

Fabrication of thin micropatternable films of silk fibroin using benign solvents.

Alessio Bucciarelli, Ramendra K. Pal, Alberto Quaranta, Devid Maniglio, Viviana Mulloni,
Antonella Motta, Vamsi Yadavalli

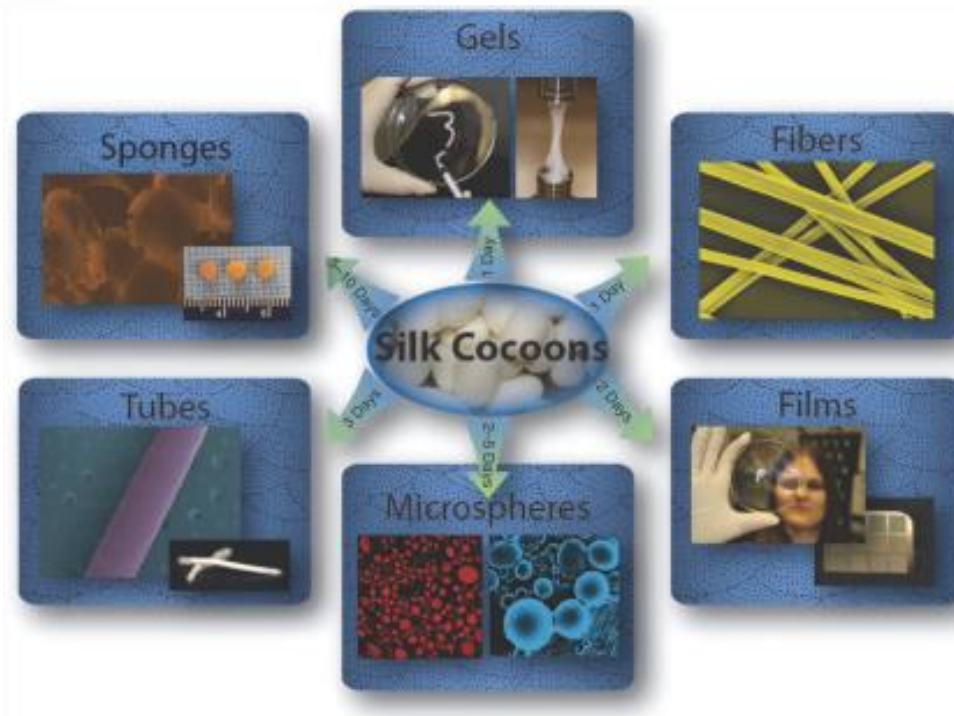
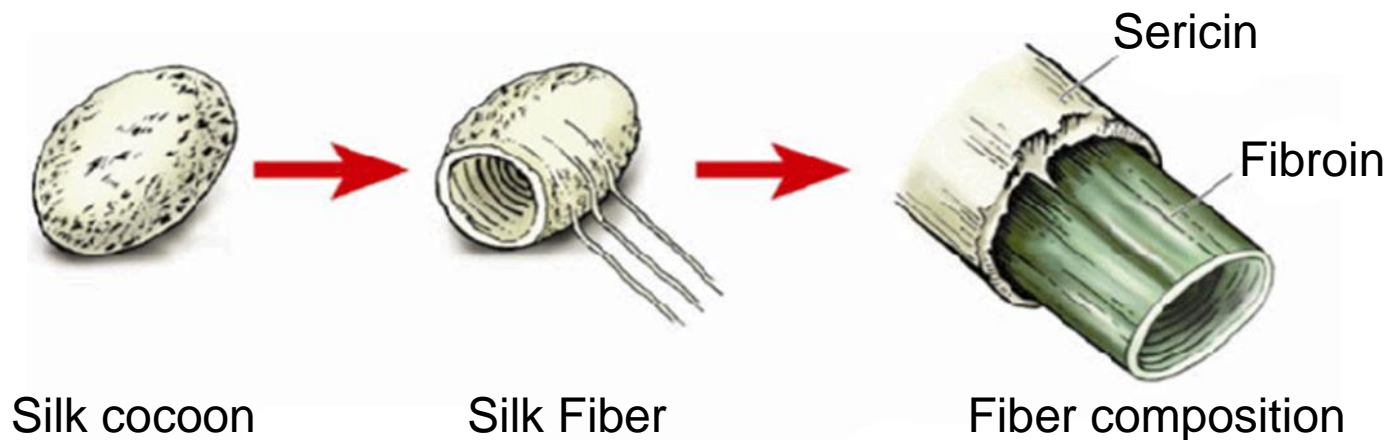
October 19, 2016



**Industrial Engineering
Department**



What is fibroin?

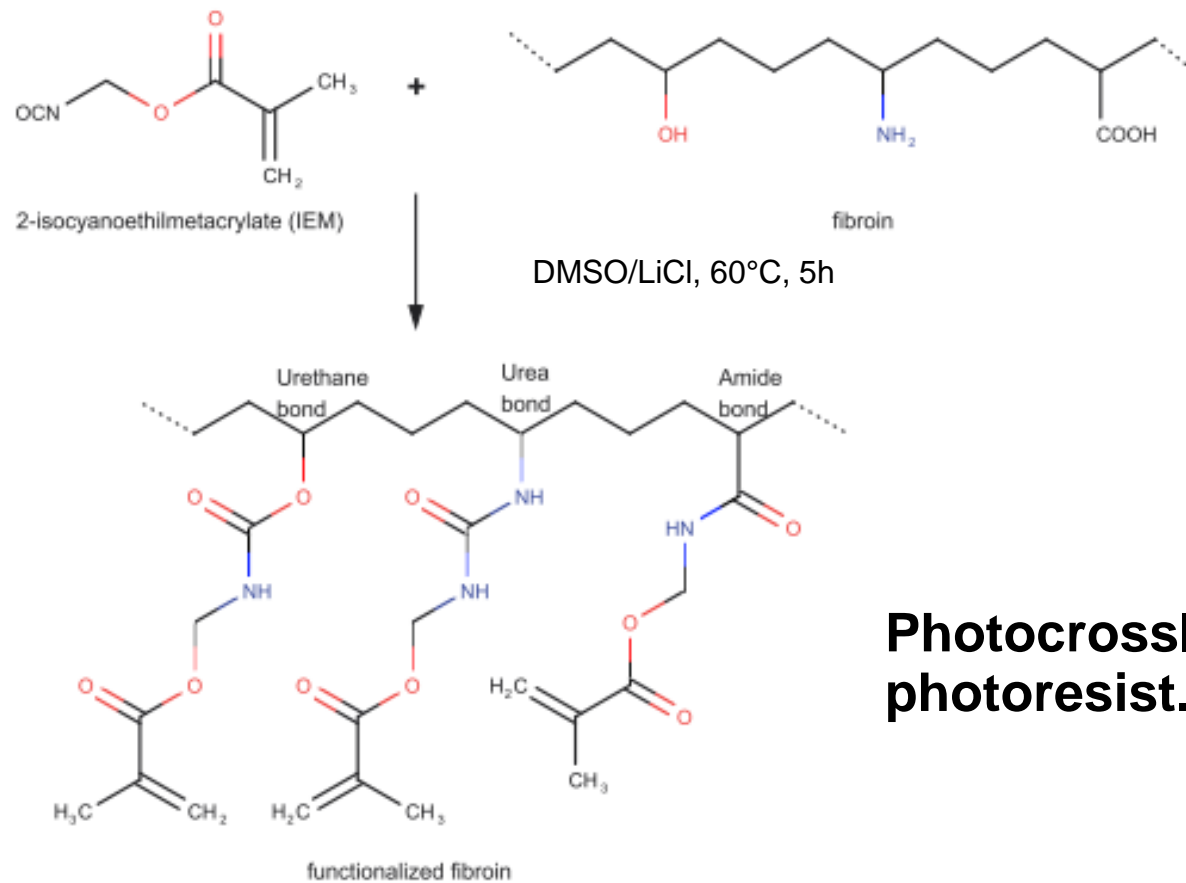


Biocompatible:
 rSF shows usually
 a positive
 interaction with
 living tissues,
 leading to a low
 inflammatory
 response.

Rockwood DN, Preda RC, Yucel T, Wang X, Lovett ML, Kaplan DL. Materials fabrication from Bombyx mori silk fibroin. Nature protocols 2011;6:1612-31.

Fibroin Film

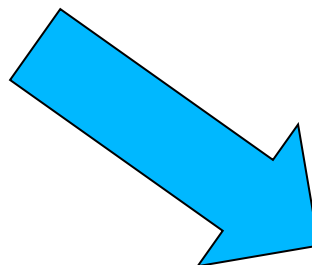
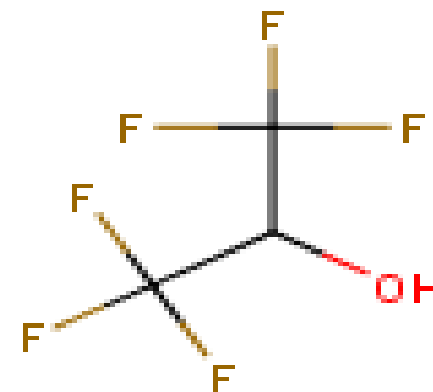
- Film and optical fiber made of regenerated silk fibroin (rSF) are transparent in the optical range.
- For the development of optical sensors we need to pattern the fibroin films.
- Conventional photolithographic method cannot be applied.



Photocrosslinkable fibroin photoresist.

Hexafluorisopropanol (HFIP):

- High cost
- Disposal are environmentally difficult and costly
- High volatility
- Not possible to work in liquid phase

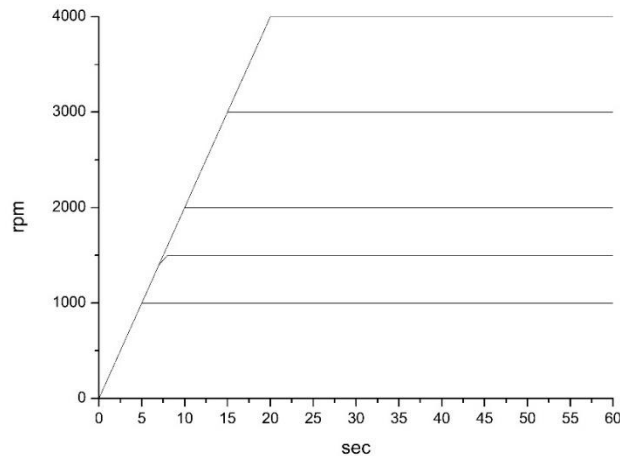
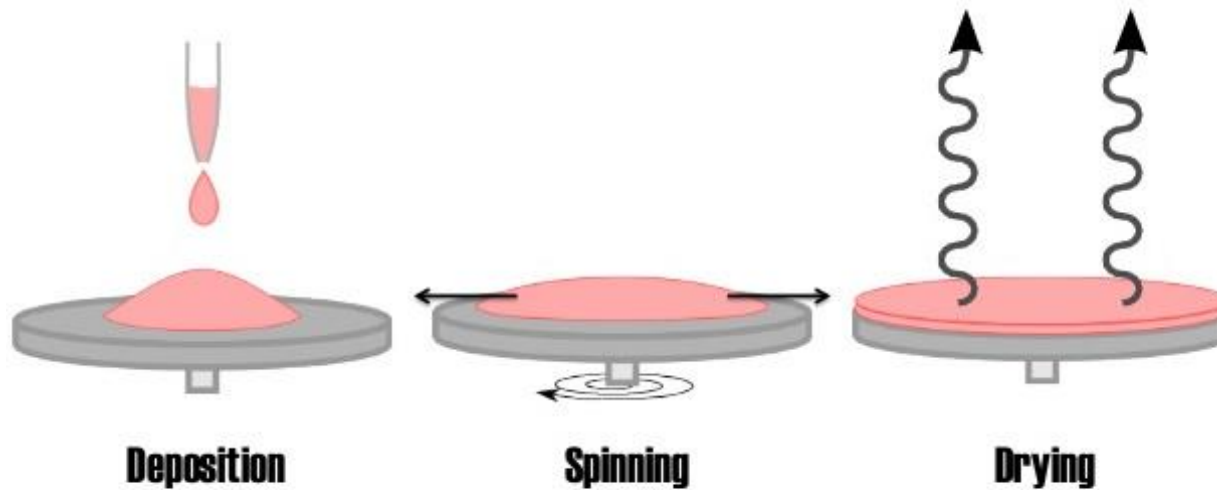


Formic Acid (FA):

- Low cost
- Disposal is easy
- Low volatility
- Is possible to work in liquid phase



Film preparation

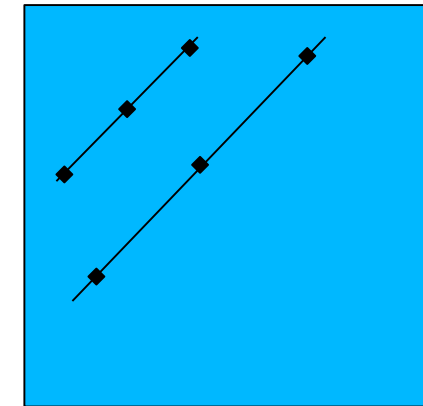
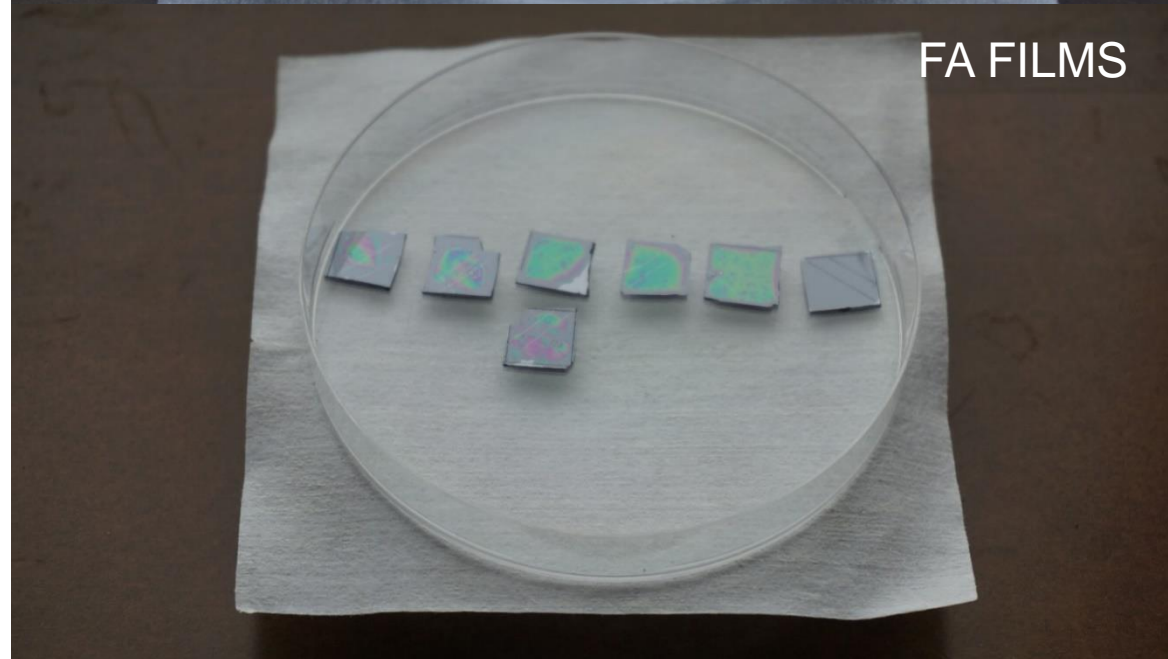
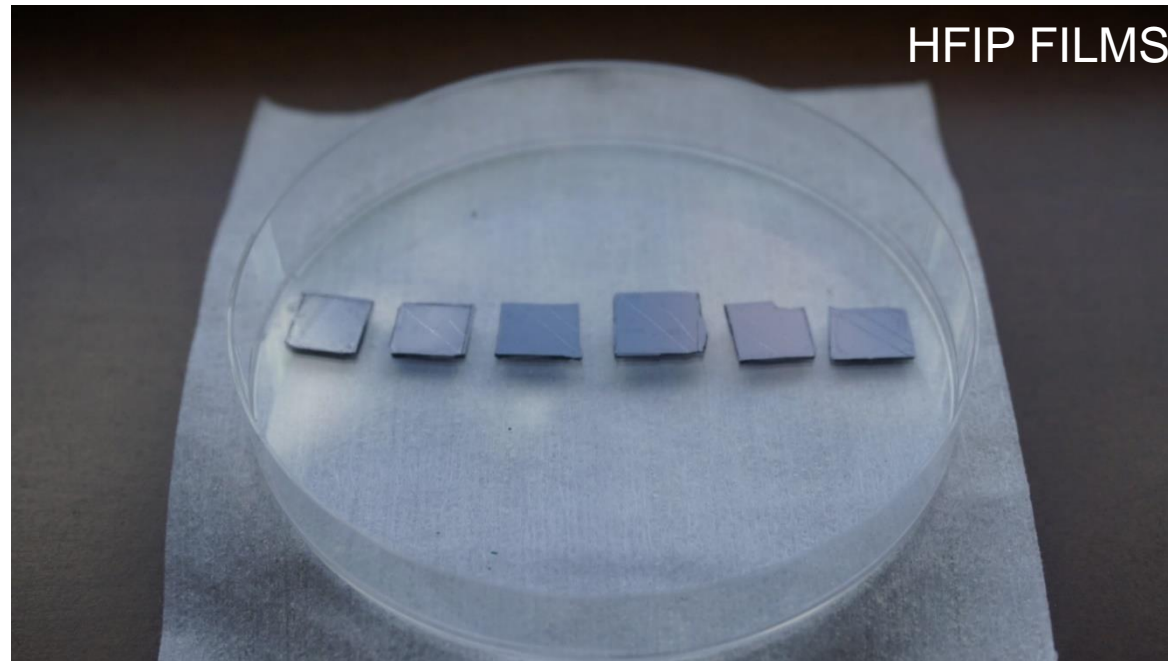


- 2mg/40 μ L (SP. COAT. , SOL. CAST.)
- 0.7mg/40 μ L-0.5mg/40uL (SPIN COAT)

Setup for Fibroin resist film producing:

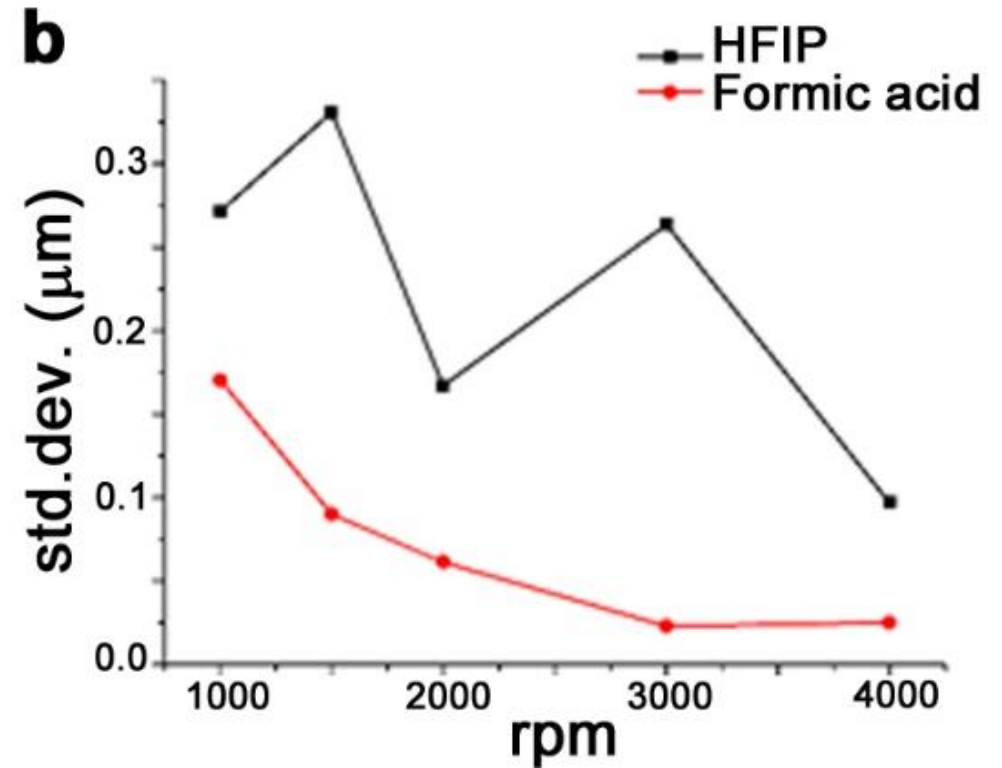
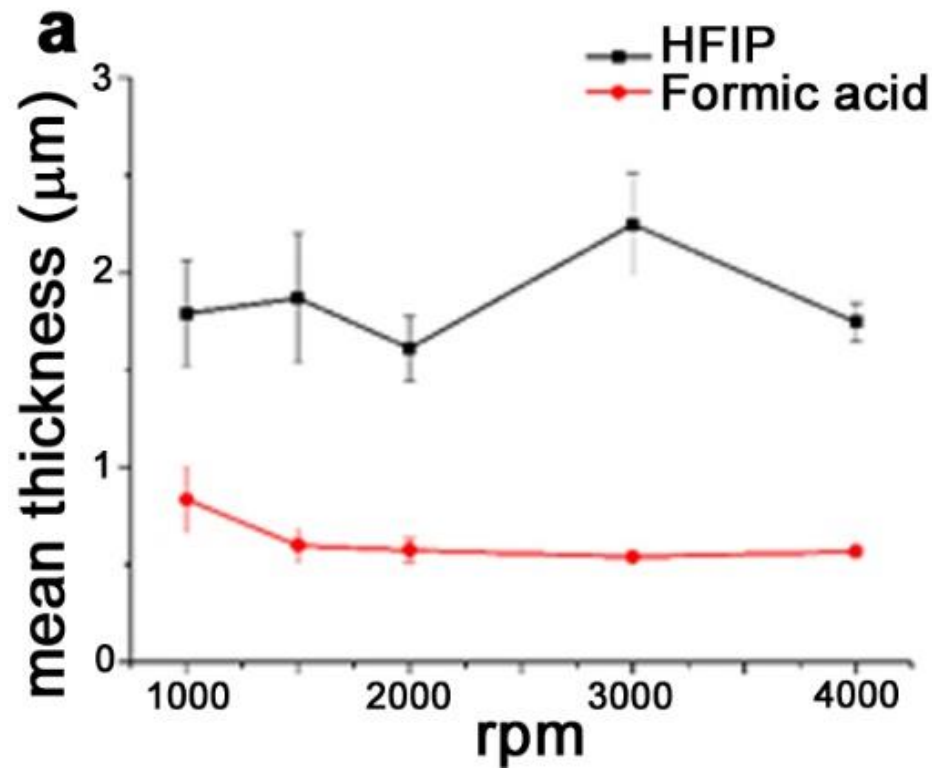
- 200 rpm/s acceleration
- 60 sec
- 1000, 1500, 2000, 3000, 4000 rpm

Film thickness measurement

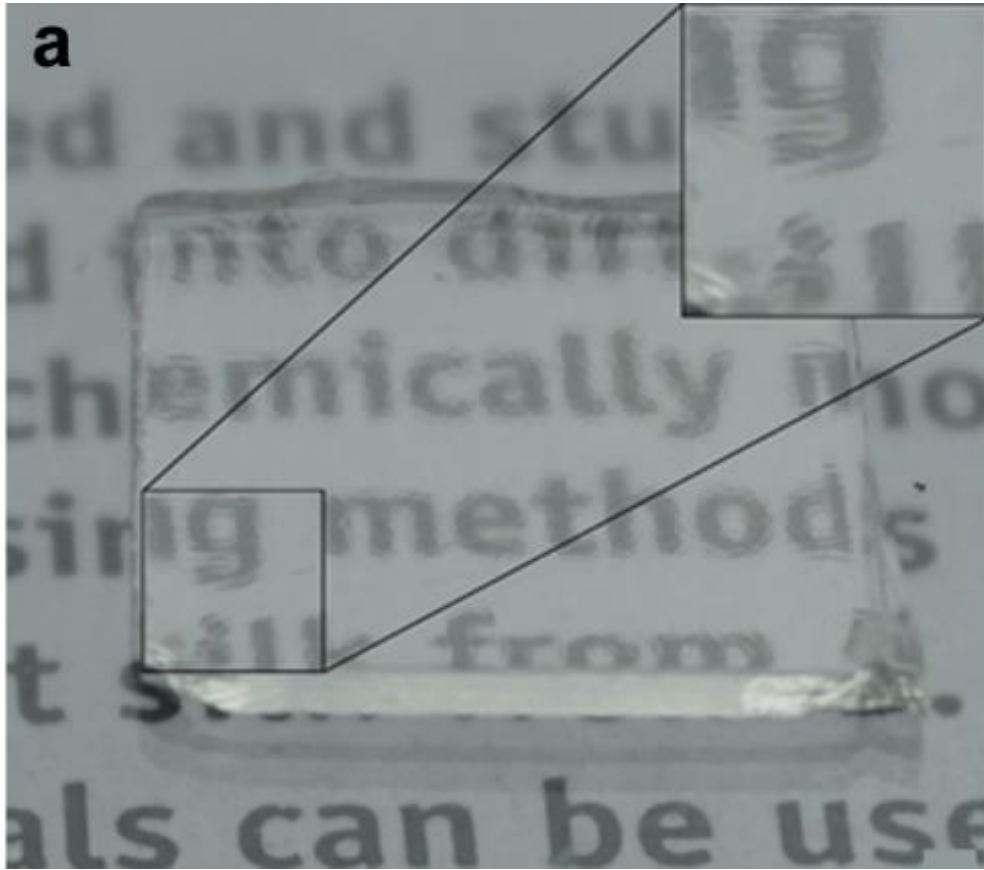


- Thickness is measured in six different points.
- Average thickness is calculated.
- Standard deviation is calculated.

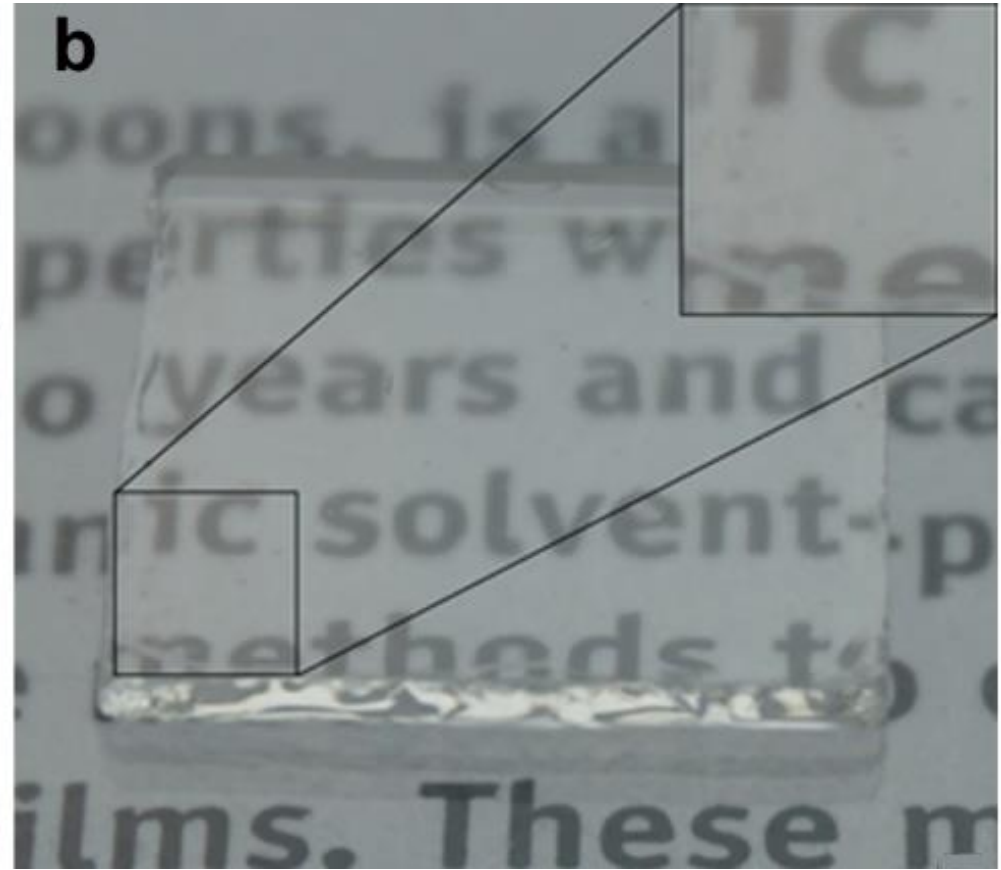
Film thickness comparison



Thickness uniformity

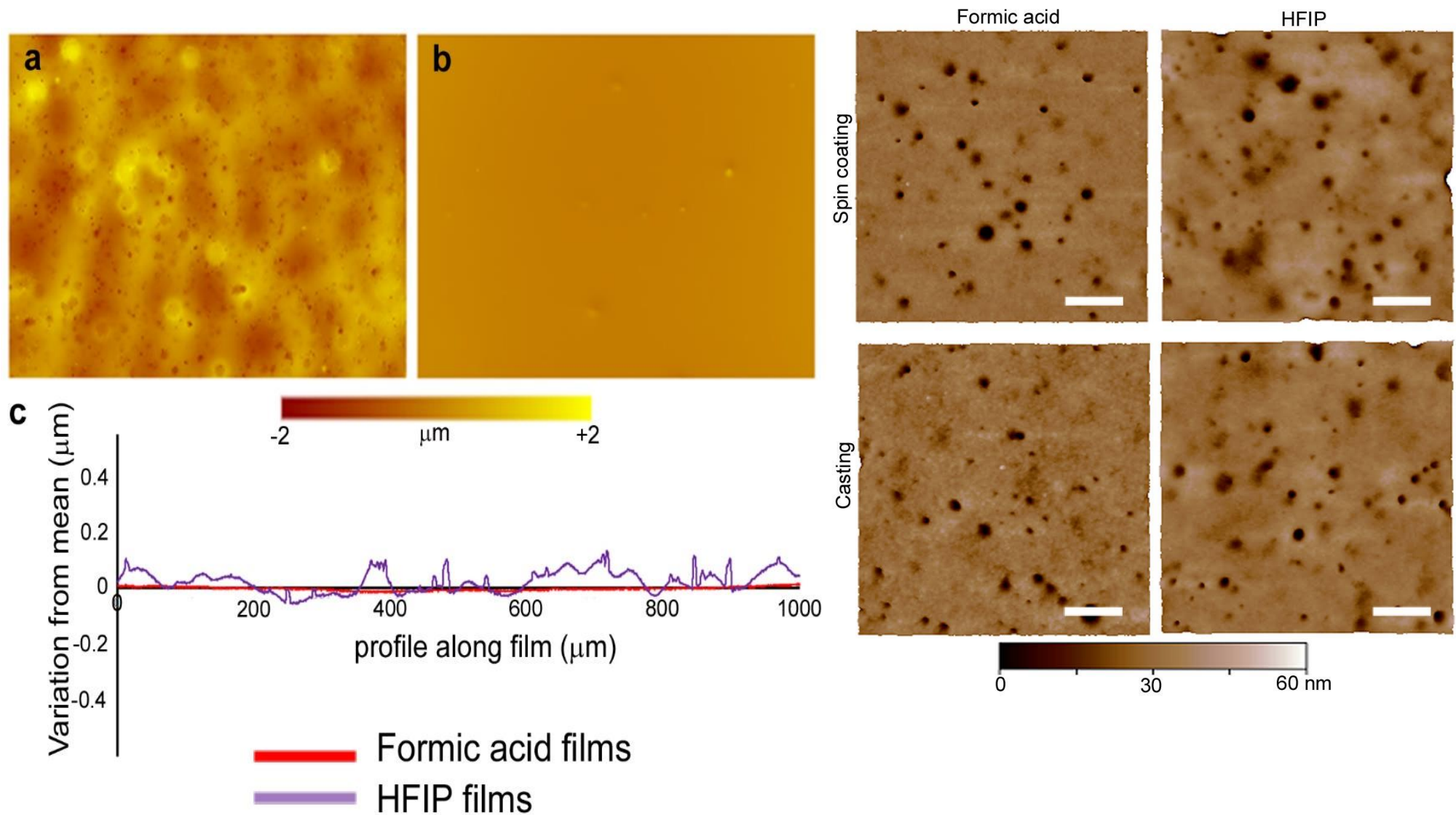


HFIP

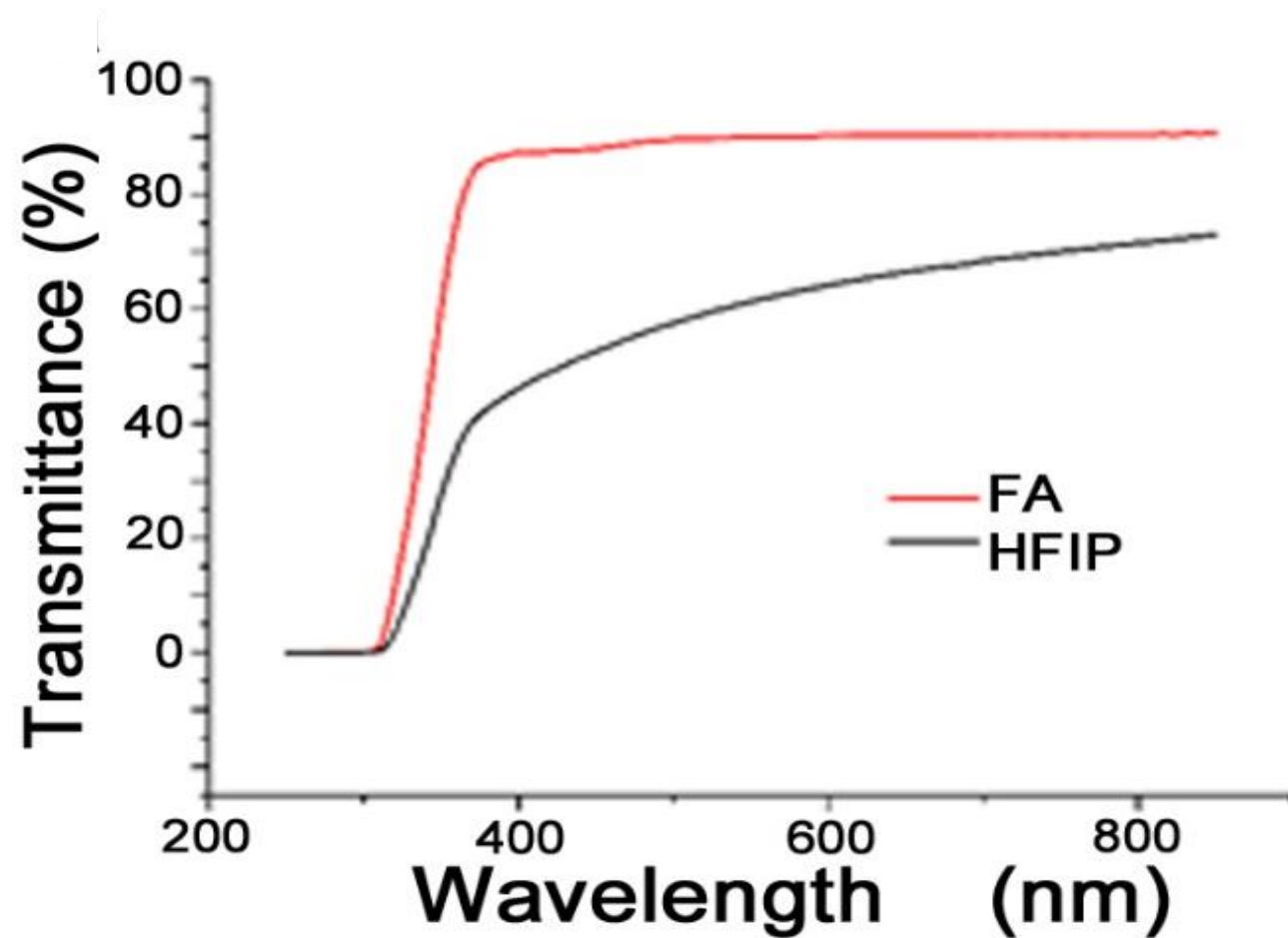


FA

Morphology comparison



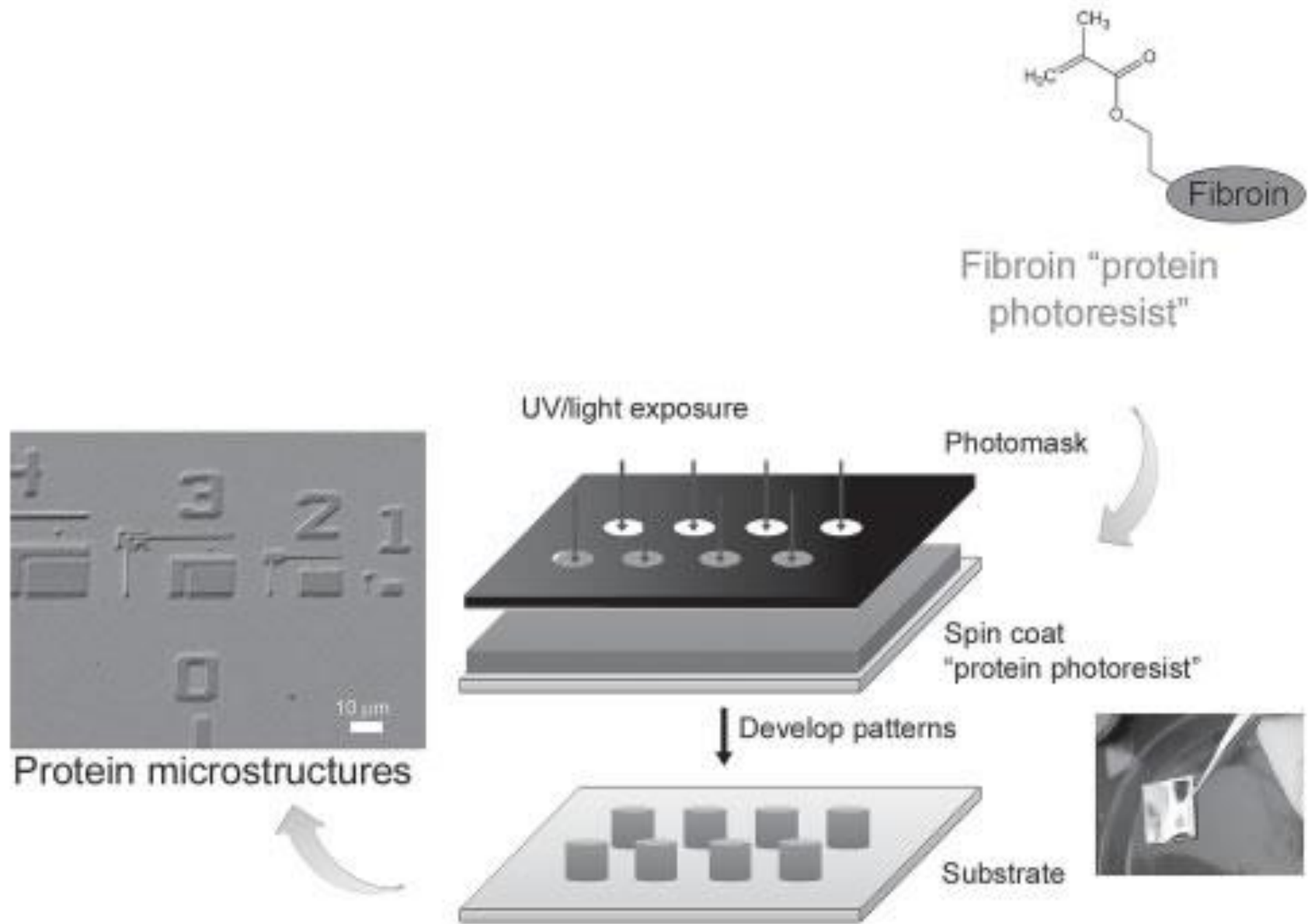
Optical Characterization



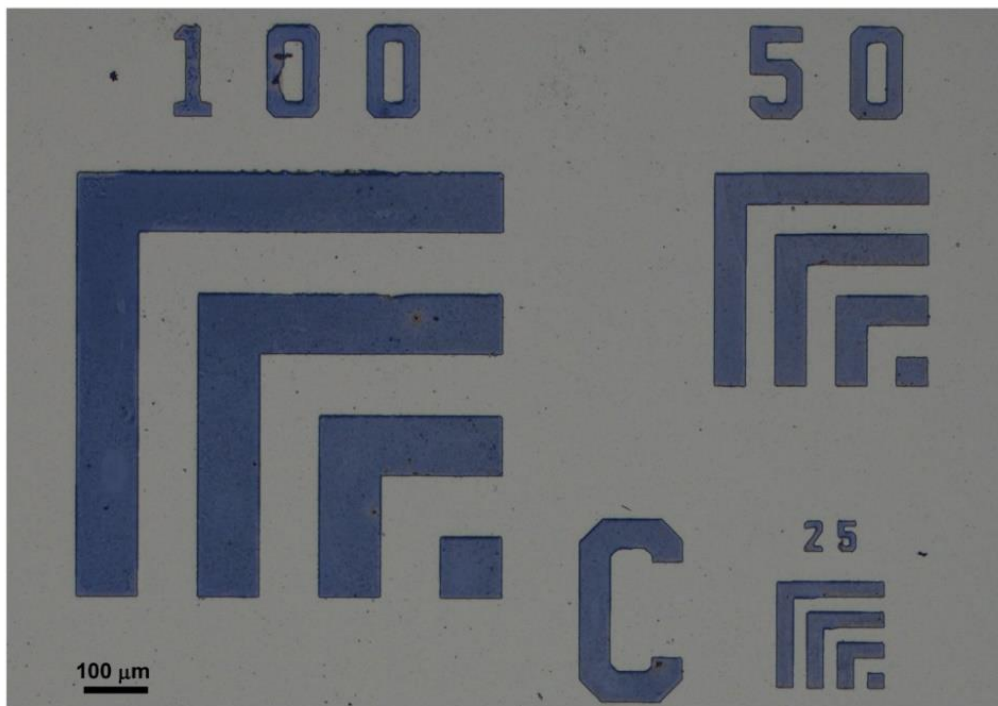
Ellipsometry

$\Delta t \pm 0,02$	$\Delta N 0 \pm 0,002$
nm	632,8nm
-2,63	0,006
-2,43	0,006
-2,37	0,005

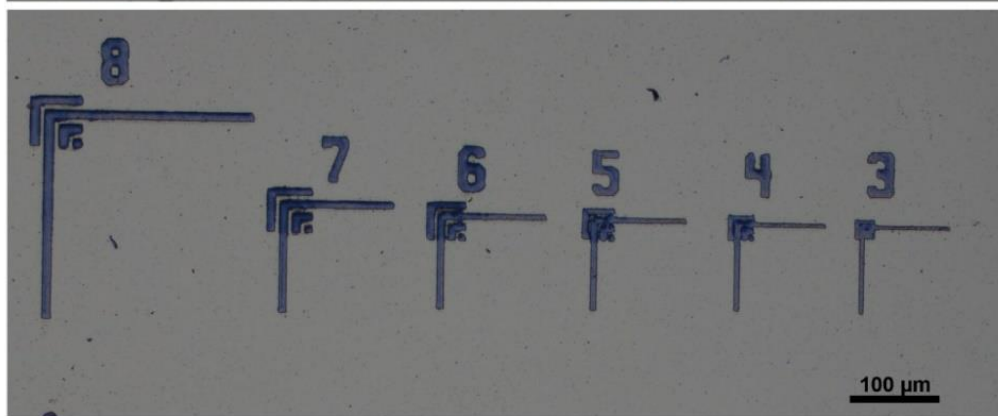
Patterning process



Kurland NE, Dey T, Kundu SC, Yadavalli VK. Precise patterning of silk microstructures using photolithography. *Advanced materials* 2013;25:6207-12.



COOMASSIE BRILLIANT BLUE
R250 STAINING TO INCREASE
THE CONTRAST.



- Found a method to use a substrate made of fibroin to obtain an implantable film.
- Development of a robust procedure: fibroin is a natural material and the amino acidic content can vary from batch to batch.
- Development of fibroin-based optical sensors.

Thank you for the attention.