# study of nano-printing in a biomaterial and its use as a secondary polymer mold

JNIL 11-12/05/23 LYON

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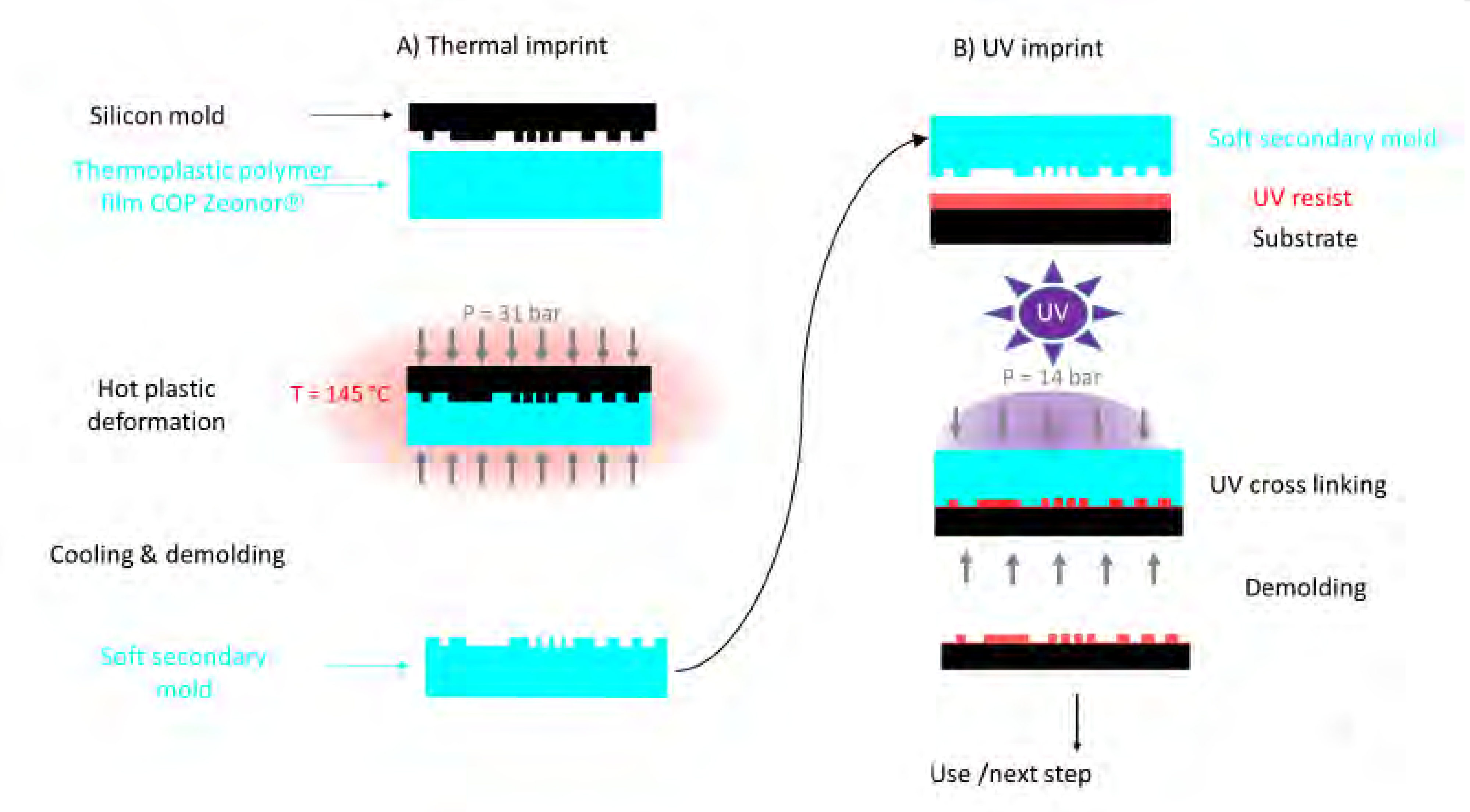
# Presentation plan

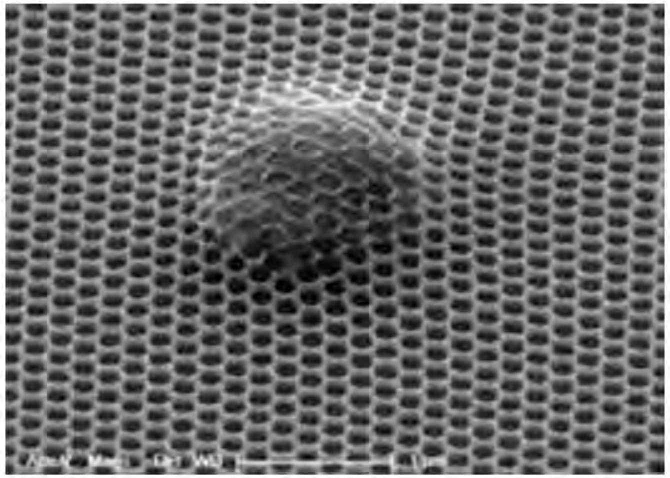
- Secondary polymer mold
  - Principle
  - Avantages
  - The environmental problem : cyclo olefin polymer  versus polylactic acid
- Our results with polylactic acid
- Conclusions and perspectives

# Secondary polymer mold principle



# Advantages and a drawback of the secondary polymer mold process

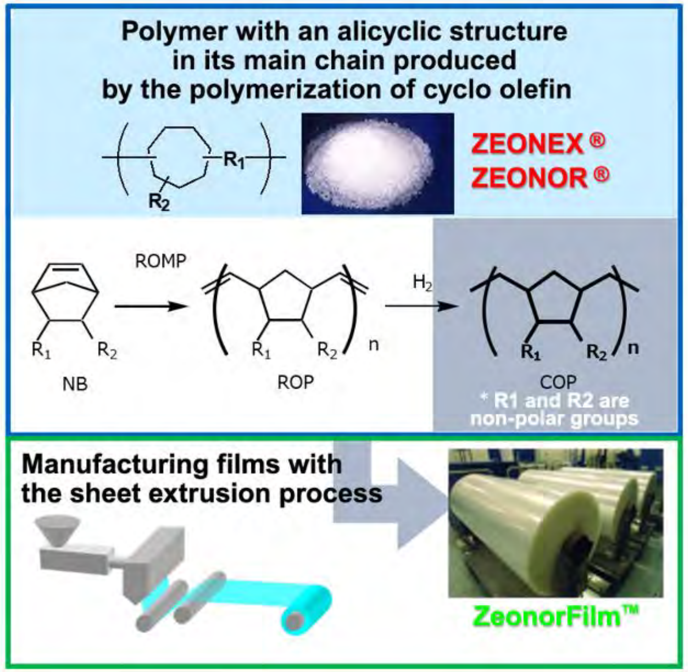
- ✓ Advantages
  - ✓ In UV imprint, the original mold does not need to be transparent (silicon OK)
  - ✓ The original mold is preserved ( no hard/hard contact)
  - ✓ Fewer non-uniform print issues
  - ✓ Easier demolding
  - ✓ No polarity reversal (what was protruding remains protruding)

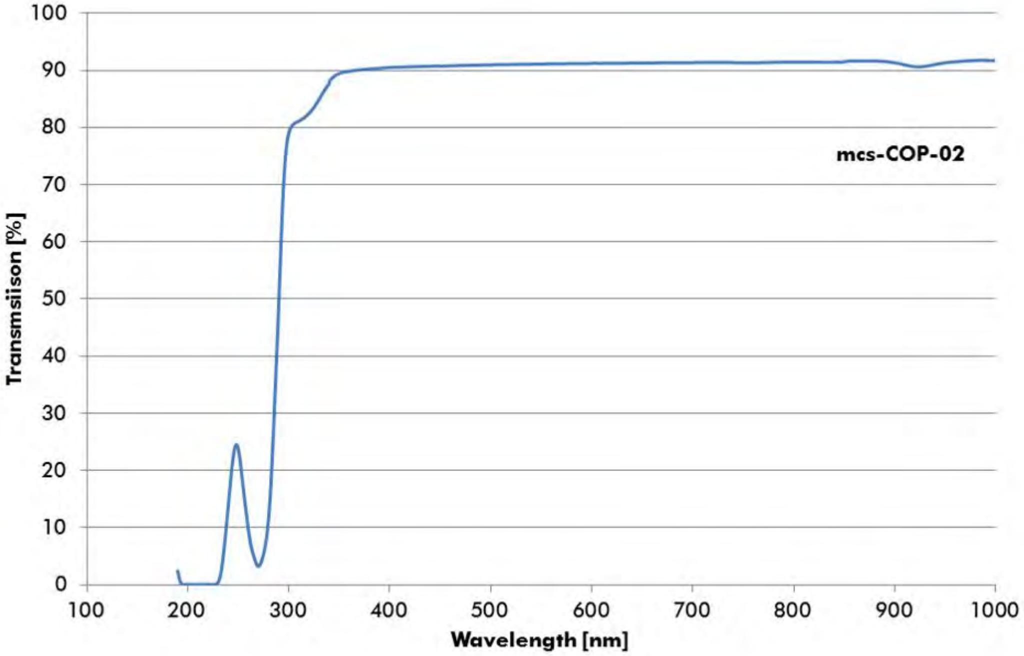


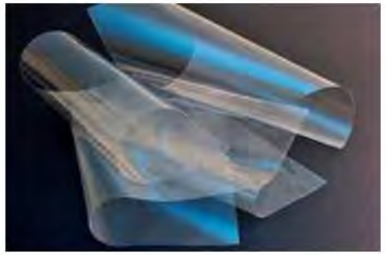
Pattern printed on a contaminating particle on the substrate

➢ But : with zeonor®, use of petro-based and non-degradable disposable polymer materials

# Zeonor® petrosourced non biodegradable

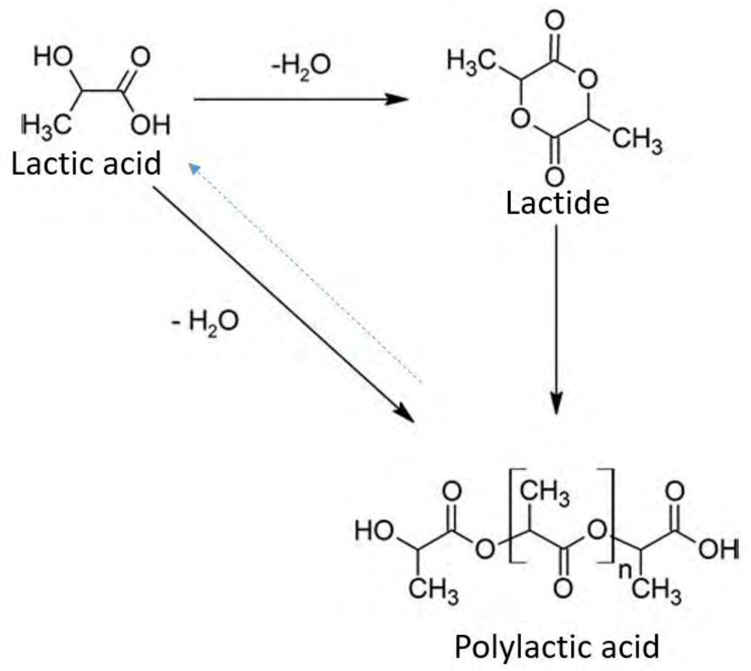


# Polylactic acids : biosourced, biocompatible, biodegradable polymer

Lactic acid : endogenous molecule

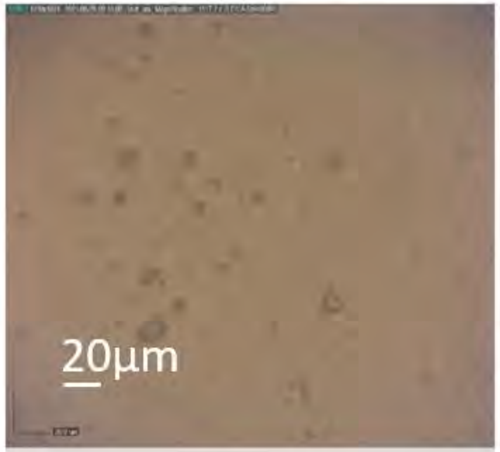




Peer, A., Dhakal, R., Biswas, R., & Kim, J. (2015). Nanoscale patterning of poly (L-lactic acid) films with nanoimprinting methods. Nanoengineering: Fabrication, Properties, Optics, and Devices XII, Proc. of SPIE 2015 Vol 9556, doi.org/10.1117/12.2188888

Farahani, A., Zarei-Hanzaki, A., Abedi, H. R., Tayebi, L., & Mostafavi, E. (2021). Polylactic acid piezo-biopolymers: Chemistry, structural evolution, fabrication methods, and tissue engineering applications. Journal of Functional Biomaterials, 12(4). https://doi.org/10.3390/jfb12040071

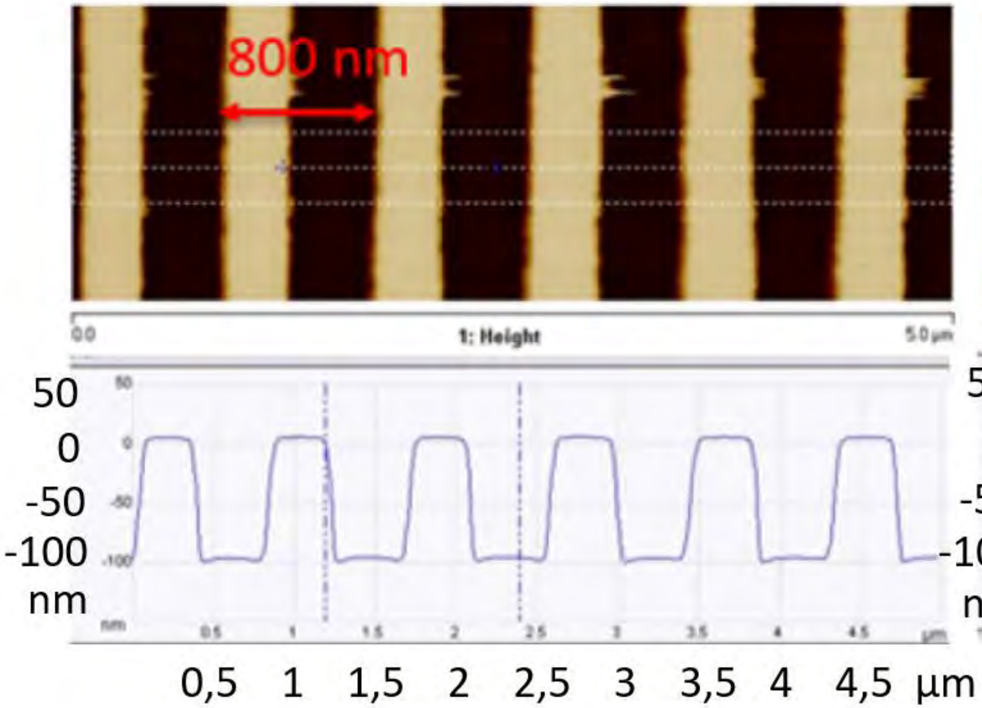
# First tests on a commercial 50µm thick PLLA film



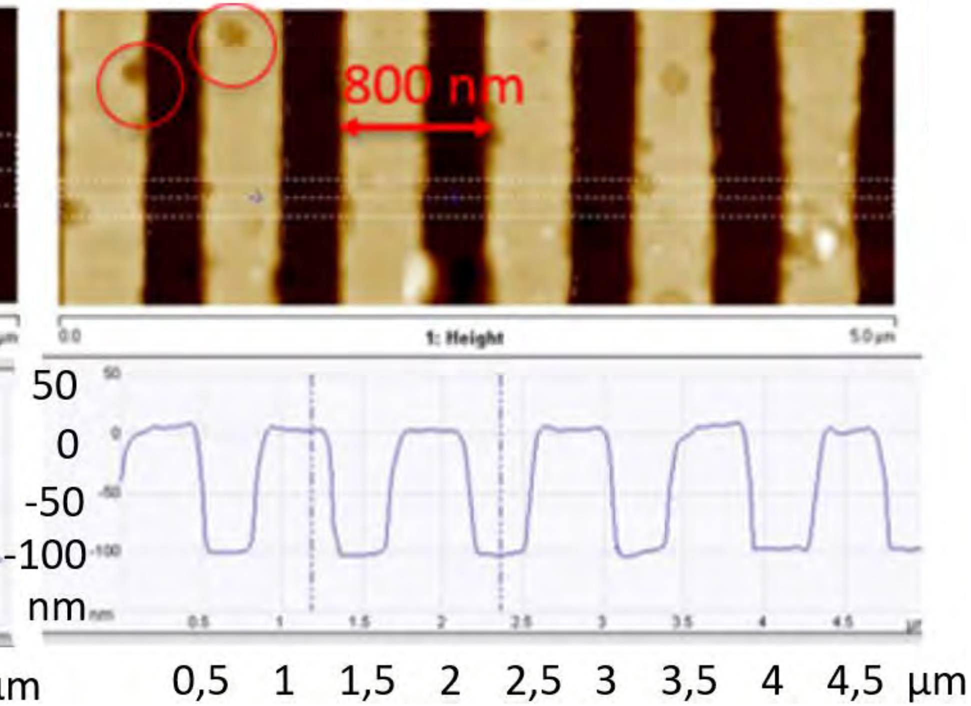

Optical micrograph of the PLLA commercial Goodfelowfilm, thickness 0.05 mm

- Numerous microscale round shape defects on the commercial film before imprint
- Numerous ~100 nm defects on the secondary mold after imprint

AFM of silicon mold




AFM of replica in PLLA film

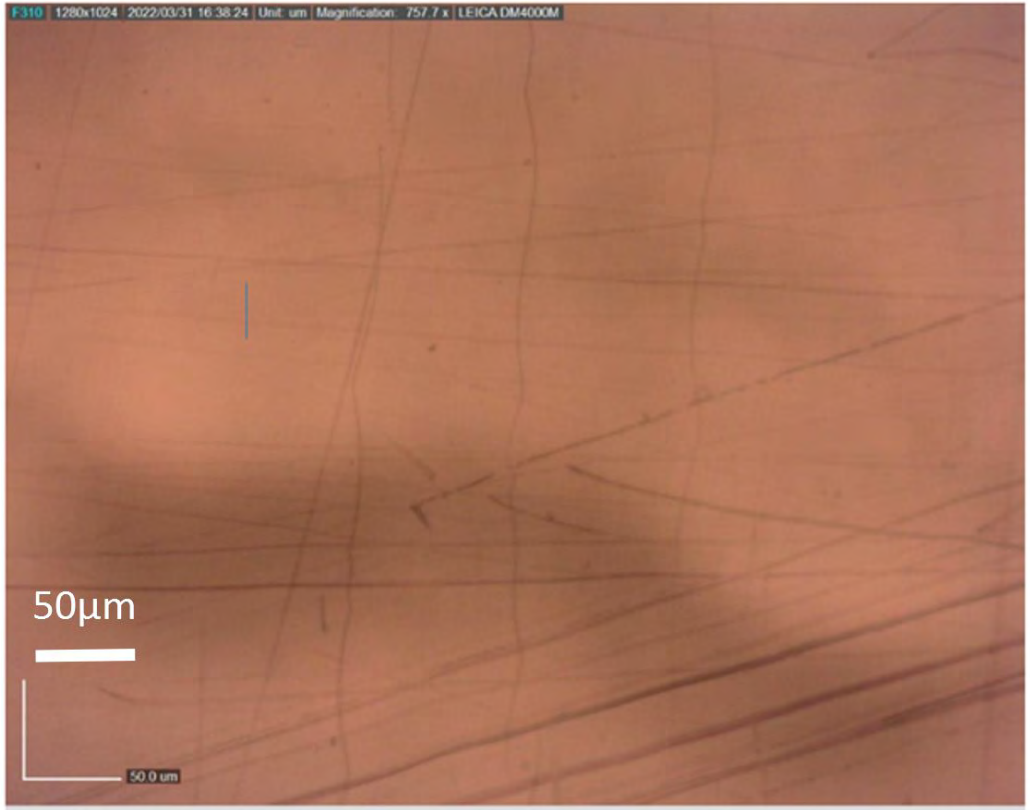


# Calendering of commercial PLA pellets

PLA pellets LX530
Corbion


Laboratoire de Chimie Agro-industriel; Toulouse

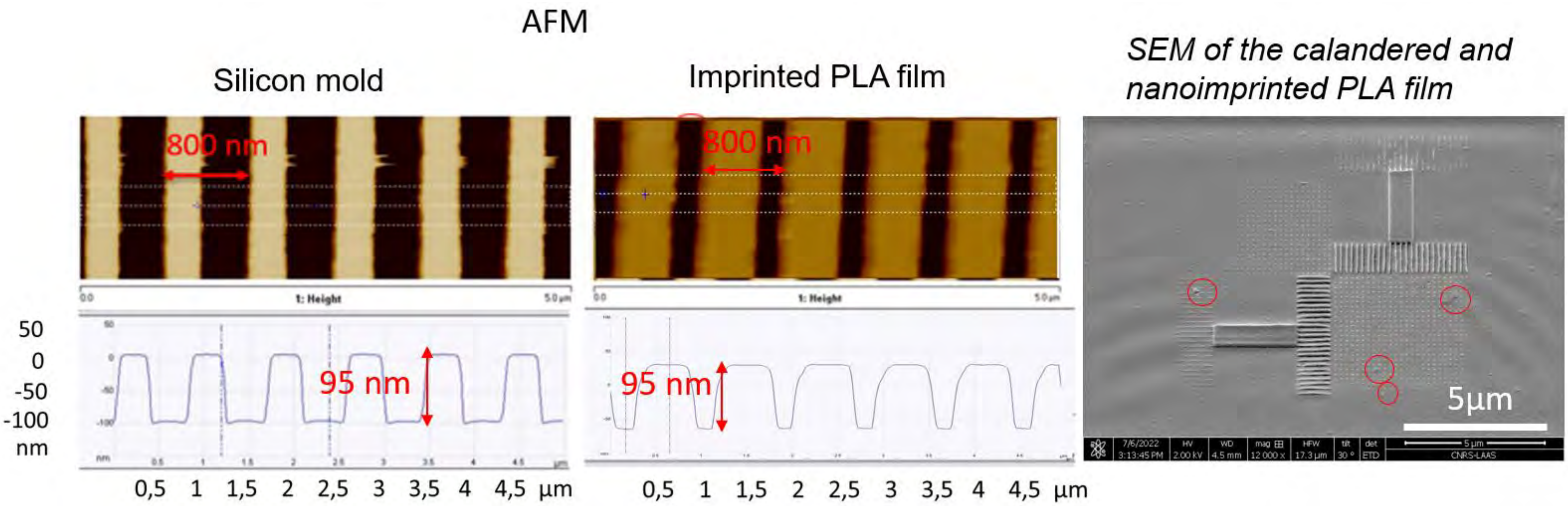
# Observation of the PLA calandered ~200µm thick film




Optical micrograph of the calendered PLA film

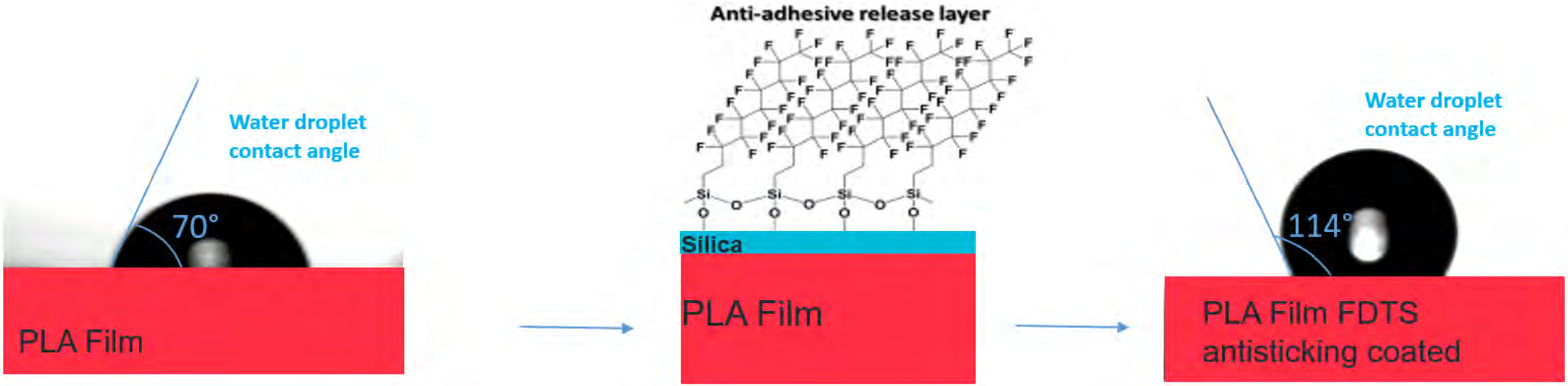
- ➢No microscale round shape defects
- ➢But grooves from the cooling roll can be seen on the film
- ➢Much larger stripes millimeter size can be seen if the rolls speed is not adapted

# A) Thermal imprint of PLA film



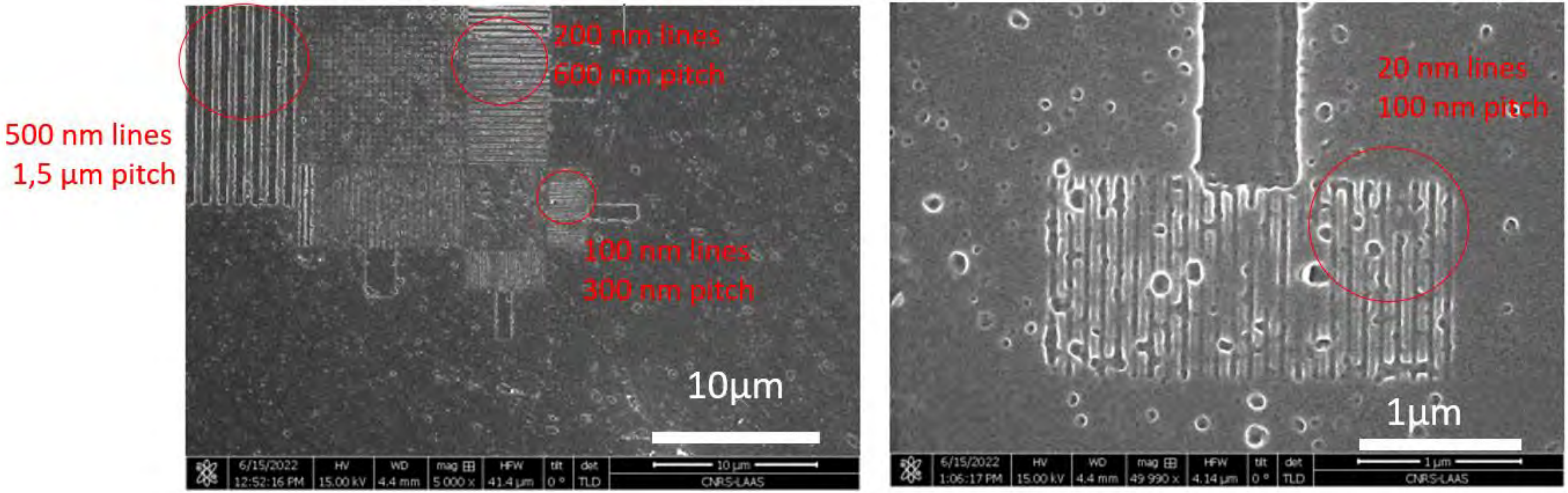

- Accurate pitch and depth
- Inverted structures
- Some Defects

# Antiscking surface treatement on the PLA secondary mold




- 1) Thin silica layer deposit
- 2) FDTS anti sticking layer deposit on the silica

# B) imprint of UV resist with PLA secondary mold




SEM of UV imprinted resist thanks to PLA secondary mold

LAAS CNRS

# Conclusions and perspectives

| | Zeonor®COP | Goodfellow PLLA film | Calandered PLA film |
|---|---|---|---|
| Nanoscale printing hability | yes | yes | yes |
| antisticking needed for UV printing? | no | yes | yes |
| Milliscale defects | no | no | Yes, but improvable |
| µscale defects | no | yes | no |
| Nanoscale defects | no | yes | Yes, improvable ? |
| biosourced | no | yes | yes |
| biocompatible | yes | yes | yes |
| biodegradable | no | yes | yes |

- ➢ The films can certainly be used in some needs for biology
- ➢ Further studies including calendering improvement or needed to see if ok for micronanotechnology