

# Structural 3D analysis of porous AlbuCol biomaterials

**Sven Zaugg**

Bachelor's thesis, Field of study: medical engineering

Expert: Prof. Dr. Arnaud Scherberich  
Supervisor: Prof. Dr. Michael de Wild

Department of Biomedical Engineering, University of Basel  
University of Applied Sciences and Arts Northwestern Switzerland



## AlbuCol project

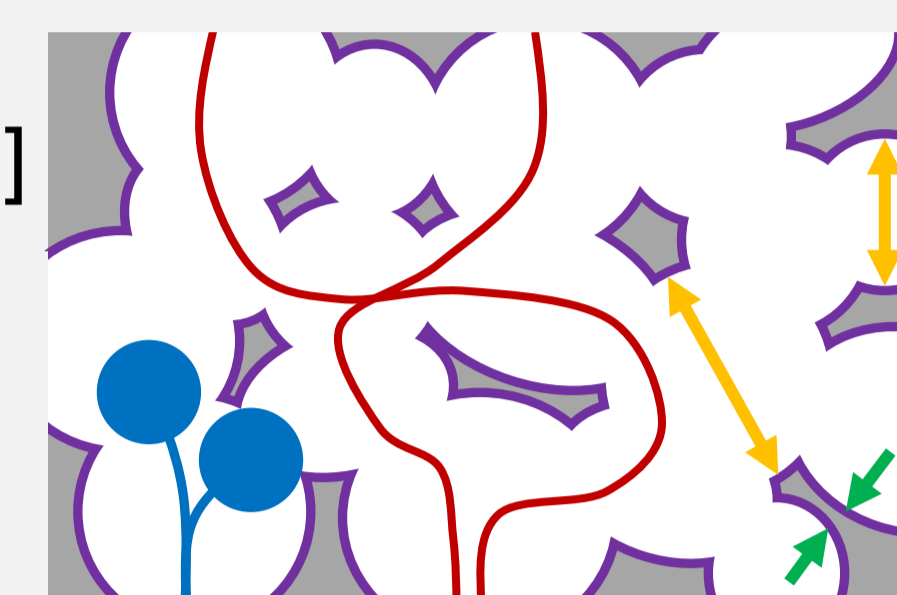
- ❖ Innovative biomaterial for scaffolding made from natural proteins [1]
- ❖ Raw materials: bovine albumin (BSA), egg white (BO), ovalbumin (OVA)
- ❖ Salts: calcium chloride (CaCl<sub>2</sub>), potassium acetate (AcK), sodium bromide (NaBr)

## Aim of this work

- ❖ Investigating foams on a structural level with  $\mu$ CT and SEM
- ❖ Analysing influence of aging, UV-sterilisation and plasma cleaning on structural properties
- ❖ Formulate statement about which foams suits to which application in tissue engineering

## Structural properties schematically

- ❖ Porosity [2]
- ❖ Pore size distribution [3]
- ❖ Structure thickness
- ❖ Interconnectivity
- ❖ Pore accessibility
- ❖ Surface to volume ratio



BSA CaCl<sub>2</sub>

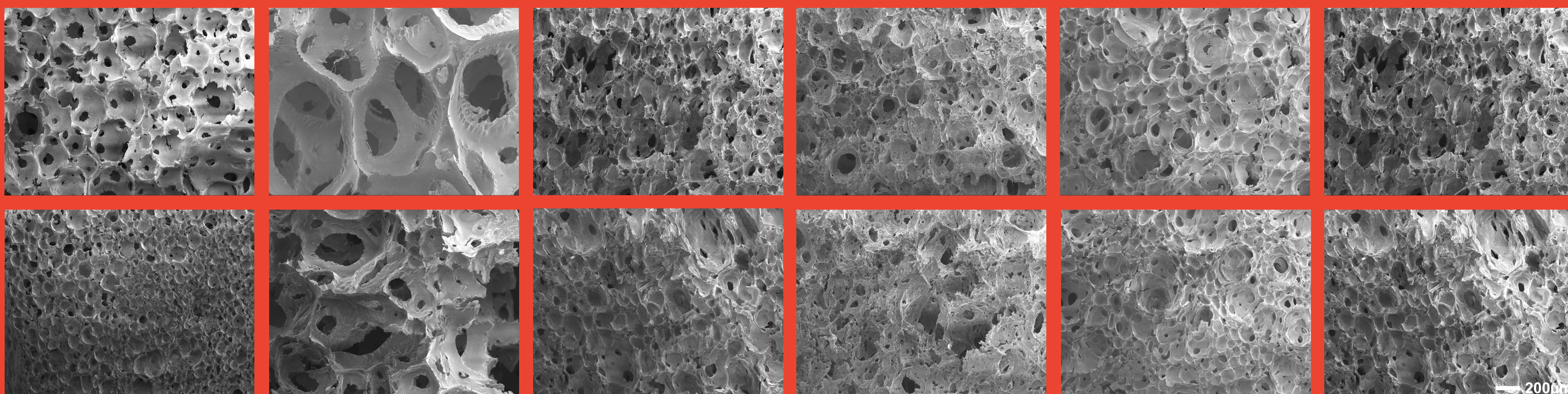
BSA NaBr

BO CaCl<sub>2</sub>

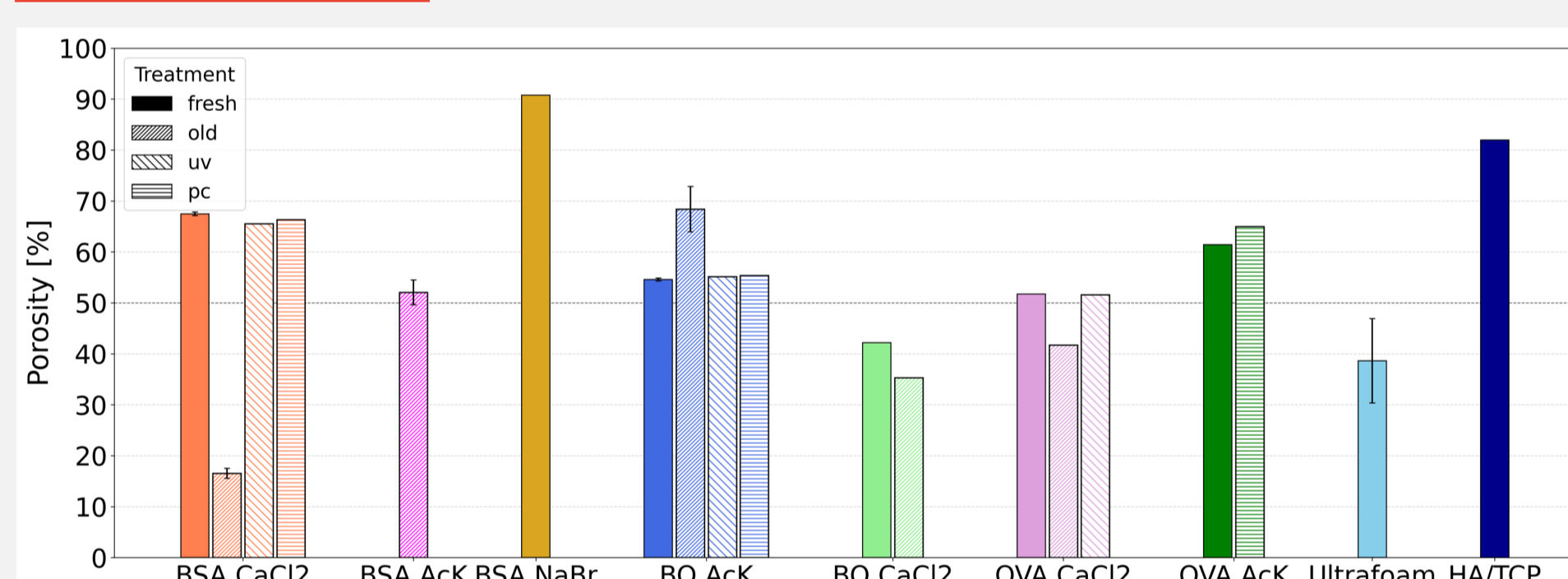
BO AcK

OVA CaCl<sub>2</sub>

OVA AcK

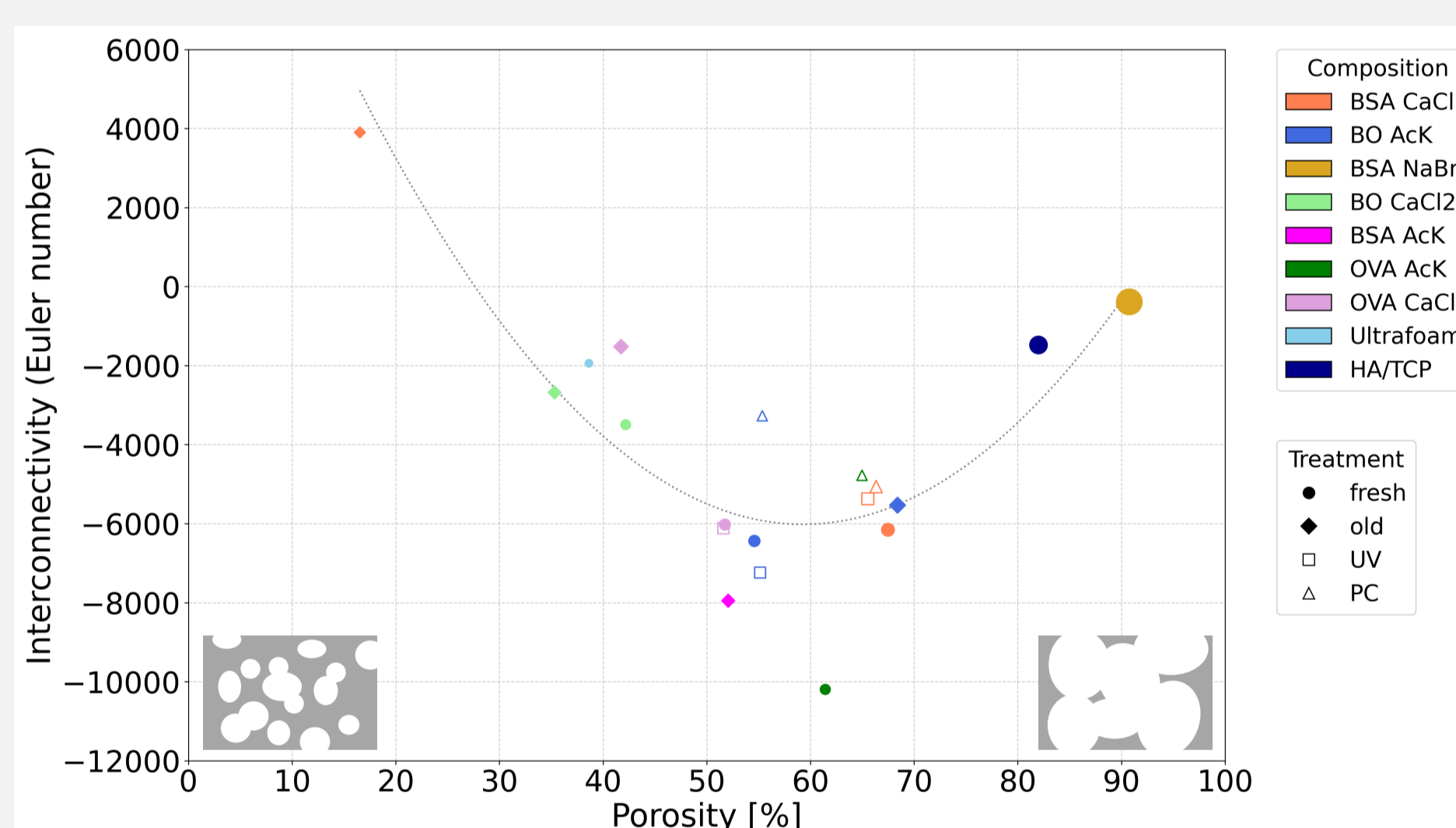


## Porosity



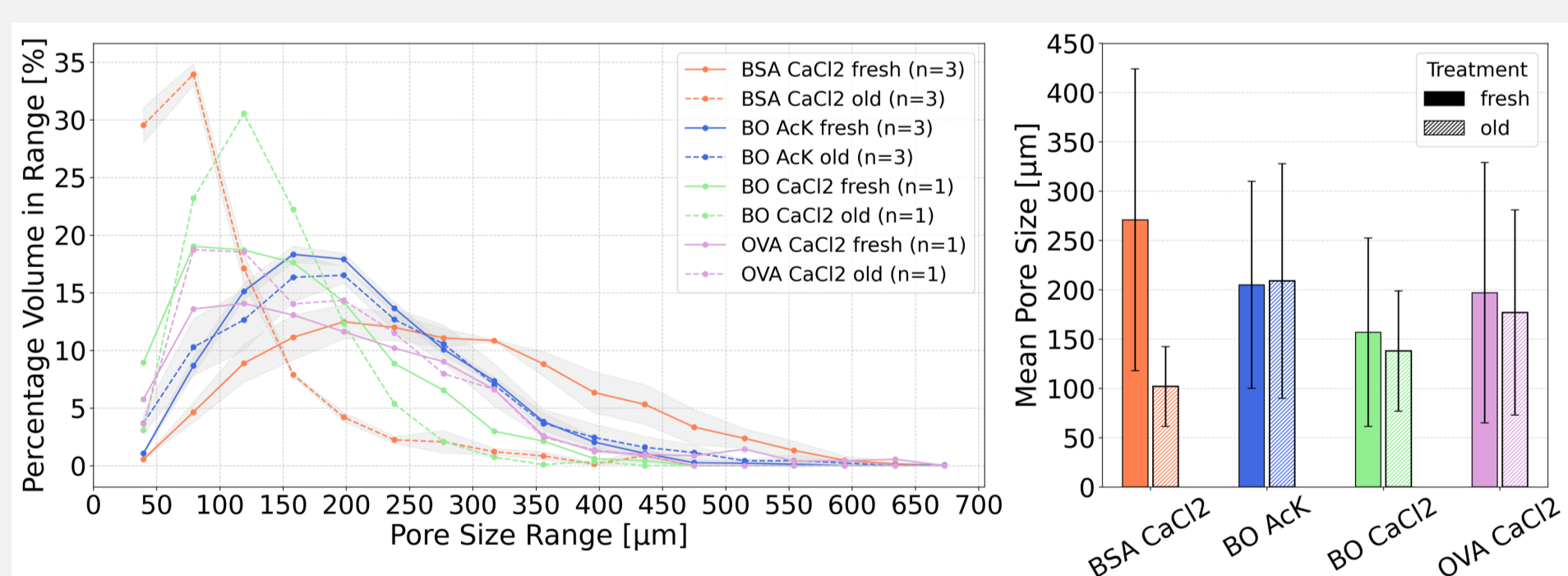
- ❖ Five fresh samples exceed 50% of porosity.
- ❖ Aging process leads to a decrease.
- ❖ UV and plasma cleaning show no influence.

## Interconnectivity



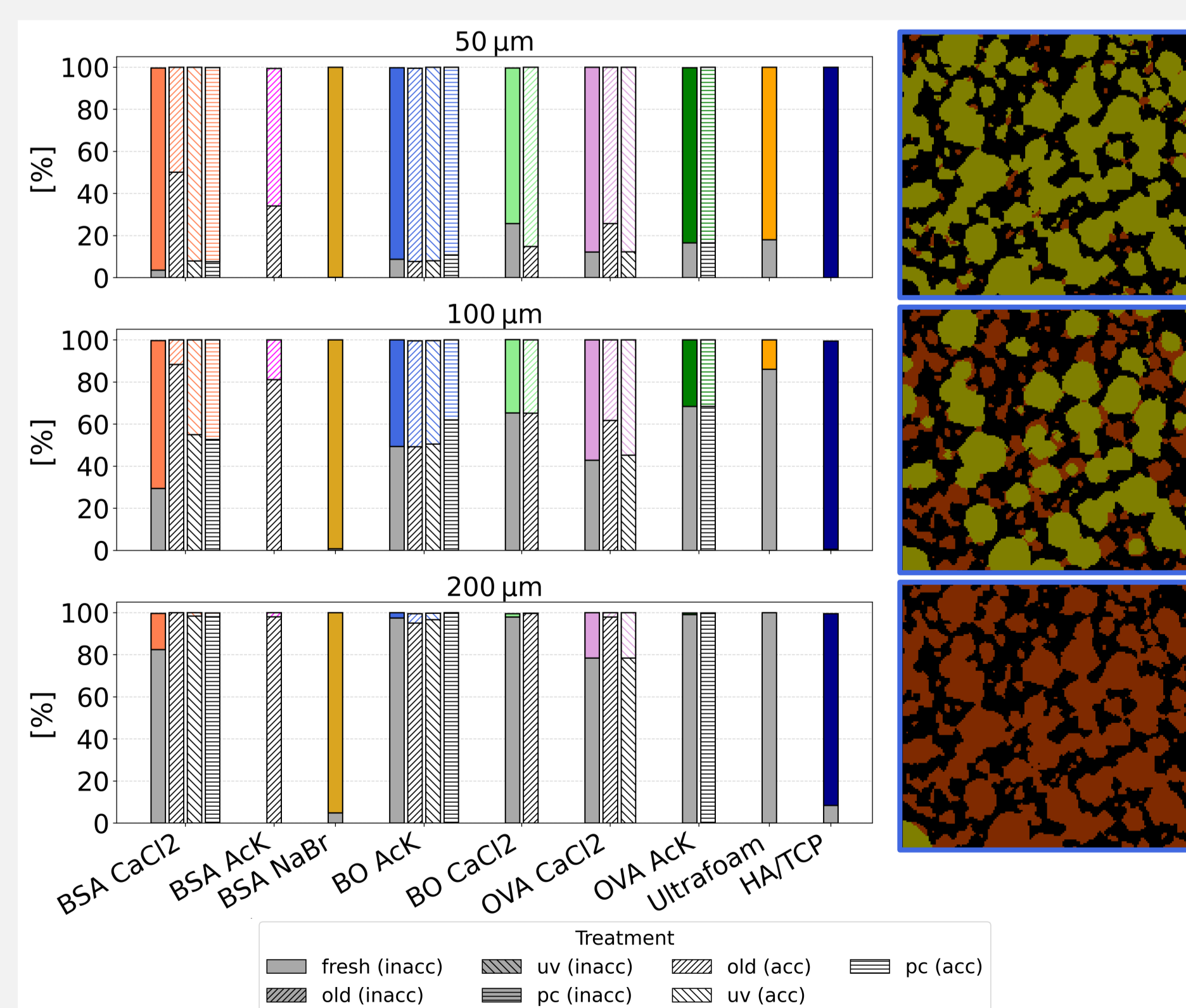
- ❖ A negative Euler number describes a well-connected pore network
- ❖ The maximum value of interconnectivity is reached between 50-70% of porosity.

## Pore size distribution



- ❖ Aging leads to a decrease in mean pore size and distribution in three cases.
- ❖ BO AcK shows contrary behaviour.

## Pore accessibility



- ❖ At a sphere diameter of 50µm most scaffolds are 80% accessible.
- ❖ 50µm has the highest biological relevance.

## Surface to volume ratio

- ❖ A high ratio describes a lot of available surface for cell adhesion.
- ❖ The maximum value of the ratio is reached in the range of 50-70% porosity.

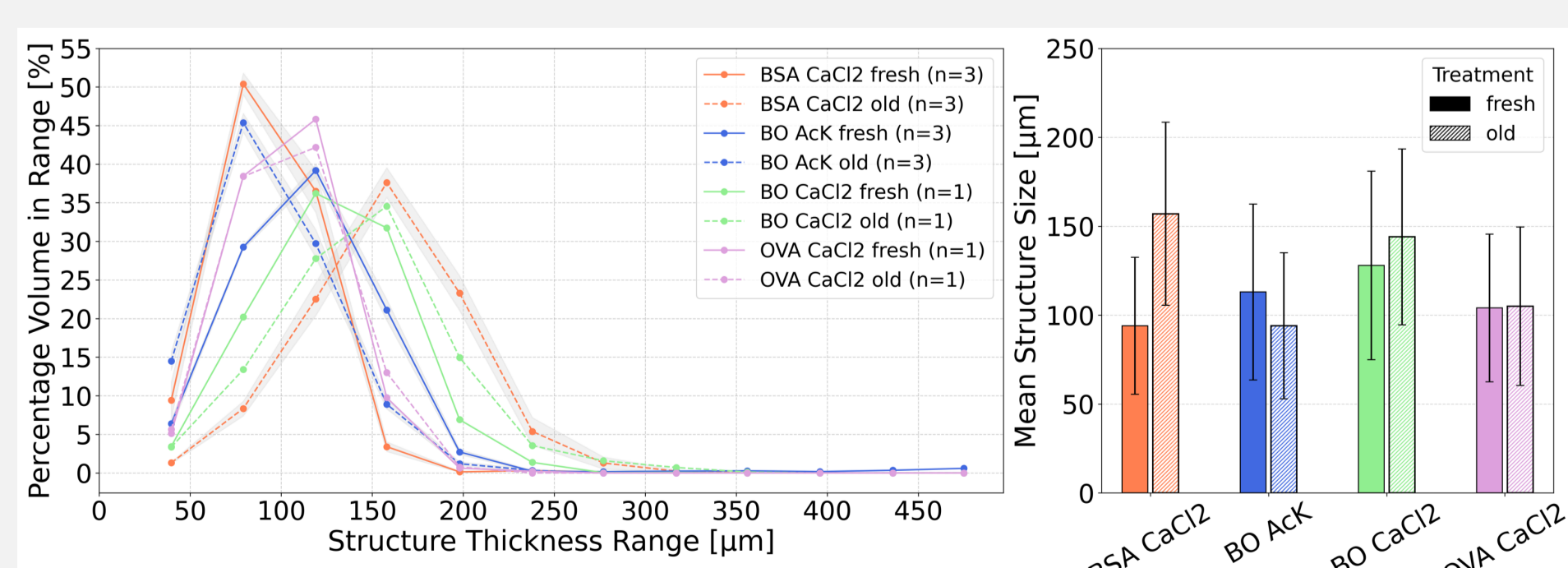
## Suitability for three applicatons

	BSA CaCl <sub>2</sub>	BSA NaBr	BO CaCl <sub>2</sub>	BO AcK	OVA CaCl <sub>2</sub>	OVA AcK	Ultra foam
Bone	✓	✓	✓	✓	✗	✓	✓
Cartilage	✓	✓	✓	✓	✗	✓	✓
Skin	✗	✗	✗	✗	✗	✗	✗

✓ suitable    ✓ unsuitable but working    ✗ unsuitable

- ❖ Suitability of the fresh composition for applications based on the reference values.
- ❖ Most are suitable for bone and cartilage but none for skin engineering.

## Structure thickness



- ❖ By aging the mean structural thickness increases probably due to liquid uptake.
- ❖ Explains the decrease of mean pore size.

## Conclusion

- ❖ These different morphological properties are partly interrelated.
- ❖ Properties must be optimally selected to create suitable scaffolds.
- ❖ Current production processes create useable scaffolds for bone and cartilage engineering.
- ❖ Aging during storage has the greatest effect and influences the structural properties.
- ❖ Neither of the two sterilisation methods show any influence.
- ❖ Porosity influences mechanical integrity, which is discussed in the work of Edona Sallauka [4].

### References

- [1] Vielversprechender Durchbruch in der Medizin durch neue Möglichkeiten, beschädigtes menschliches Gewebe zu ersetzen, www.interreg-oberrhein.eu
- [2] Sajad Arabnejad et al. "High-strength porous biomaterials for bone replacement: A strategy to assess the interplay between cell morphology, mechanical properties, bone ingrowth and manufacturing constraints", 2016.
- [3] Kausik Kapat et al. "Influence of Porosity and Pore-Size Distribution in Ti6Al4 V Foam on Physicochemical Properties, Osteogenesis, and Quantitative Validation of Bone Ingrowth by Micro-Computed Tomography", 2017.
- [4] Edona Sallauka. "Biomechanical analysis of porous and non-porous tissue", 2025.