Functionalization of PU foams via inorganic and organic coatings to improve cell and tissue interactions

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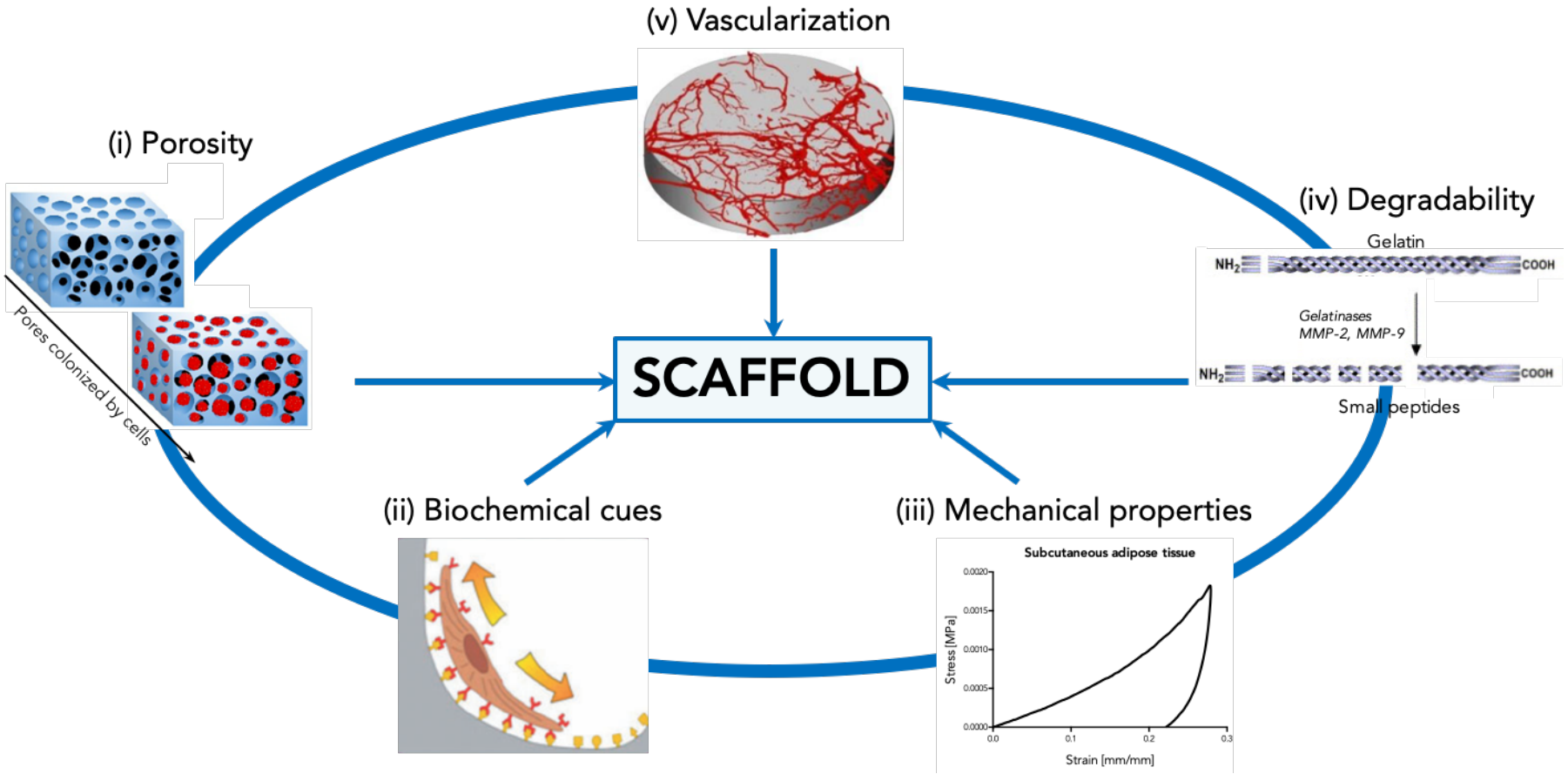
Scaffolds production and requirements

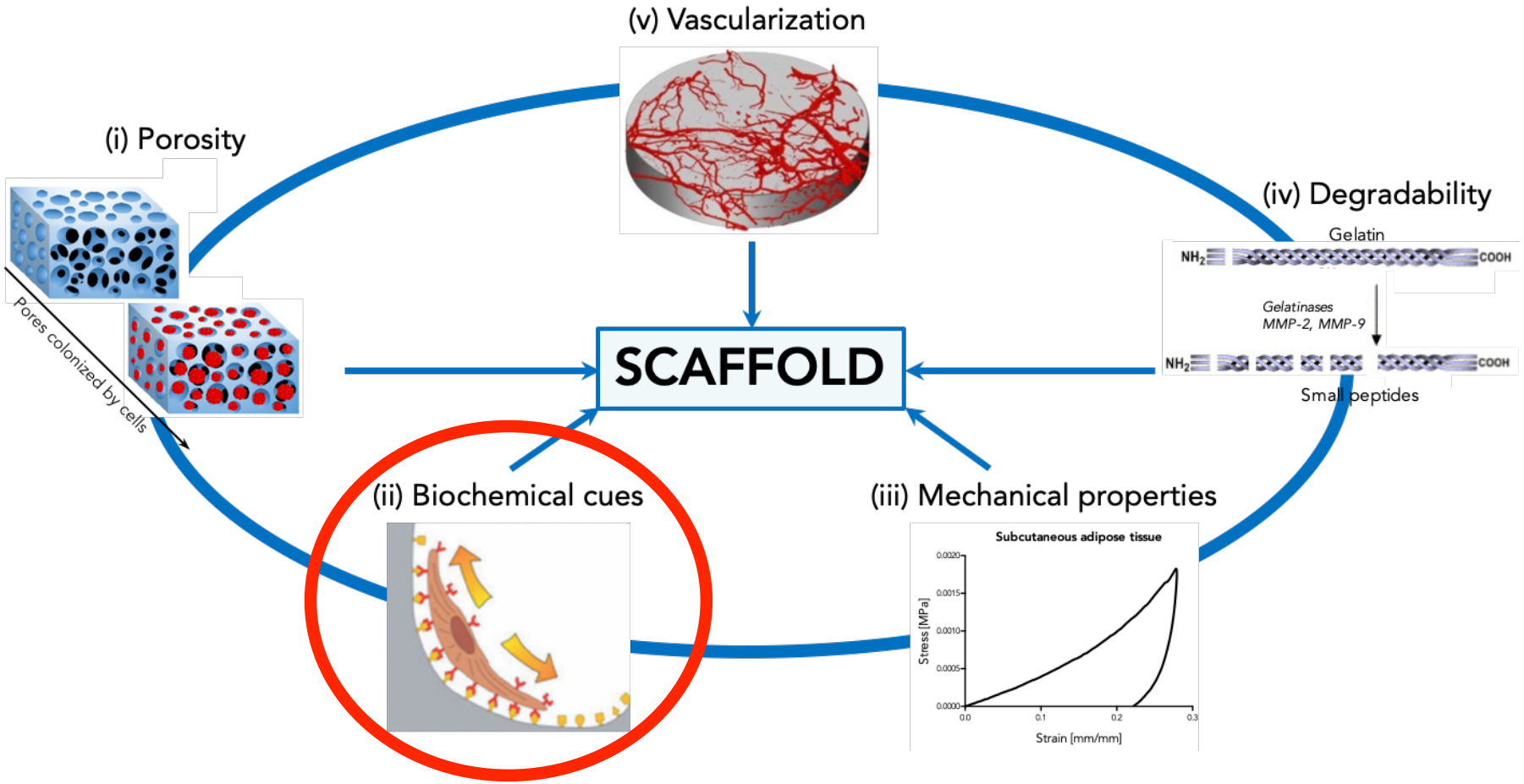
- **scaffolds** intended for **tissue regeneration** must match **specific requirements**



- **versatile formulations** to tune the **structural properties**

Scaffolds production and requirements

- **scaffolds** intended for **tissue regeneration** must match **specific requirements**

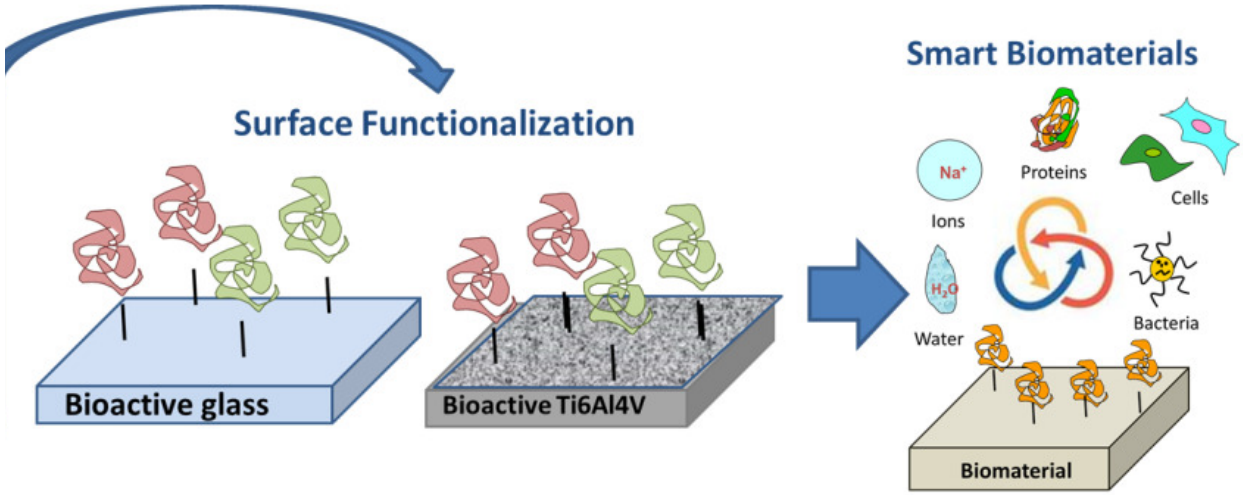


- **versatile formulations** to tune the **structural properties**

Scaffolds production and requirements

- **a correct surface bioactivity** is fundamental to properly **guide cells fate** and **tissue infiltration/regeneration**

different bioactive coatings can be used to promote a desired response



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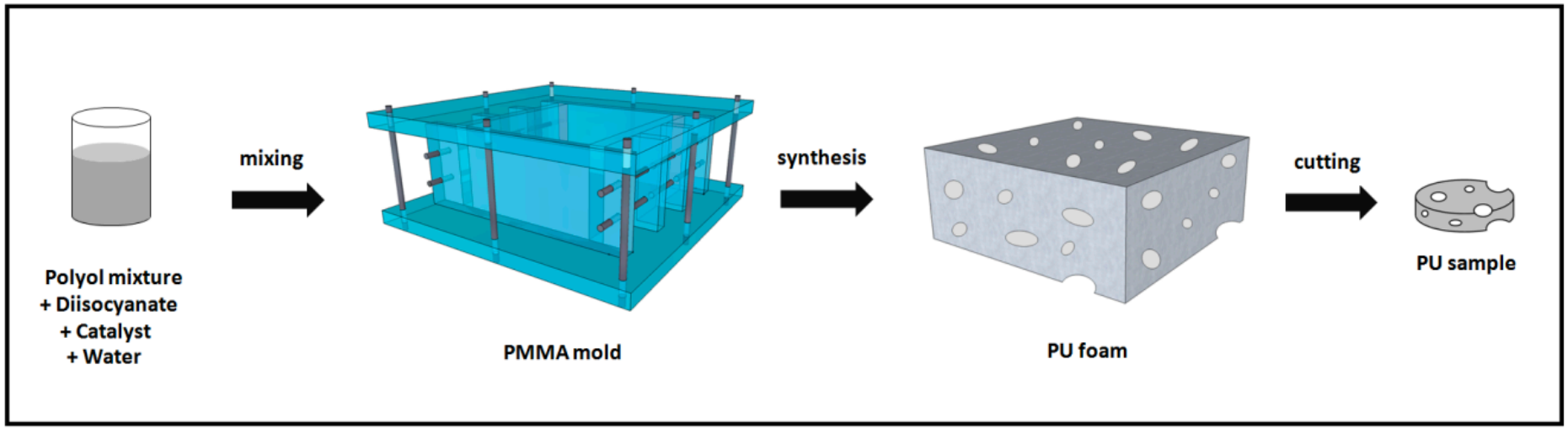
Aim of the work

- use of **polyurethane foams** as scaffolding materials
- **coating** of polyurethane foams either by using
    - **calcium phosphates** → to target the regeneration of bone tissue
    - **gelatin hydrogels** → to target the regeneration of soft tissue

Production of polyurethane foams

- **polyurethane foams** used as **porous structures** for **scaffolds production**



- **one-step gas foaming** reaction
- **water** (2% w/$w_{polyols}$) used as **expanding agent**
- **versatile formulations** to tune the **structural properties**

Polyurethane foam coating to obtain hybrid scaffolds

- PU foams coated by inorganic or organic coating to target different tissues regeneration

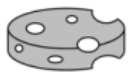
1) PU samples

2) coating of the PU samples in an vacuum chamber

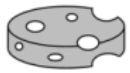
3) inorganic/organic coated samples

Inorganic coating

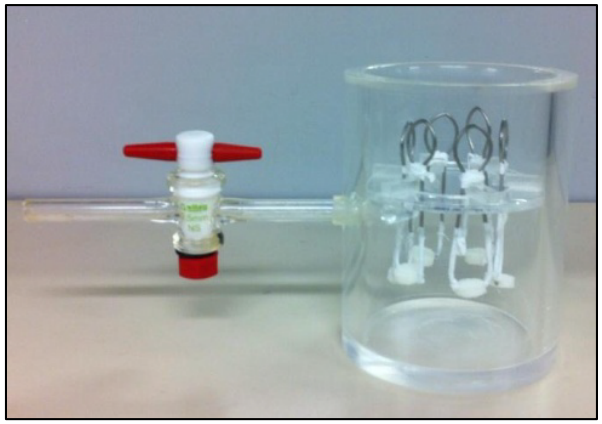
Organic coating



PU sample



PU sample



PU_CaP

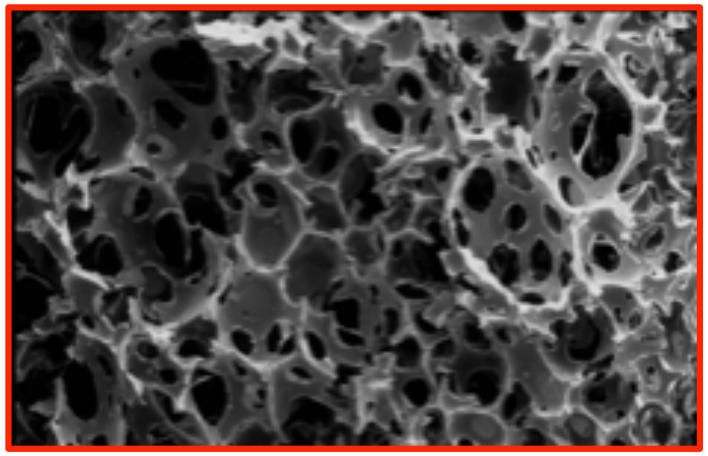
★ Calcium phosphates

Gelatin hydrogel (6 or 15% w/v)

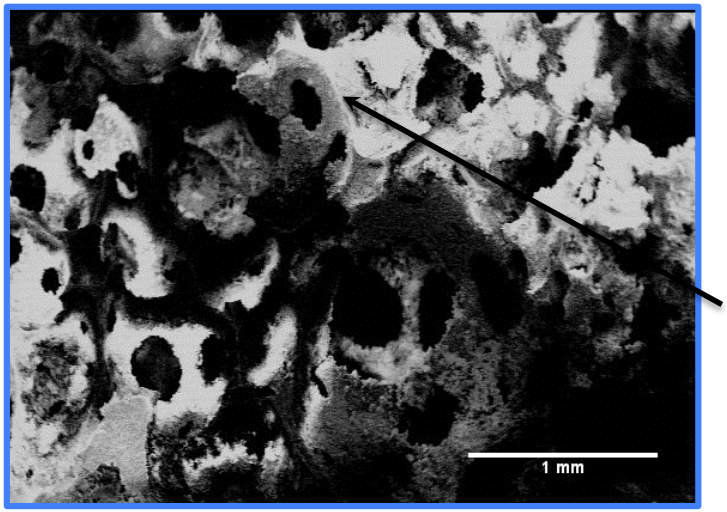
PU_gel

Morphology: Scanning Electron Microscopy

PU

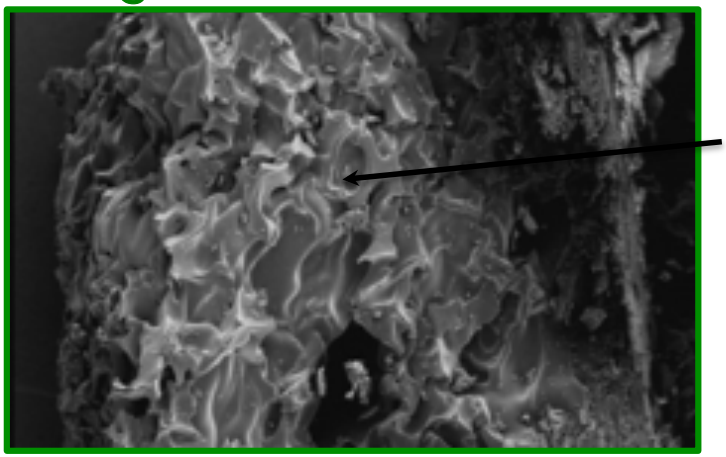


PU_CaP



Inorganic coating

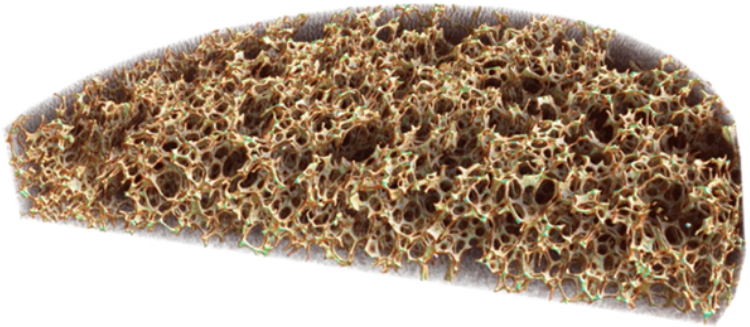
PU_gel



Organic coating

Morphology: Micro-CT

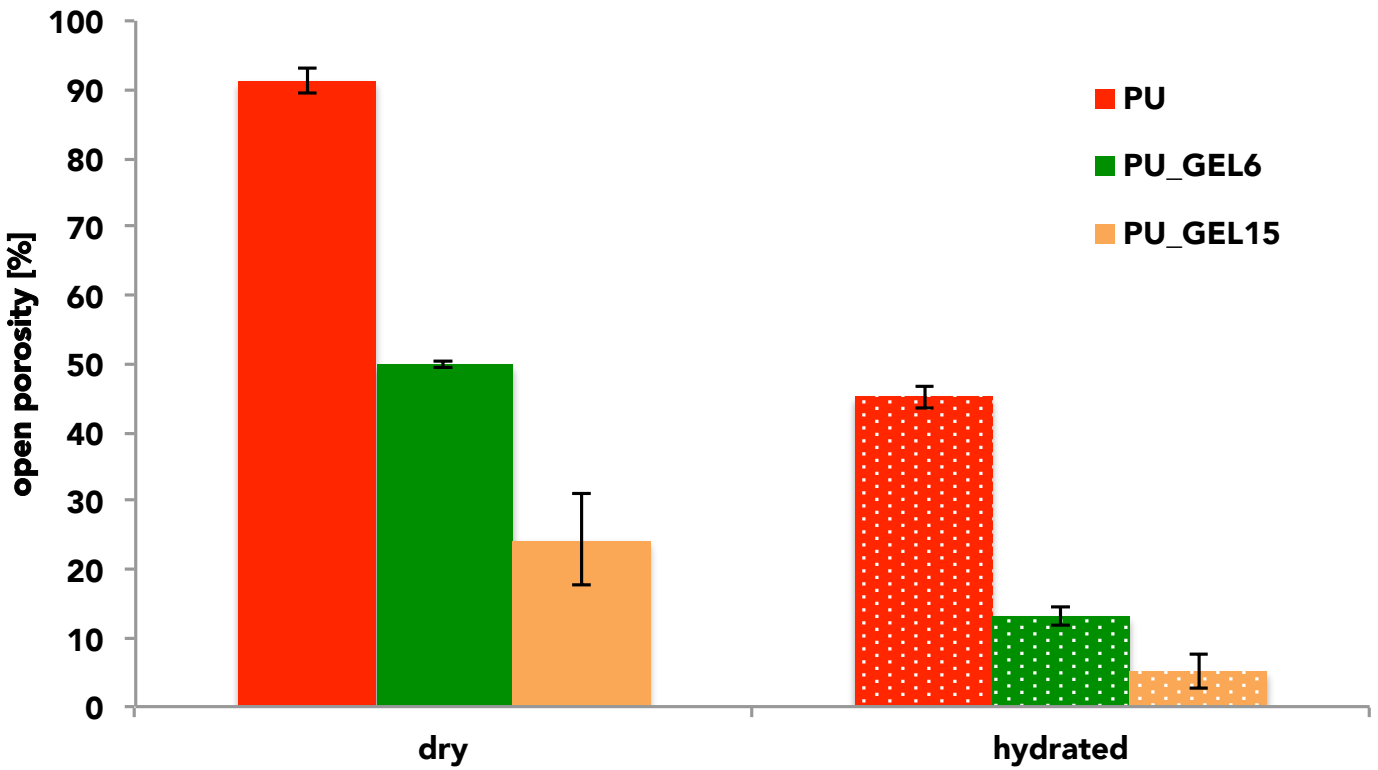
PU



PU_gel

- influence of gelatin hydrogels on pore interconnections

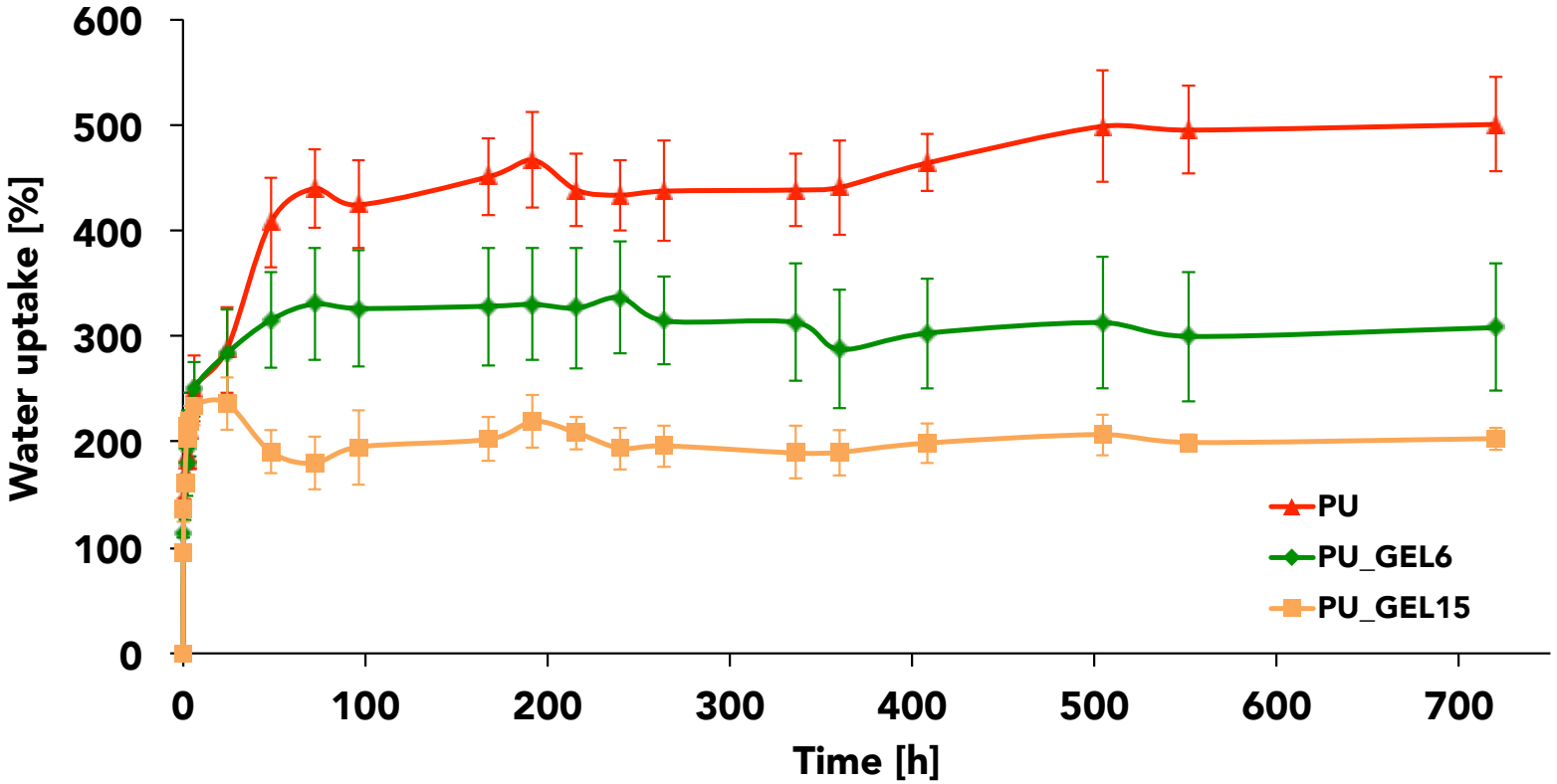
Morphology: Micro-CT



- influence of gelatin hydrogels on pore interconnections
- influence of **hydration** on **pore interconnection**

Water uptake: PU_gel

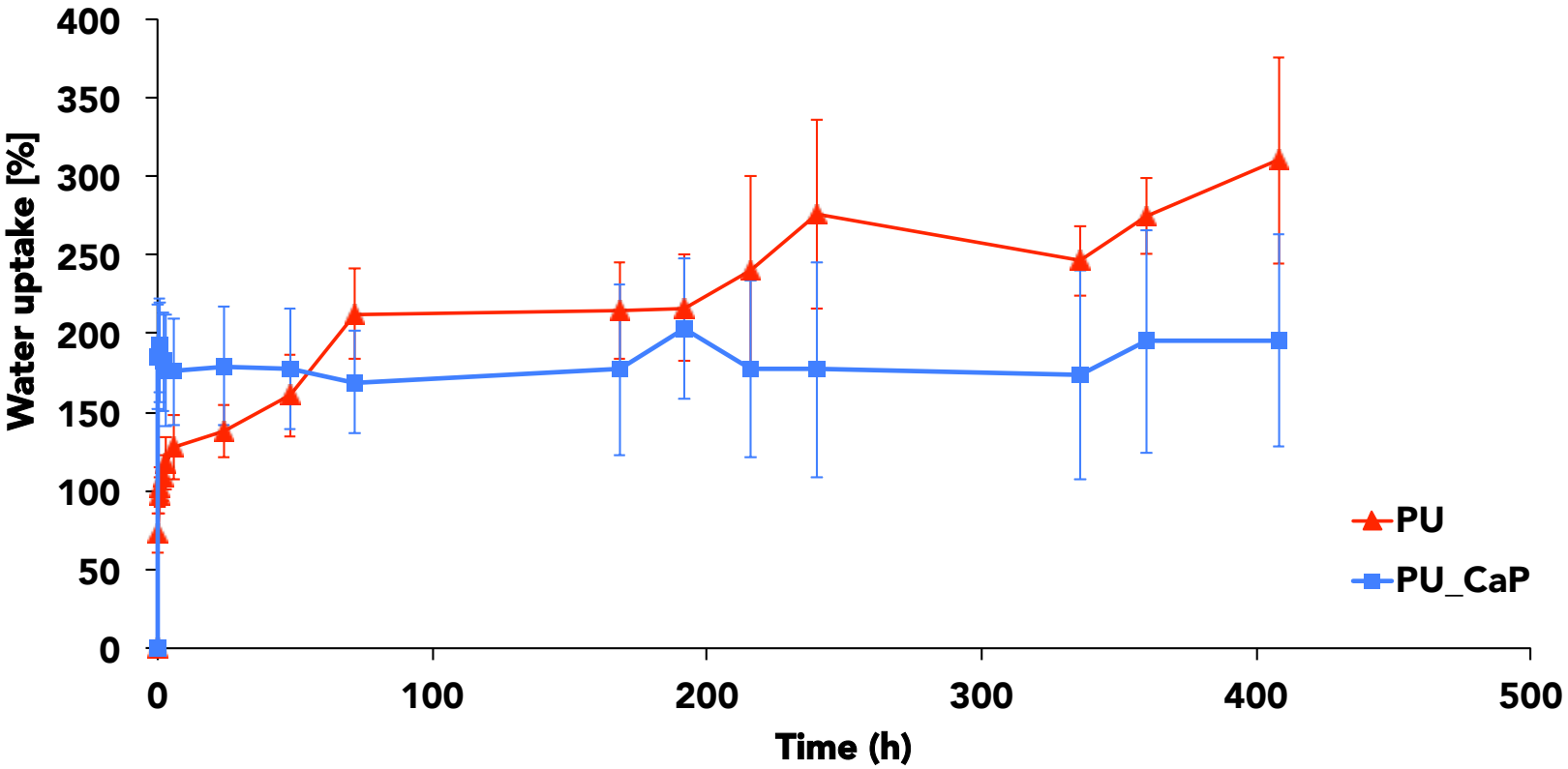
- **Stability** and **water uptake** at **37 °C** (physiological temperature)



- PU foams: stable at 37 °C
- Gelatin hydrogels improve water uptake
- PU_gel6 higher water uptake compared to PU_gel15

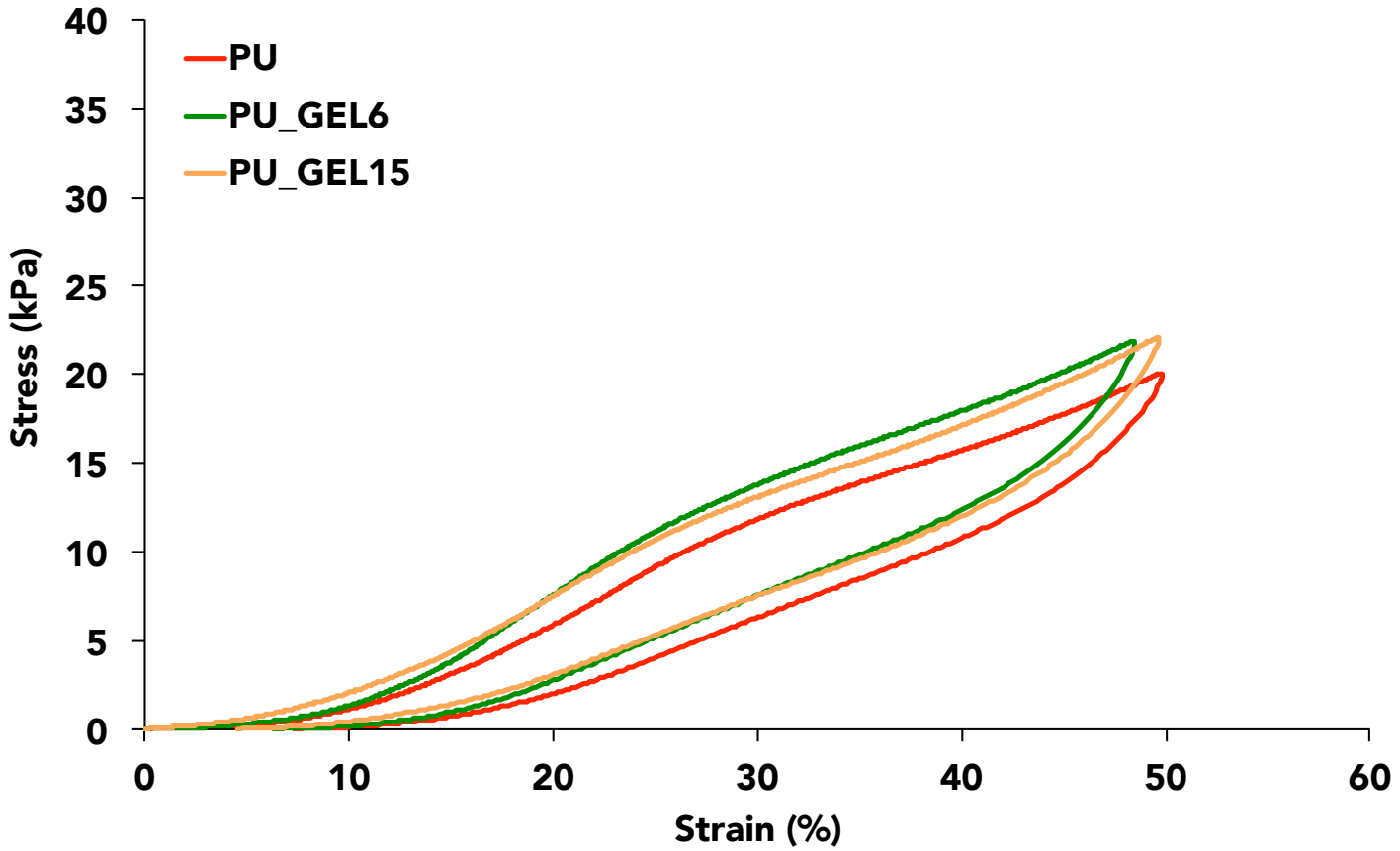
Water uptake: PU_CaP

- **Stability** and **water uptake** at **37 °C** (physiological temperature)



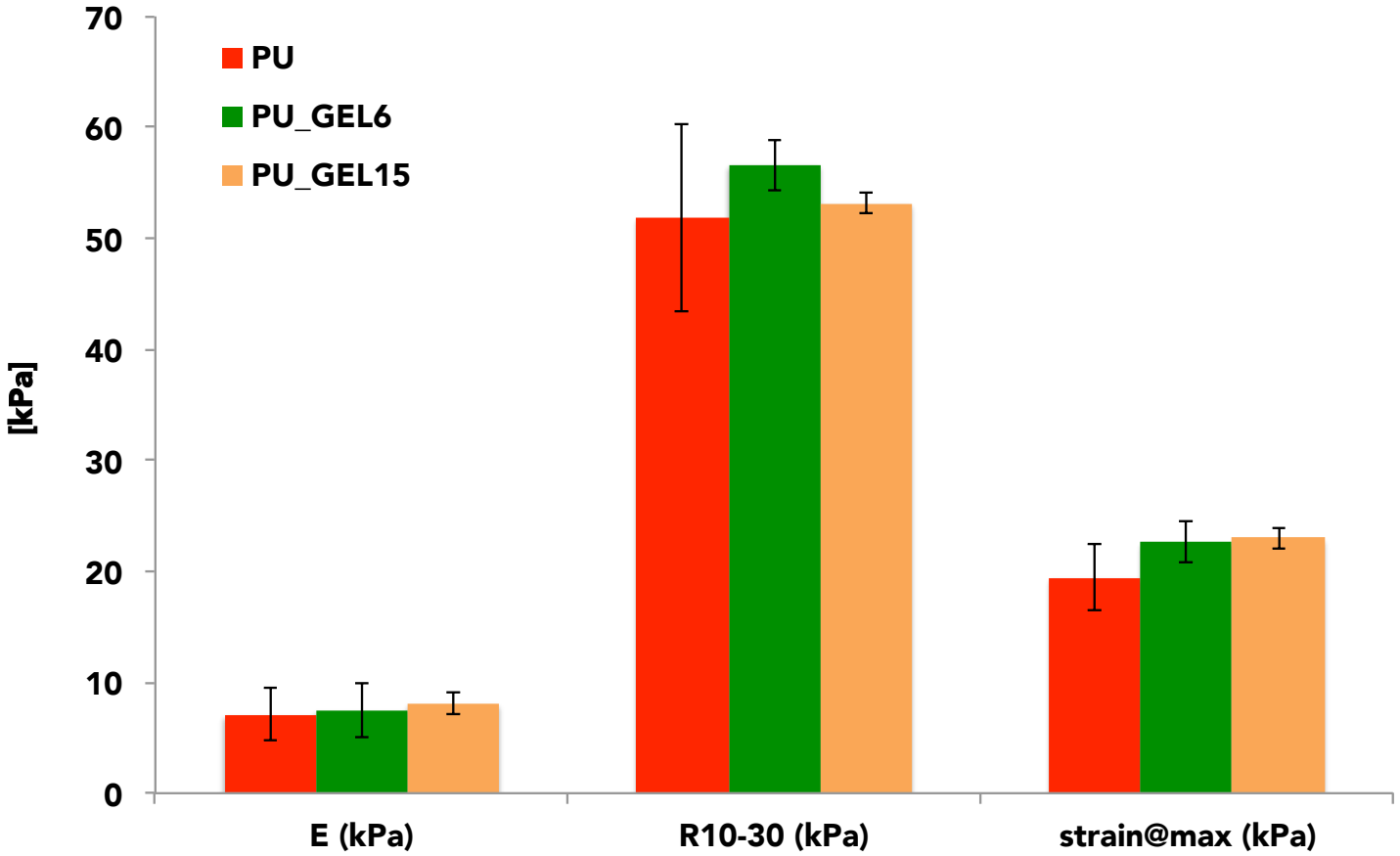
- PU foams: stable at 37 °C
- CaPs coating: stable at 37°C

Mechanical compressive properties: PU_gel



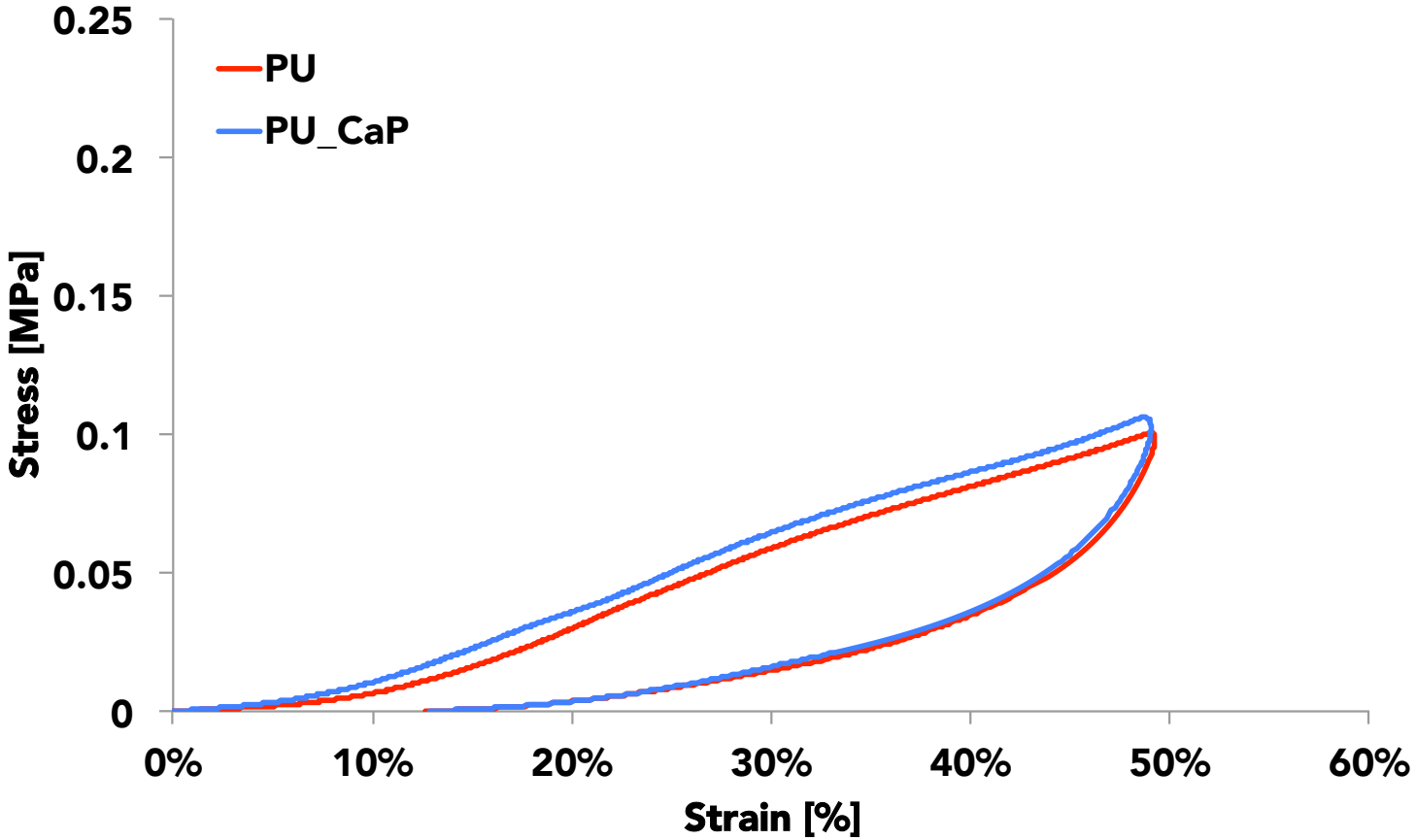
- stress/strain behavior PU_gel6 and PU_gel15 comparable to that of control PU
- PU_GEL15: behavior slightly different from PU and PU_gel6

Mechanical compressive properties: PU_gel



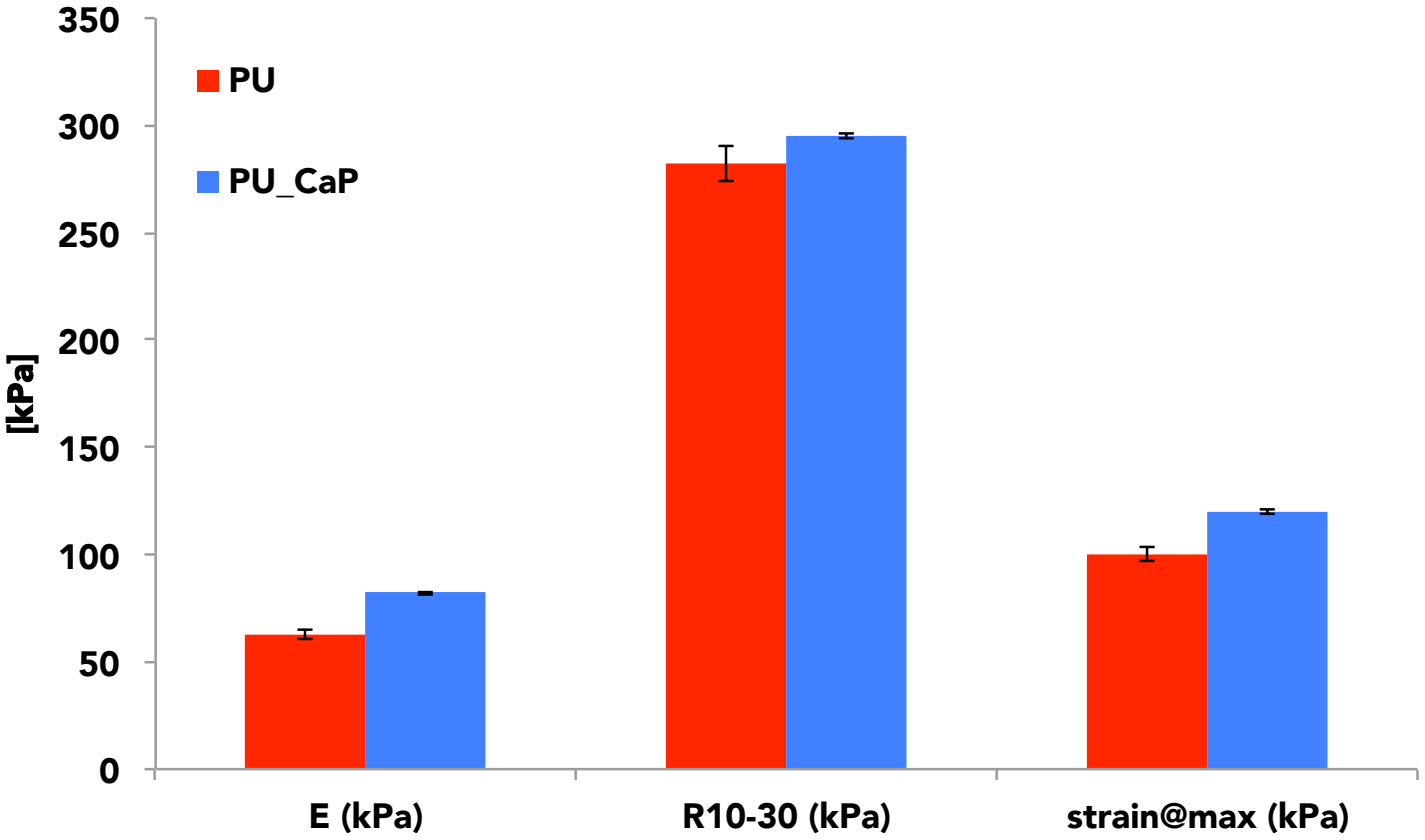
- no significant difference between PU_gel6 and PU_gel15 versus PU scaffolds
- **low contribution** of **gelatin coating** to mechanical properties

Mechanical compressive properties: PU_CaP



- PU_CaP: no improvement in the mechanical properties of the PU

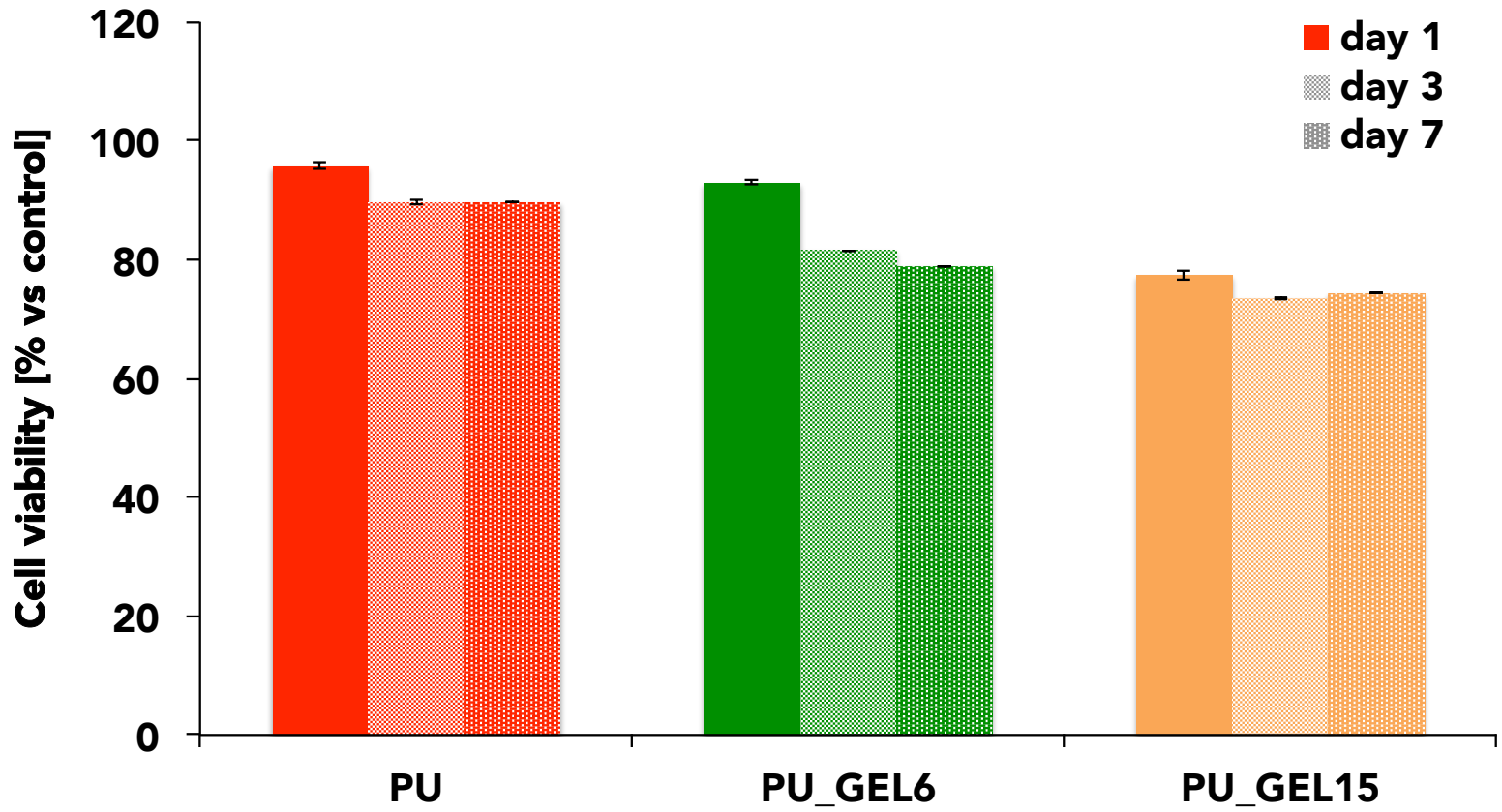
Mechanical compressive properties: PU_CaP



- PU_CaP: values of the mechanical parameters → no significant difference compared to PU

In vitro cytotoxicity tests: PU_gel

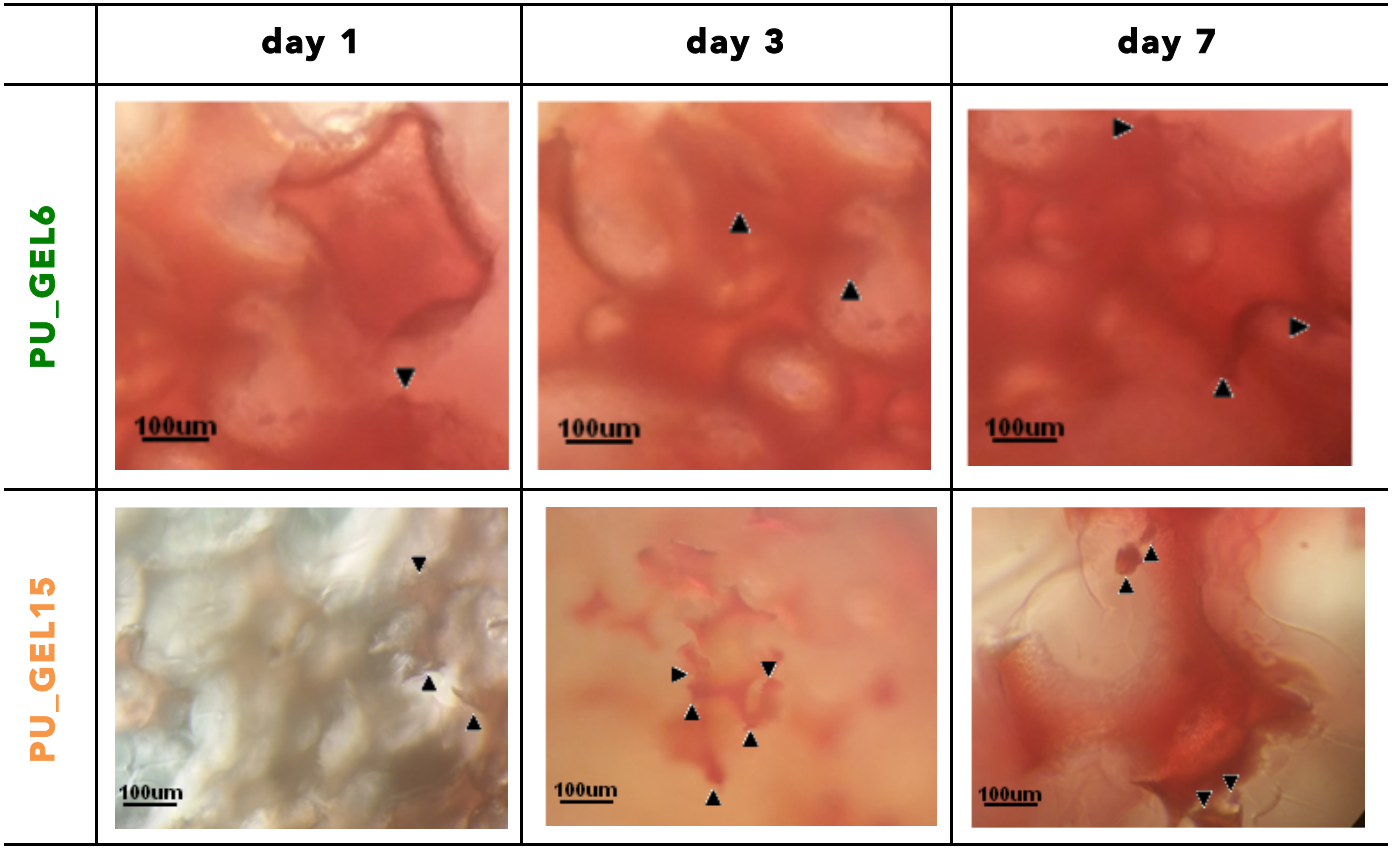
- Indirect cytotoxicity on PU_gel with adipose derived stem cells
- Target: soft tissues regeneration



- PU and PU_gel showed no cytotoxic effects

In vitro cytocompatibility tests: PU_gel

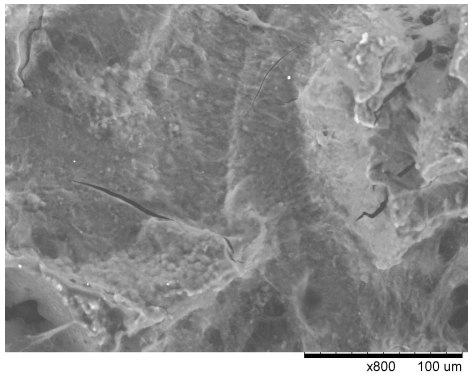
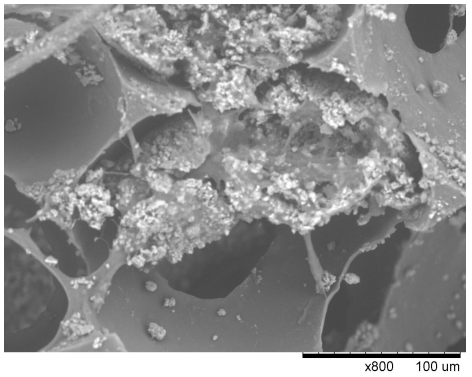
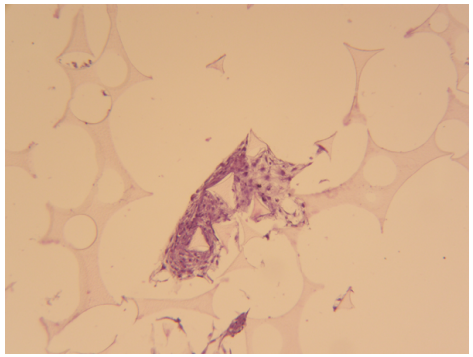
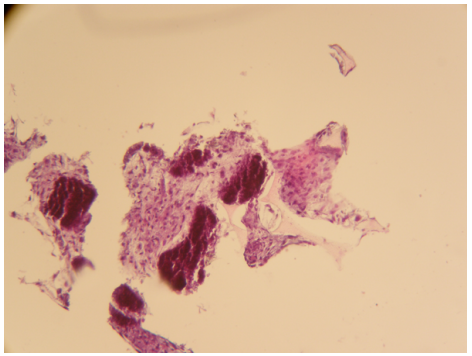
- Direct cytocompatibility on PU_GEL with adipose derived stem cells
- Target: soft tissues regeneration



- Cells adhesion and lipid droplets accumulation → suitable for adipose tissue regeneration

In vitro cytocompatibility tests: PU_CaP

- **Direct cytocompatibility** on PU_CaP with **amnionic mesenchymal cells**
- Target: **bone tissue regeneration**

PU	PU_CaP
	
	

- PU_CaP: **cells adhesion** and inorganic matrix **deposition**

Conclusions

- PU foam scaffolds → **successfully coated** by inorganic and organic coatings
- **possible** use as **scaffolds** for bone tissue and soft tissue regeneration

- **morphological analyses:**
  - **effective coating** by CaPs → to **mimic** the **inorganic bone** component
  - gelatin hydrogel → to **improve cells adhesion**

- **adequate mechanical properties** for hard and soft tissue **regeneration**

- **cells successfully adhered** and **proliferated** on the scaffolds → **correct functionality**
  - depositing inorganic extracellular matrix → **bone tissue** regeneration
  - accumulating lipid droplets → **adipose tissue** regeneration

THANK YOU