Superswelling microneedle arrays for dermal interstitial fluid proteomics

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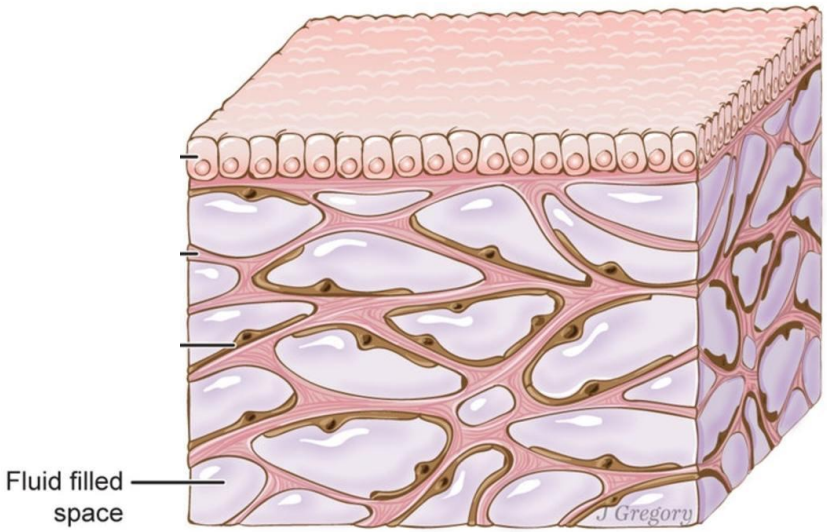
Advanced Delivery Science

Dermal intertitial fluid

Dermal ISF: Fluid found in the extracellular space in the dermal layer. It comes from substances that leak out of blood capillaries. Brings oxygen and nutrients to cells and to remove waste products from them.

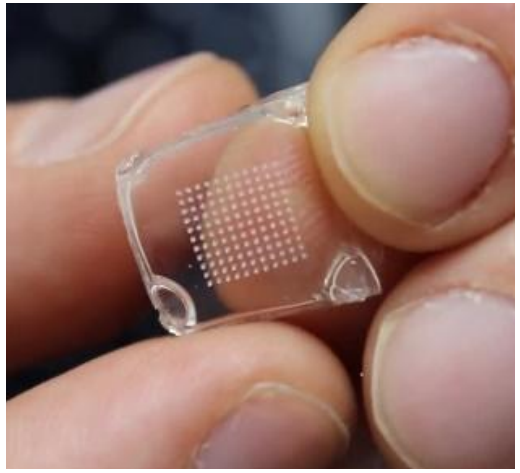


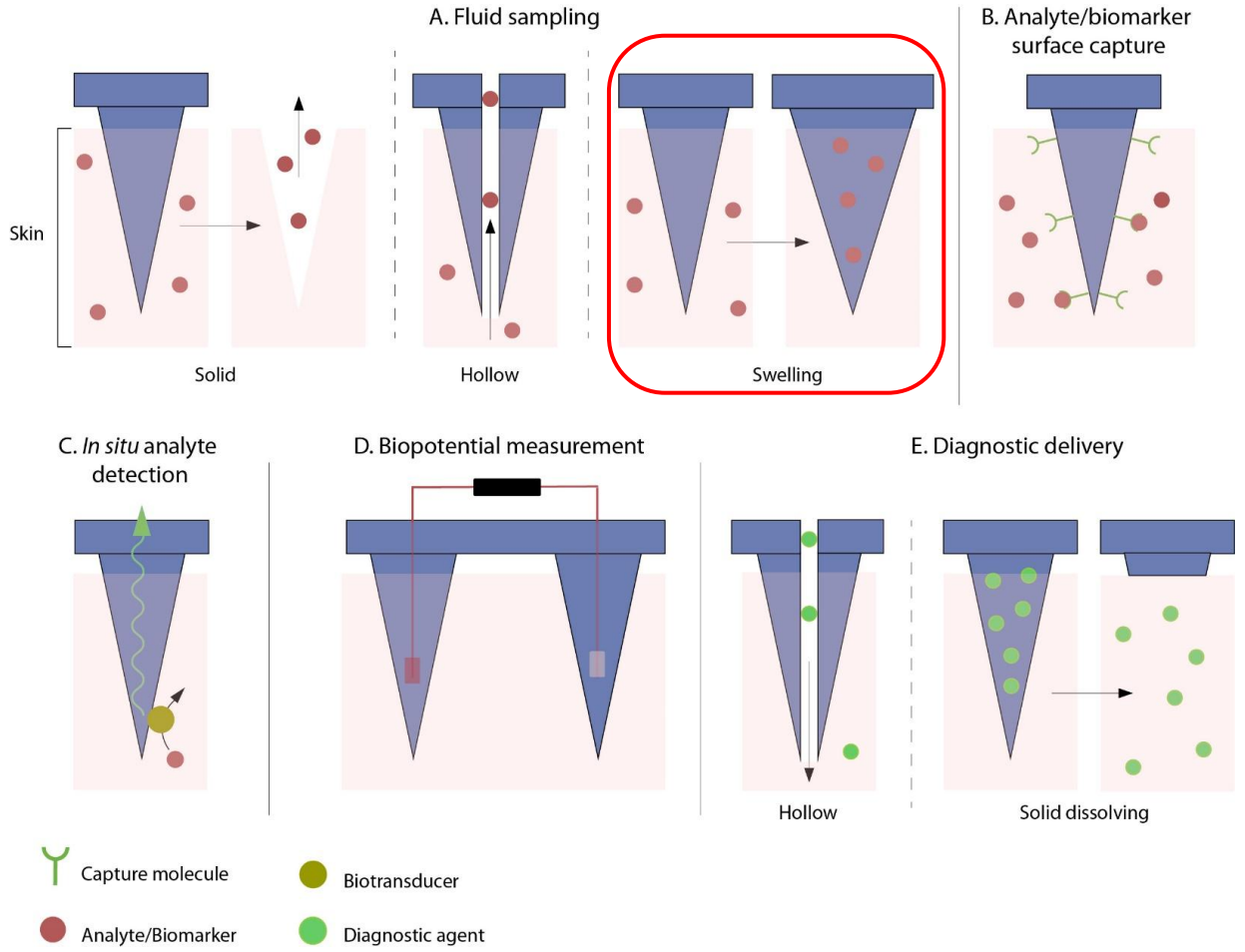
Equilibrium of components with systemic circulation

New source of biomarkers, blood substitute

Sampling remains a big challenge

Microneedles

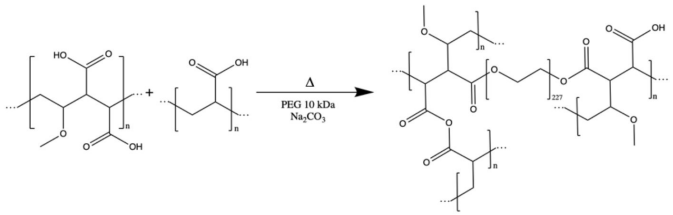


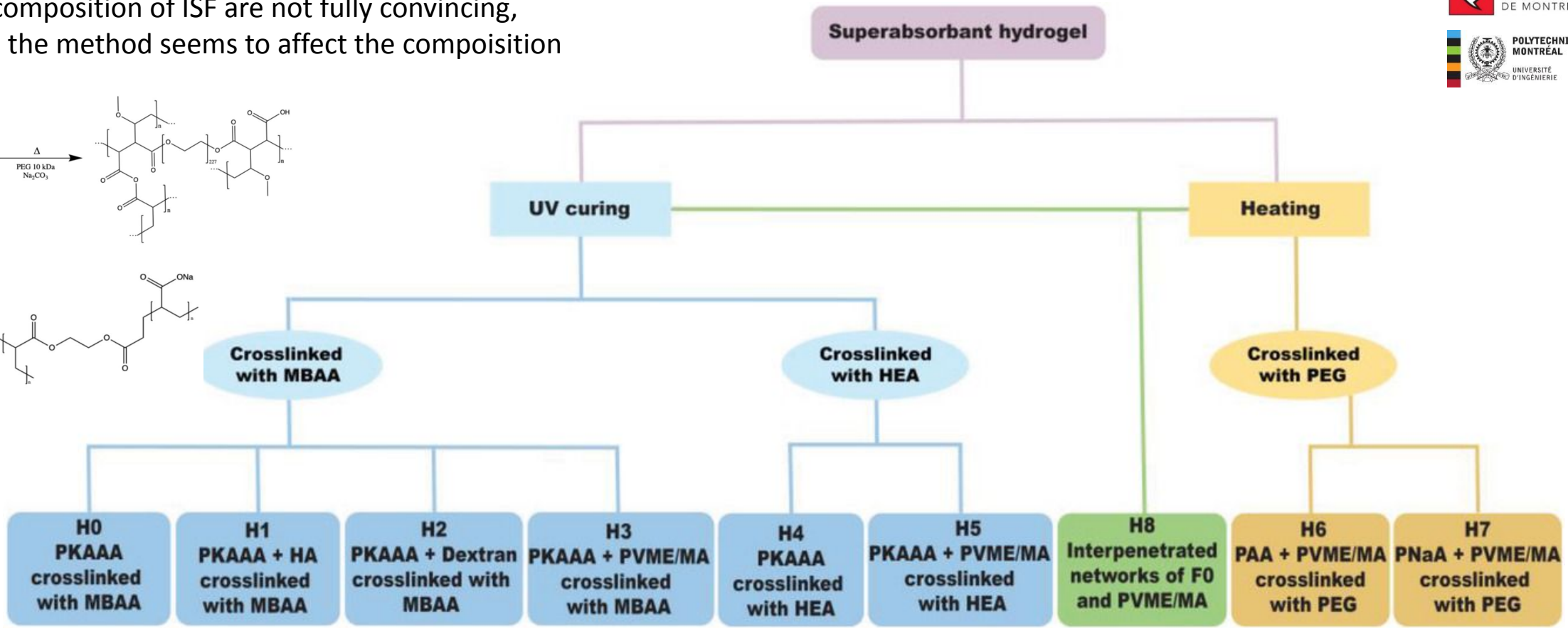


Babity S. *et al*. *Small*, 2018

Superswelling hydrogels for ISF composition exploration

Data about composition of ISF are not fully convincing, moslty becuase the method seems to affect the compoisition





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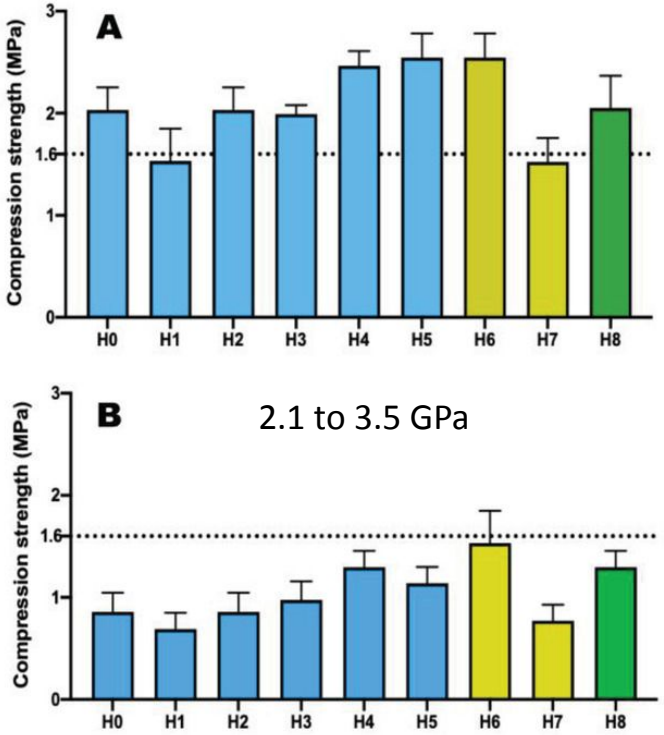
Swelling polymers



2.1 to 3.5 GPa

All generated materials showed mechanical properties

and superswelling capacity (≥ 100 $g.g^{-1}$)

Some formulations (PVME/MA and dextran doped H2) showed structural collapse at around 30 min

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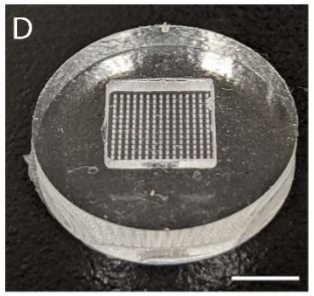
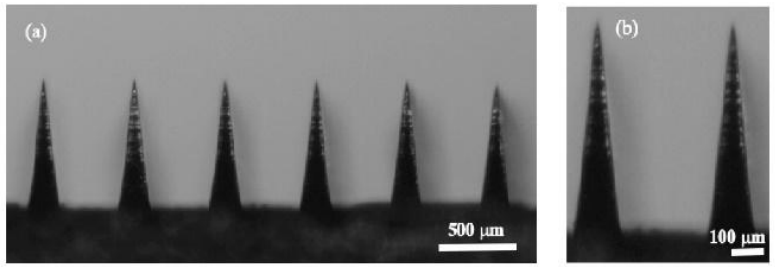
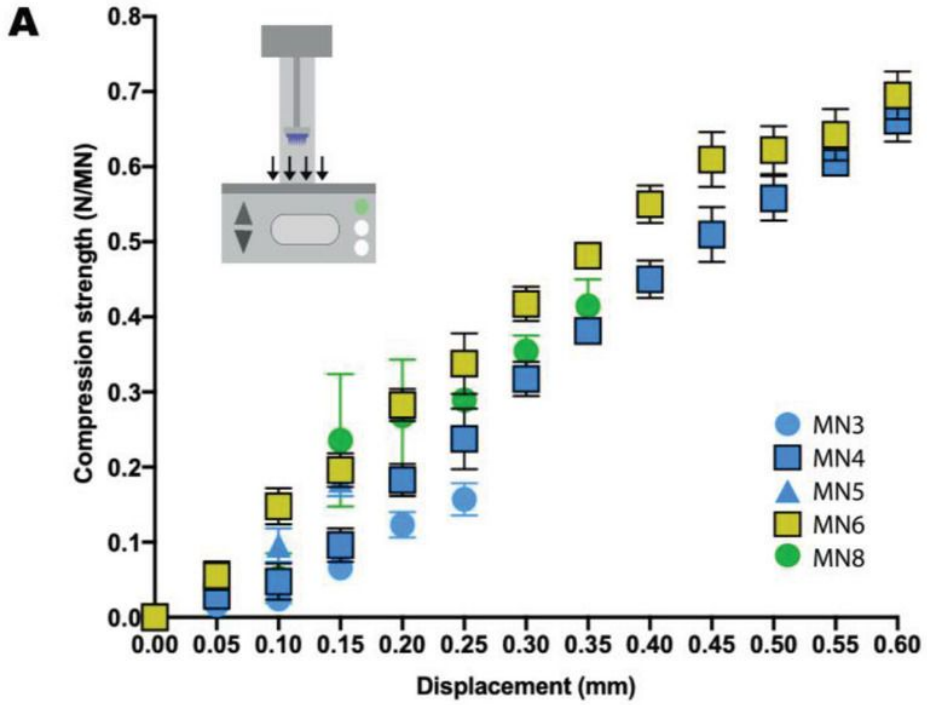
MNs, manufactring and characterization

Micromolding with PDMS molds







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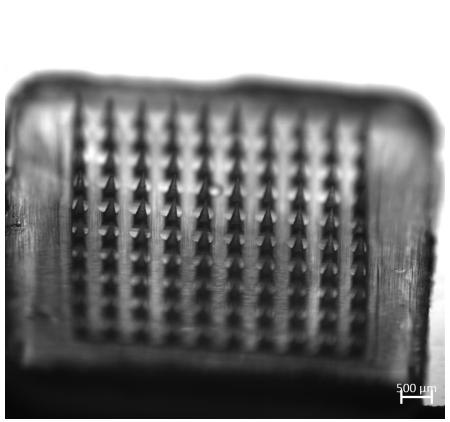
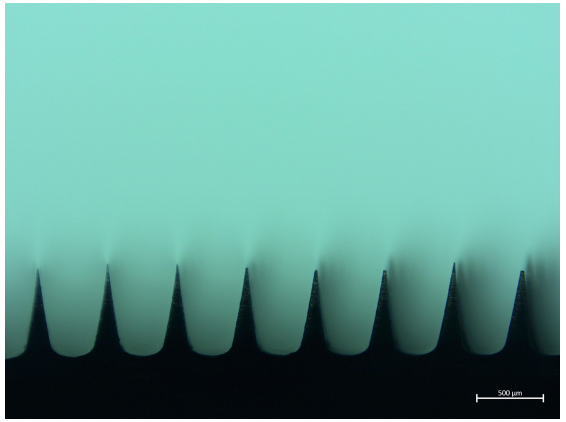
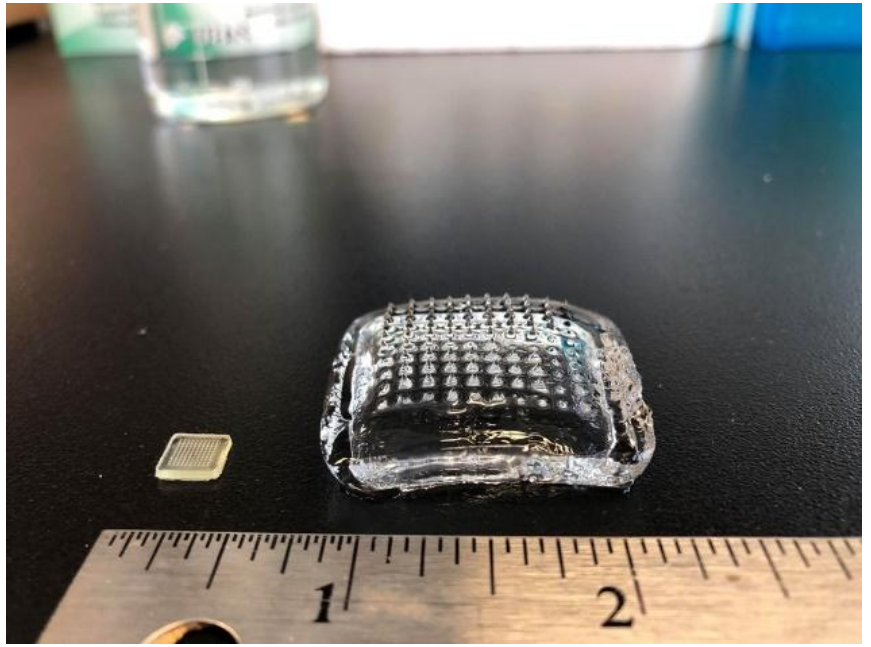
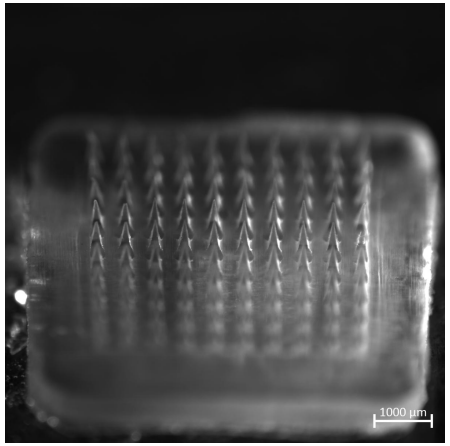
New swelling polymers

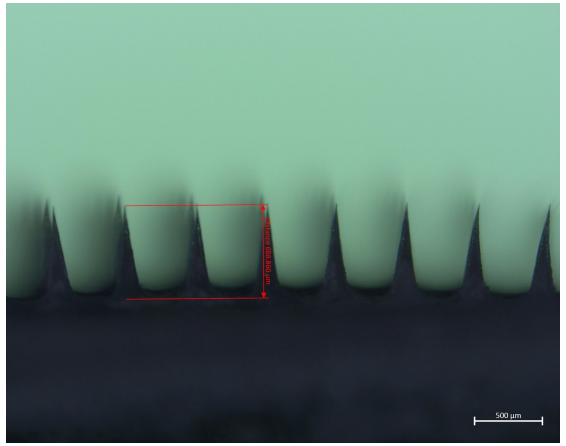




30 min



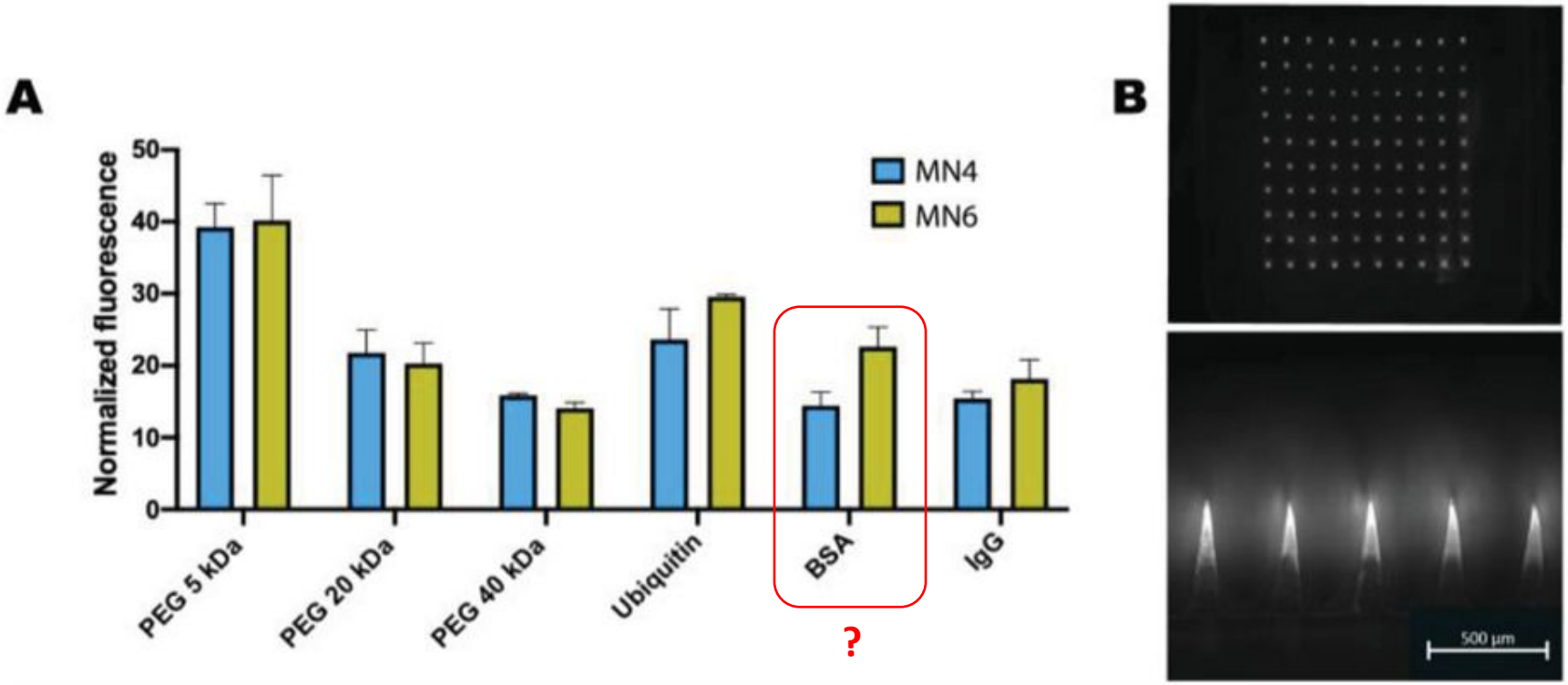




4 days vs 3h;
keep the shape after swelling and drying back;
Critical for washing (EtOH-water mixture): no leaching materials (biocompatible and no interference)

Laszlo E. et al. Unpublished data.

Analytes uptake



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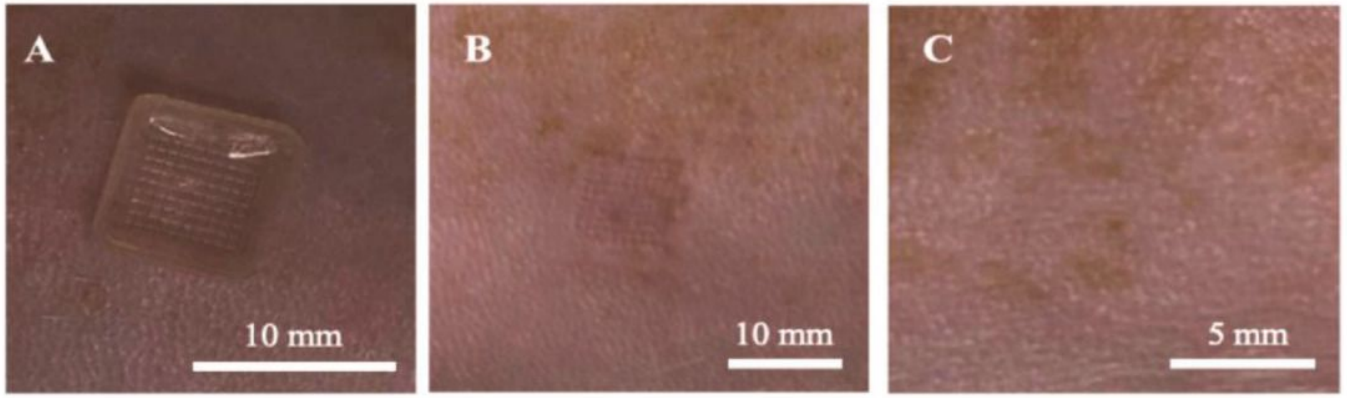
In vivo analyses



- 422 protein in total (no depletion, non targeted proteomics)
- 30 % of total detected proteins were unique to the ISF (associated with structural fonctions)
- Surprisingly, **the nature of the MN material affect the pool of collected proteins**: 56 proteins (13%) only in MN4-derived ISF and 18 proteins (4%) in MN6-derived ISF.
- This may result from differences in swelling rates or composition, molecular interactions between biomarkers and the polymeric backbone of the hydrogels.

Laszlo E. *et al*. *Adv. Funct. Mater.*, 2021

Conclusions

- We deisgned a new platform of swelling hydrogel MNs:
  - Biocompatible
  - Able to extract ISF from skin
  - Compatible with proteomics
  - Polymer speficic extraction (**interesting but also a challenge to consider**)

Next

- Get insights on the influence of the material on the extracted composition
- Evaluation in disease models for the quantification of circulating bomarkers

Acknowledgment

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