TRAETTINO STEFANIA

PhD student at ESPCI Paris from September 2018

Supervisor: Prof. Cloitre Michel

- 03/2017-12/2017: Traineeship at Université Libre de Bruxelles

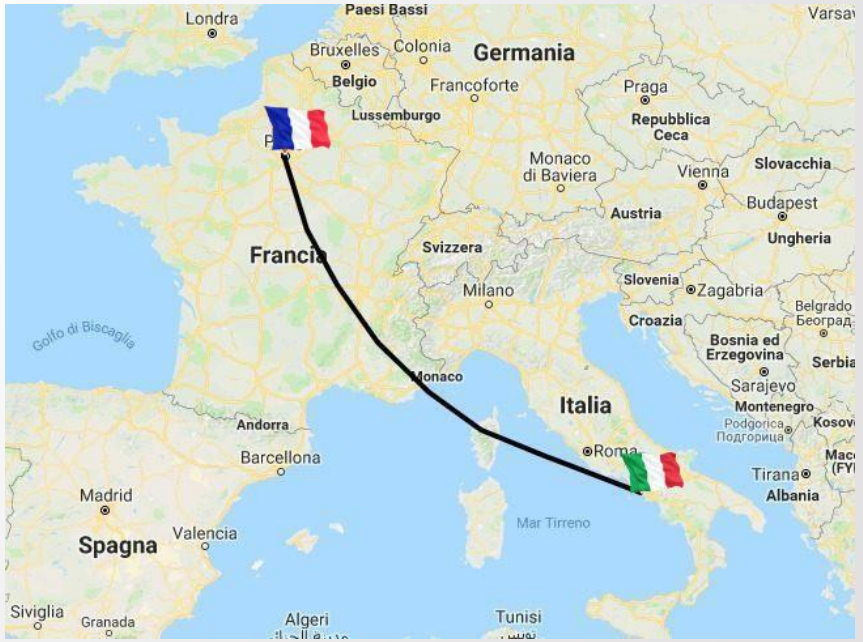
  Title Master thesis:

  Colloidal photonic crystals on soft substrate of sodium alginate for wearable sensors

- 07/2018: Master degree in Chemical Engineering at "Università degli studi di Napoli, Federico II" (Italy).

- Journal article published:

  V. Miskovic, S. Traettino, C. Minetti, H. Machrafi, A. Amirfazli, F. Dubois, and C. Iorio, "Fabrication and Characterization of Polystyrene Colloidal Photonic Crystals on Soft Sodium Alginate Film", J. Nanoelectron. Optoelectron. 13, 472–478 (2018).



RAWINTS project: RApid skin Wound healing by INtegrate Tissue engineering and Sensing

In collaboration between "Università degli studi di Napoli, Federico II" and "Université Libre de Bruxelles".

The goal of **RAWINTS** project:

Fabrication of a *cost-effective, disposable, wearable sensor* made of photonic crystal on biocompatible membrane usable for the early detection of Chemical, Biological, Radiological and Nuclear agents

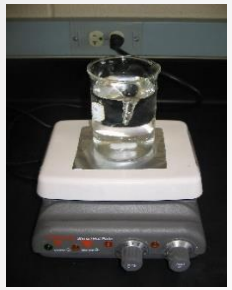
Fabrication of a suitable, low-cost and flexible membrane

Mixing and dissolution

in water+glycerine

(2g of SA in 100 ml of water+ 10ml of glycerine)

Sodium Alginate in powder form

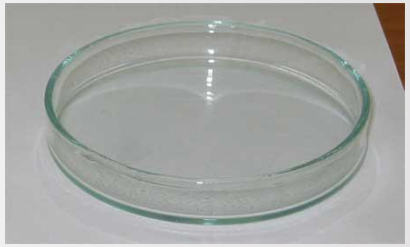


Spin coating process

100 rpm for 10 sec

Drying

room temperature for 24 h



Salt bath and drying

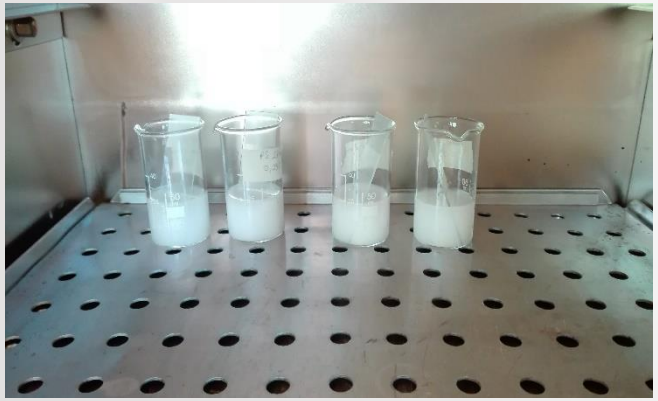
Salt solution of 2 g/100 ml of $CaCl_2$ for 5 min.

Drying at room temperature for 24 h

- Biocompatible
- Biodegradable
- Flexible
- Not soluble in water
- Transparent
- Easy to peel off

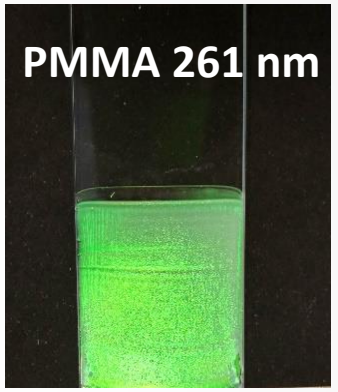
Preparation of 3D colloidal photonic crystals

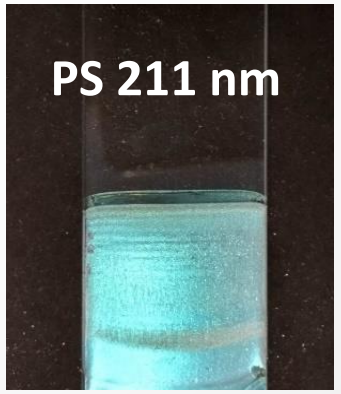
Dilution of colloidal PS and PMMA particles to 0.25% in deionized water

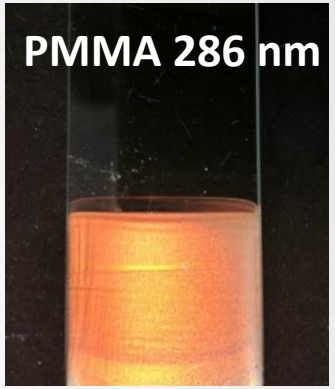


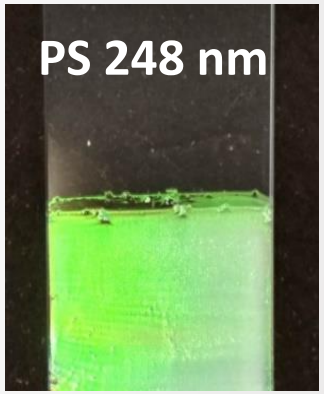
Drying in oven at 50°C and relative humidity of 30% for 24 h.

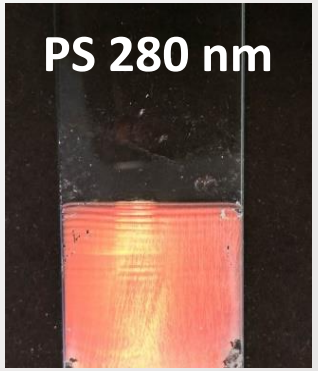
A solid structure of PhCs was obtained

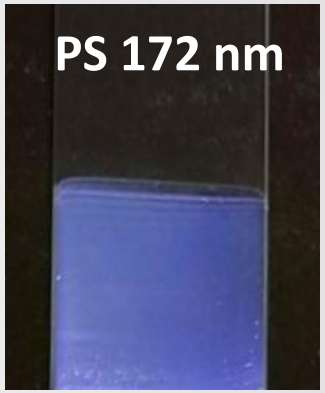


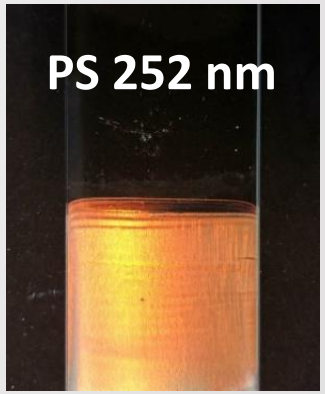








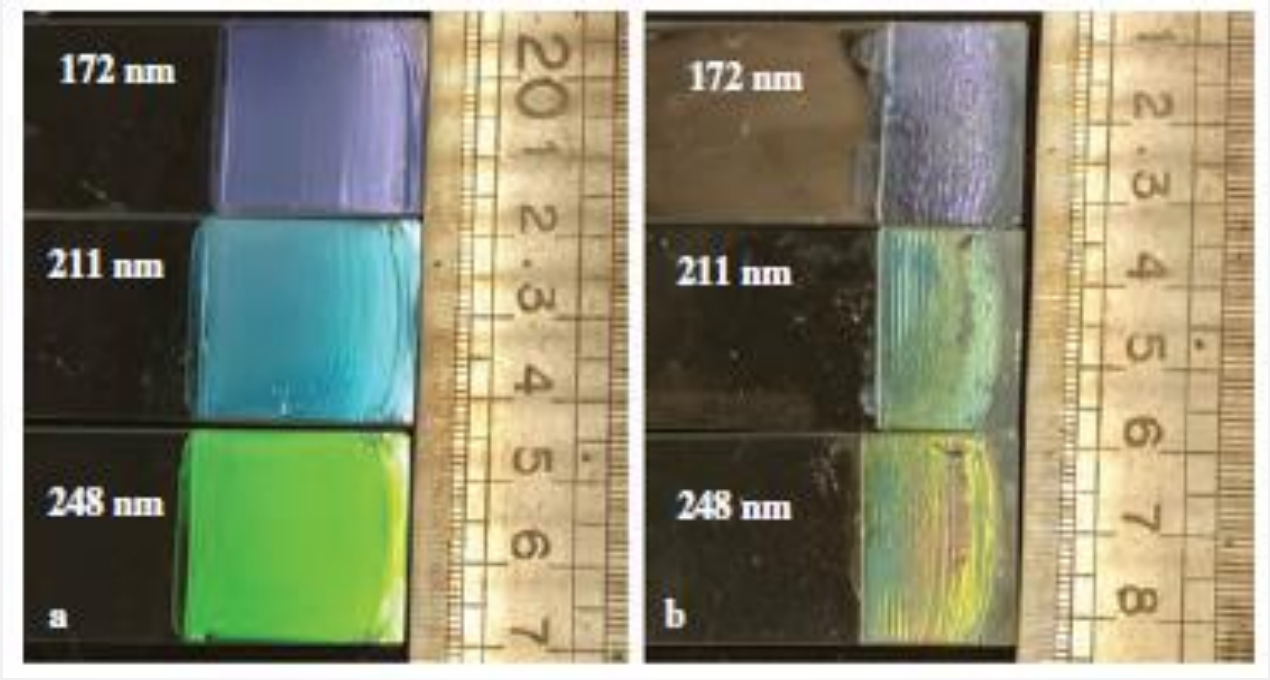




Photonic crystal on soft substrates of sodium alginate

PhCs on glass

PhCs on sodium alginate substrate

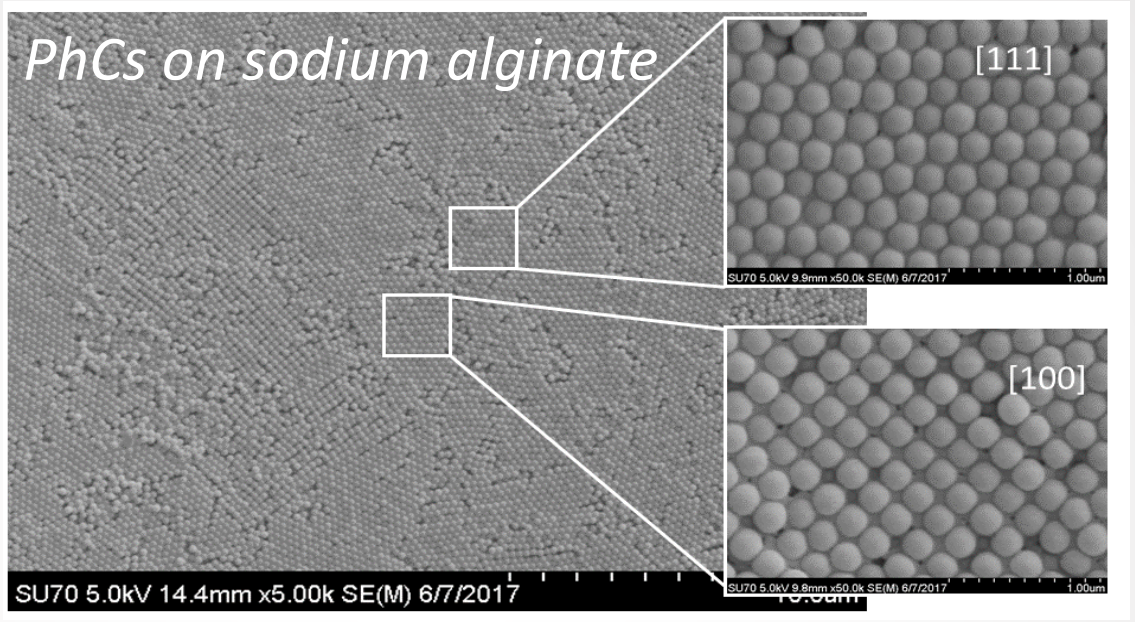


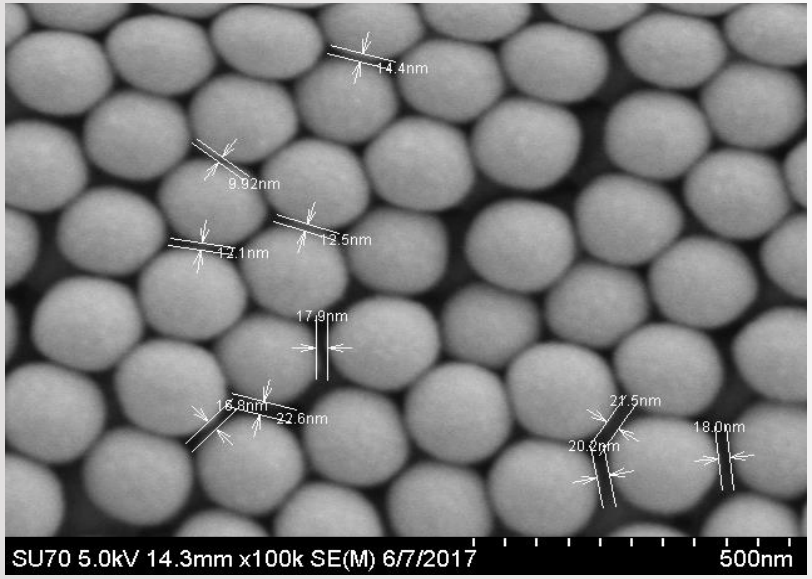
The colors exhibited by the colloidal crystals on the sodium alginate substrate are weaker

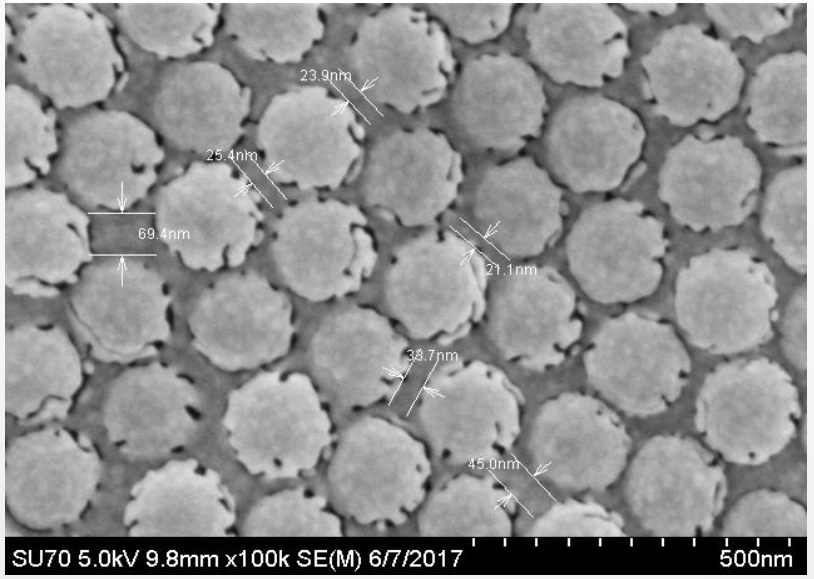
→

Fabrication procedure must be improved

SEM analysis



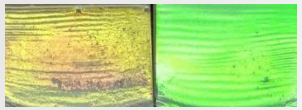


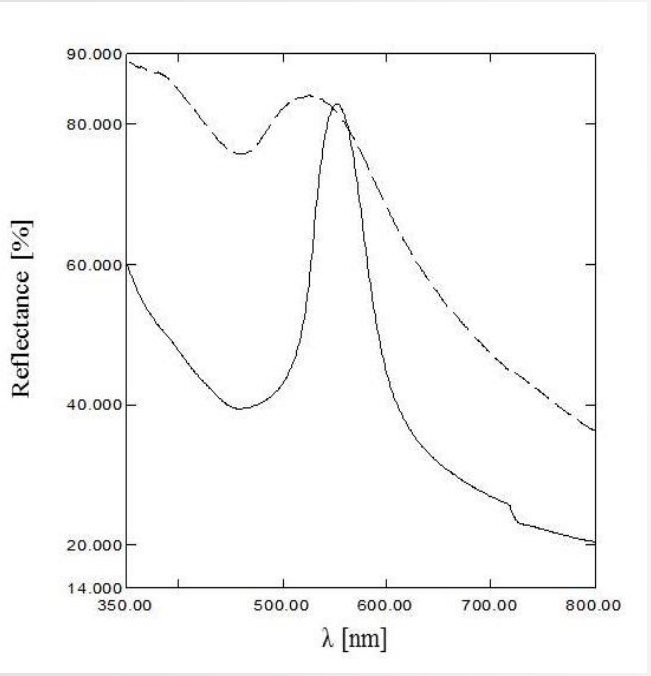


- More undesired dislocations and voids are present in the PhCs on SA films.
- High density of [100] FCC planes on the crystals obtained on SA films.
- Larger space between microspheres on SA compared to that on the glass

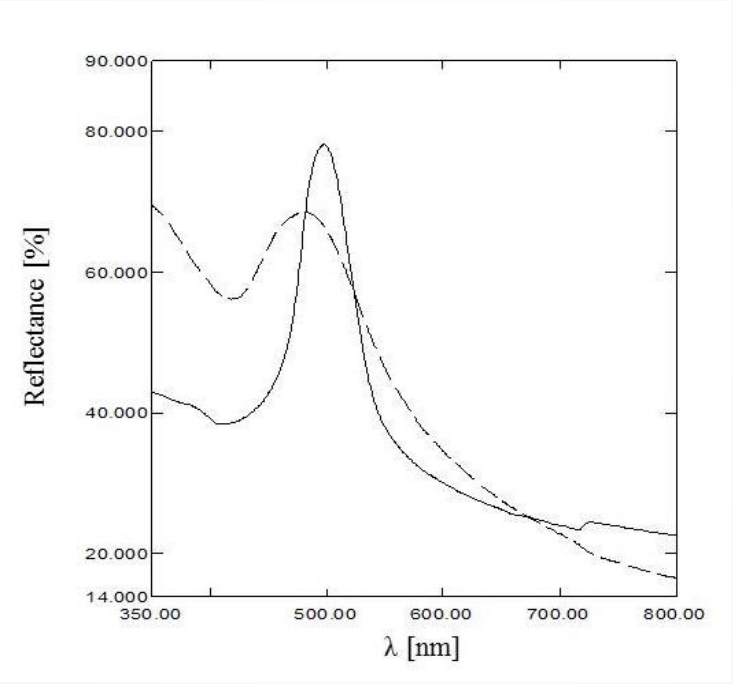
Comparison between PhCs on glass and PhCs on sodium alginate fims

PS 248 nm

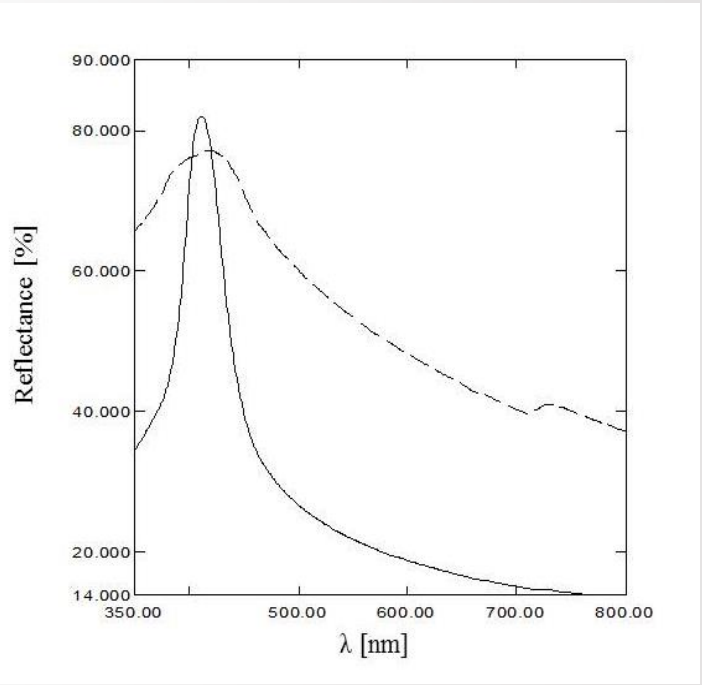




PS 211 nm



PS 172 nm



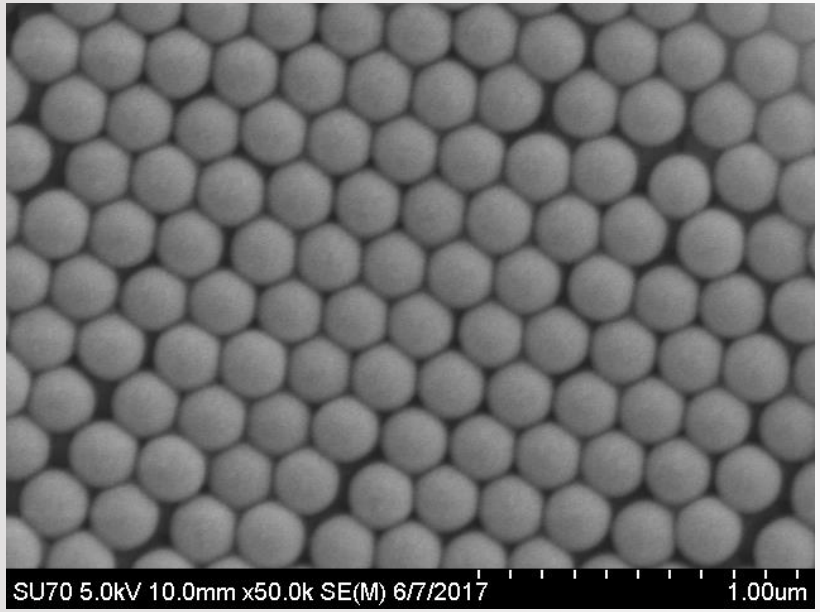
Sphere diameter [nm]	Calculated $\lambda_{max}(\theta=8°)$ [nm]	Experimental $\lambda_{max}(\theta=8°)$ on glass [nm]	Standard deviation σ [nm]	Experimental $\lambda_{max}(\theta=8°)$ on sodium alginate [nm]	Standard deviation σ [nm]
248	584.03	553.20	1.13	526.24	1.32
211	496.89	498.35	0.92	482.18	1.08
172	405.05	411.40	0.91	417.17	1.09

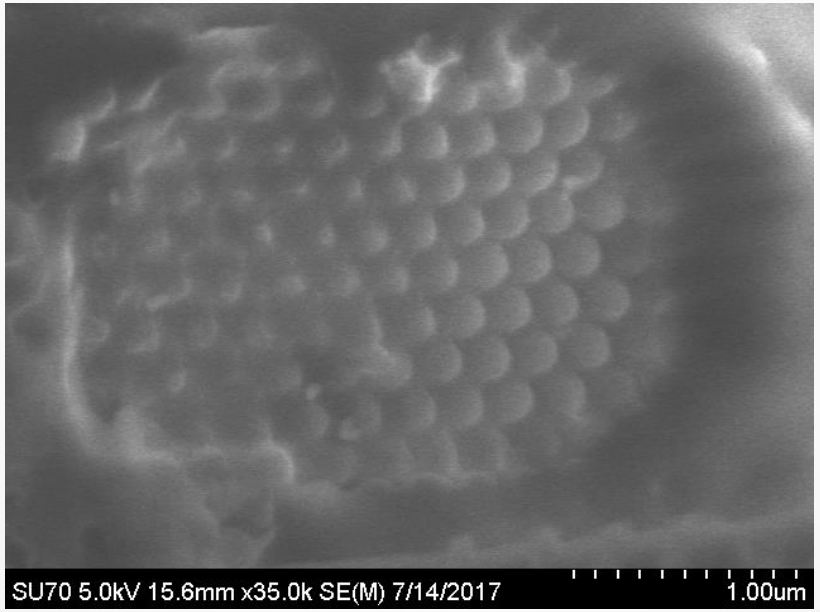
Inverse opal structure by using PNIPAM hydrogel

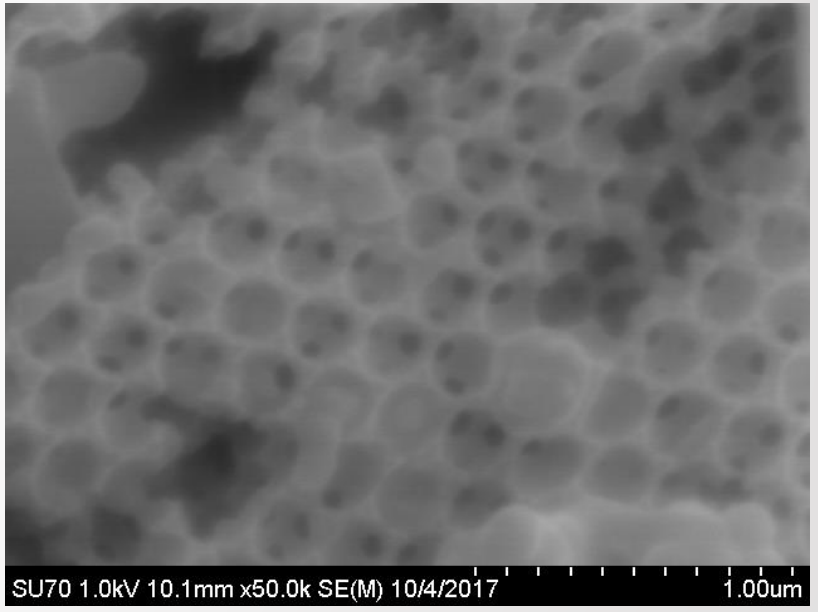
- Polymerization at 60° for 24 h.

- PS particles removal by immersion in a toluene solution for one day

Photonic crystal on glass → **Infiltration with hydrogel** → **Particles removal**



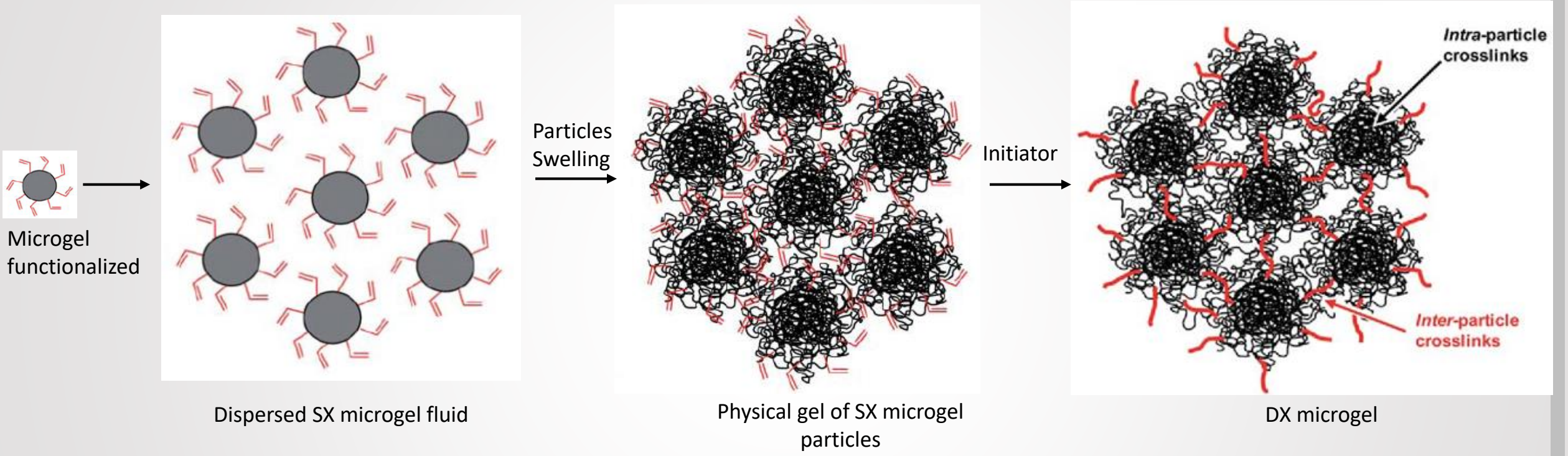




Only a small part of the samples (≈1.00µm) presents the desired inverse opal structure. → Impossible to detect the opal structure by using spectrophotometer

Supramolecular double-networks based on microgels with reversible covalent interactions

Permanent double-networks from microgel building blocks

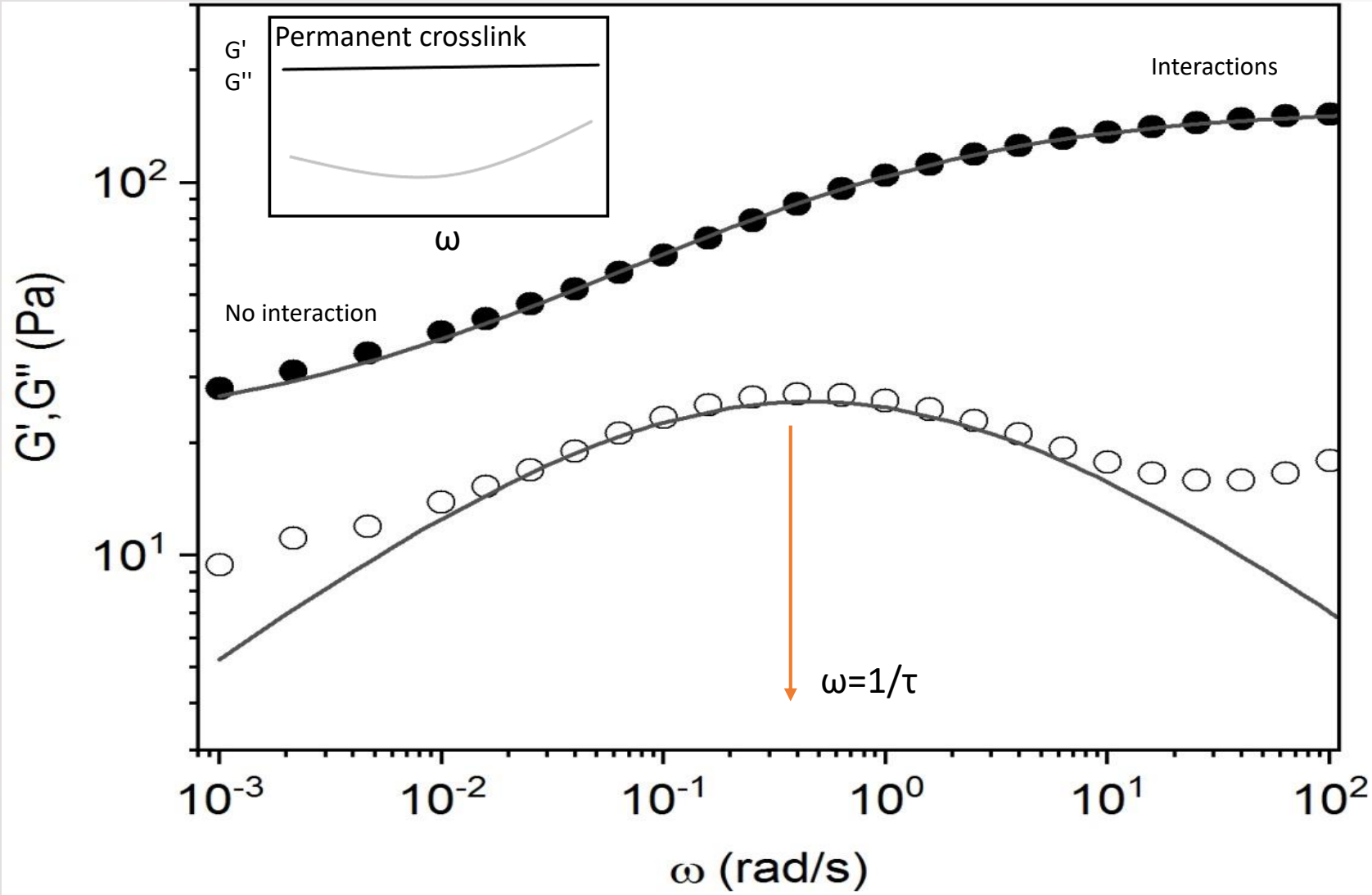


- Final state: soft composite gels with solid like properties
- Mechanical and transport properties
- Potential application: soft tissue repair

R. Liu, A. H. Milani, J. M. Saunders, T. J. Freemont and B. R. Saunders *Soft Matter*, **7**, 9297 (2011)

Reconfigurable double-network

- Reversible covalent bond ⟶ new dynamic properties/characteristic time scale, associated with break up of bond

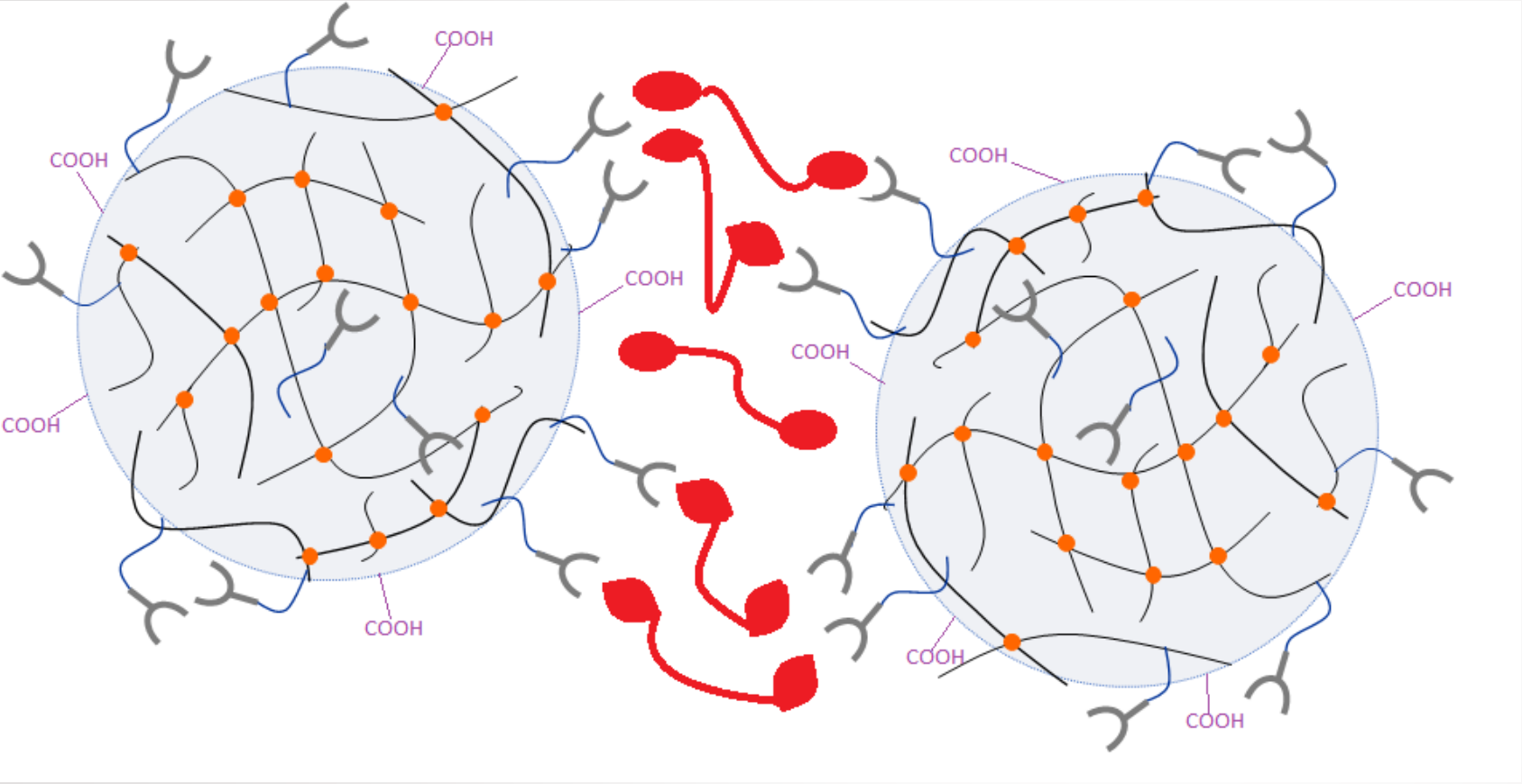


Example: hydrophobically modified microgels in the jammed regime

- Elasticity is frequency dependent
- Complex yielding

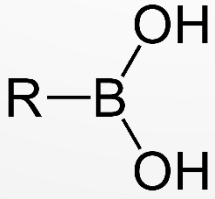
τ= relaxation time of adhesive interactions

Double-network from reversible covalent chemistry



- Existing or newly synthesis by microgels (MAA-EA)
- Take advantage of carboxylic function to graft boronic acid moieties
- Rheology will depend on the equilibrium constant of the covalent bond (T, pH, competitors…)

= boronic acid



= diols/PVA

Next step: exchangeable reactions

Future plan

- Preparation Double Network → R. Nicolaÿ (ESPCI)
- Tune the interactions (T, pH, competitors…)
- Investigate the local dynamic → DSL - D. Vlassopoulos (FORTH)

  Microscopy – S. Seiffert (JGU)
- Rheology
- Modelling: → Theory: E. Van Ruymbeke (UCL)

  Simulation: R. Bonnecaze (University of Texa)

THANK YOU FOR YOUR ATTENTION!