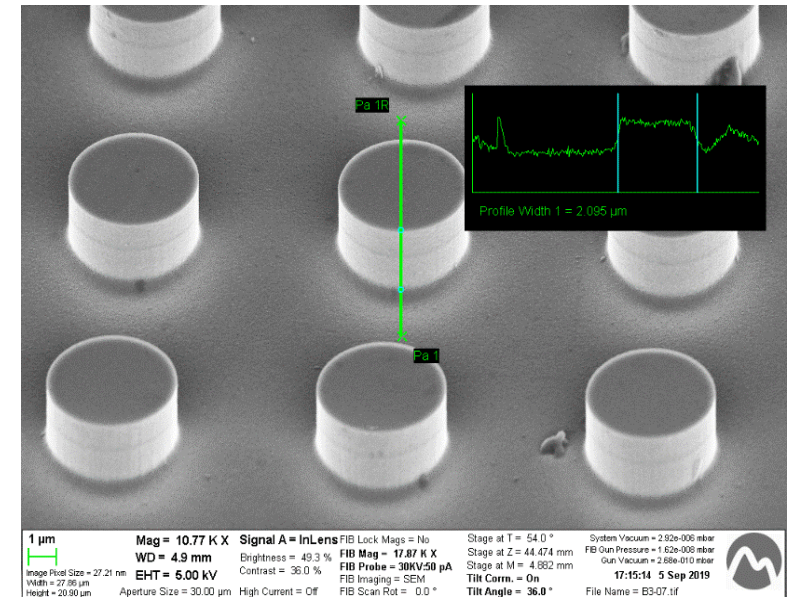
Pillars: act as anchor points allowing greater proliferation



- ✓ Textured plastic foils are useful as templates for replication of textures by injection moulding
- ✓ Textures placed in different positions and in parts with different thickness can be reproduced using this method
- ✓ Different surface properties have been verified

### Next steps:

- Improving texturized films
- Durability of microtextures



# Thank you

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