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AffordBoneS
Personalized and affordable multi-substituted calcium phosphate scaffolds

MARIE CURIE ACTIONS

Manufacturing of biomimetic scaffolds for bone regeneration by using vat photopolymerization method – opportunities and challenges –

Antonia Ressler*, Erkka J. Frankberg, Roope Ohlsbom, Setareh Zakeri, Markus Hannula, Jari Hyttinen, Martin Schwentenwein, Susanna Miettinen, Erkki Levänen

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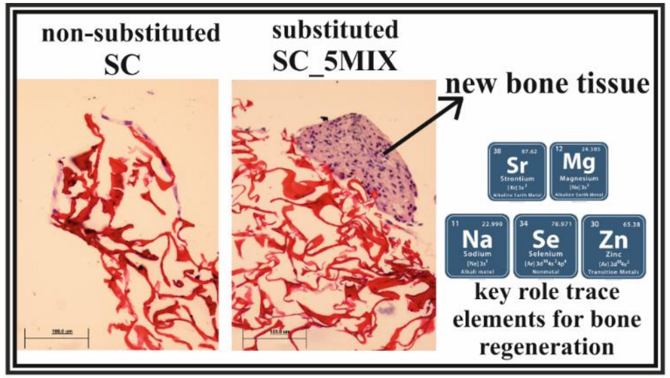
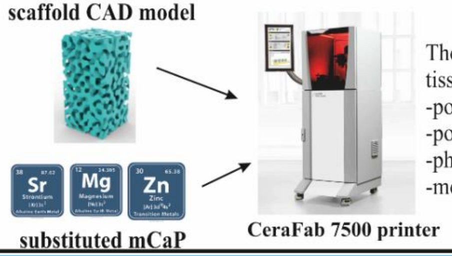


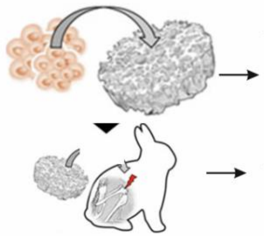
Objective 1/WP1
mCaP precipitation, design of mCaP scaffolds using CAD and scaffold fabrication



The mCaP scaffold properties accroding to the bone tissue engineering requirements:
-porosity: 50-90 %
-pore size distribution: 100-500 µm
-phase content: hydroxyapatite/tricalcium phosphate
-mechanical properties reqired for bone augmentation

Collaboration with : LITHOZ

Objective 2/WP2
***In vitro* and *in vivo* osteogenic properties of mCaP scaffolds**



***In vitro* cell culture in static and dynamic conditions**
-live/ded assay, Cell Counting
-quantitative reverse transcription polymerase chain reaction
-imunocytochemical and immunohistochemical staining
-histological staining

***In vivo* characterization during three months in rats**
-micro-computed tomography
-inflammation detection

Objective 3/WP3
Obtaining a demonstration of personalized mCaP scaffolds in collaboration with Planmeca

-obtaining CAD design according to the real patient cases provided by Planmeca

-printing costumized scaffolds on CaraFab 7500 using previously optimized printing parameters

Collaboration with : PLANMECA


Prof. Erkki Levänen


Dr. Erkka Frankberg


Prof. Susanna Miettinen


LITHOZ
Dr. Martin Schweintenwein


Pontus Degerlund
PLANMECA


Dr. Antonia Ressler

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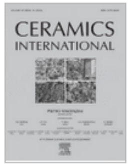
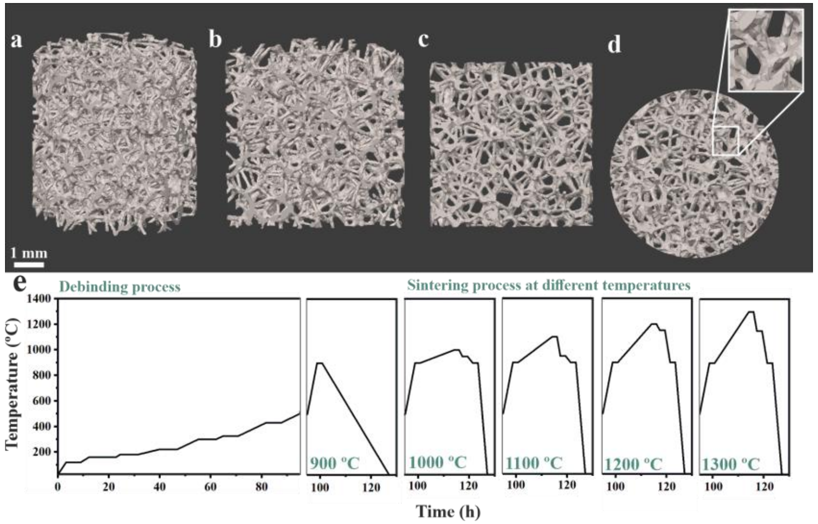
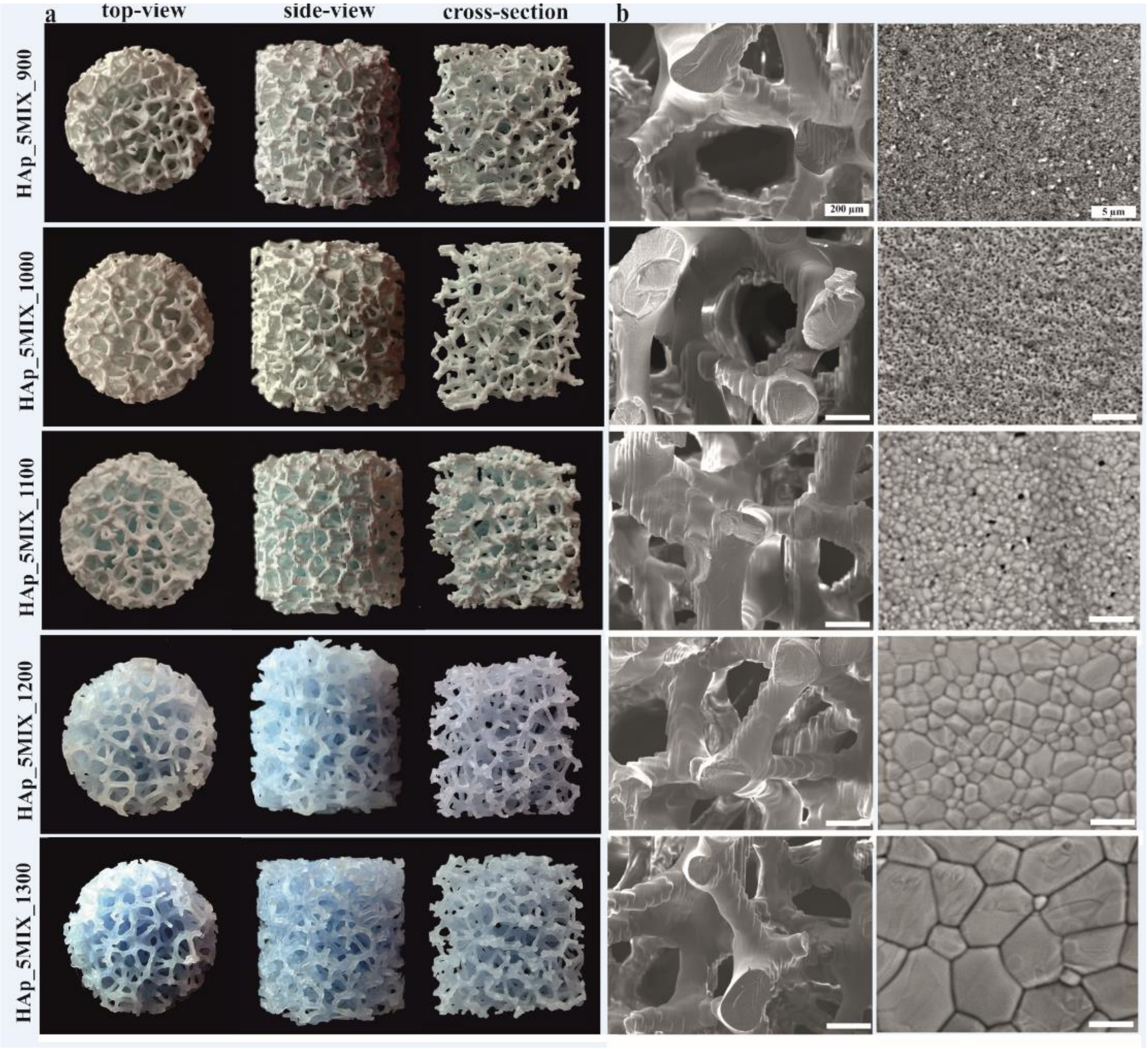


Vat photopolymerization of biomimetic bone scaffolds based on Mg, Sr, Zn-substituted hydroxyapatite: Effect of sintering temperature

Antonia Ressler [a], Setareh Zakeri [a], Joana Dias [b], Markus Hannula [c], Jari Hyttinen [c], Hrvoje Ivanković [d], Marica Ivanković [d], Susanna Miettinen [c e], Martin Schwentenwein [b], Erkki Levänen [a], Erkka J. Frankberg [a]





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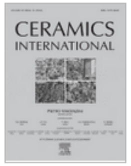

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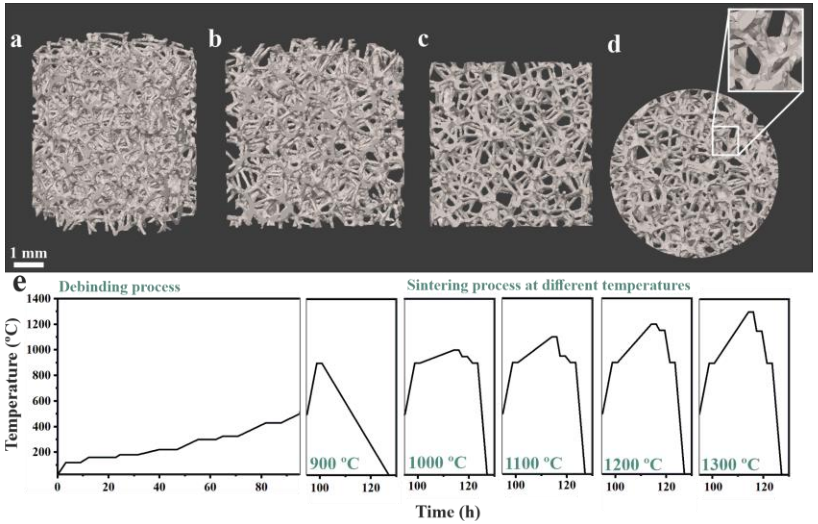
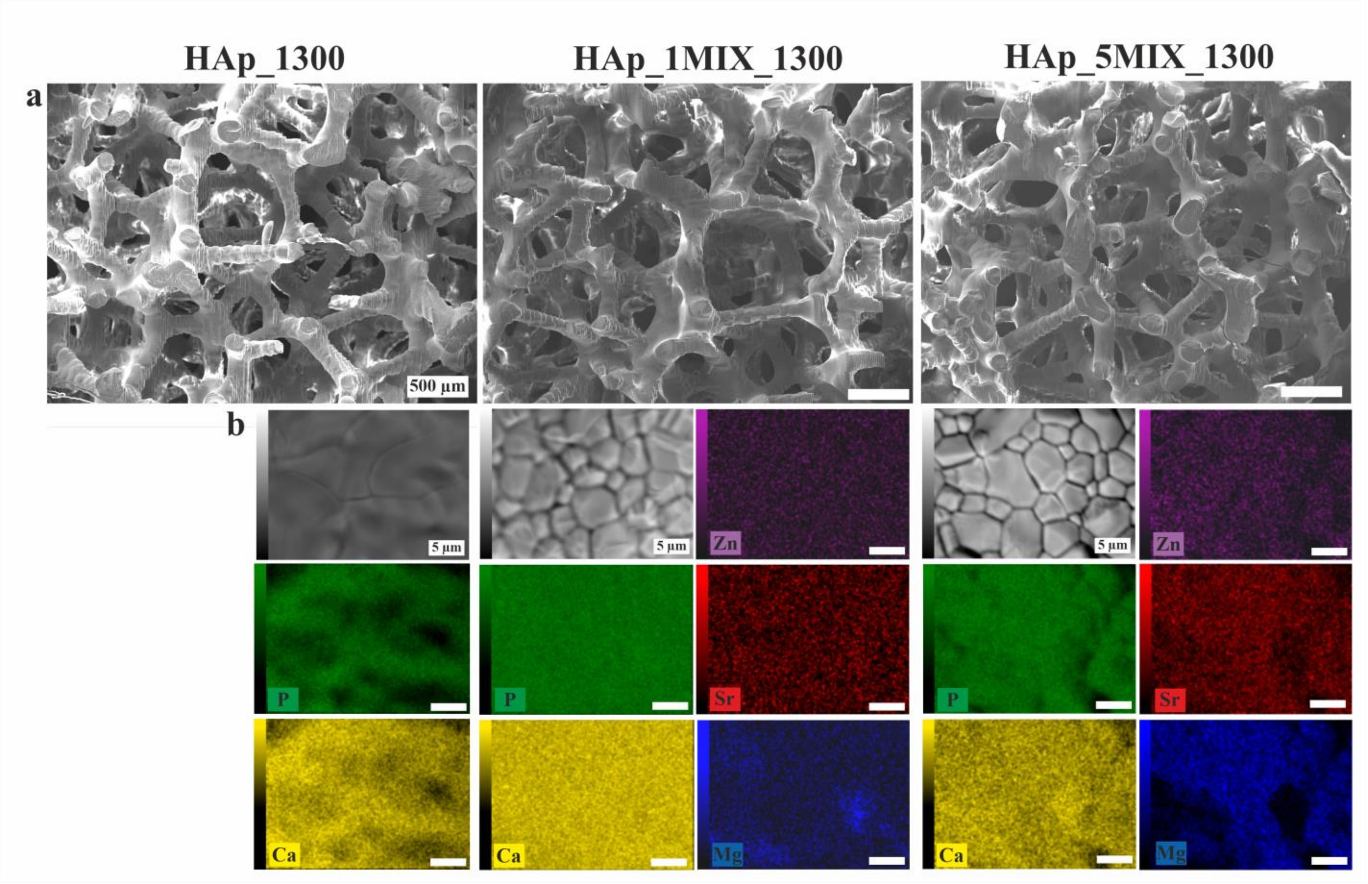
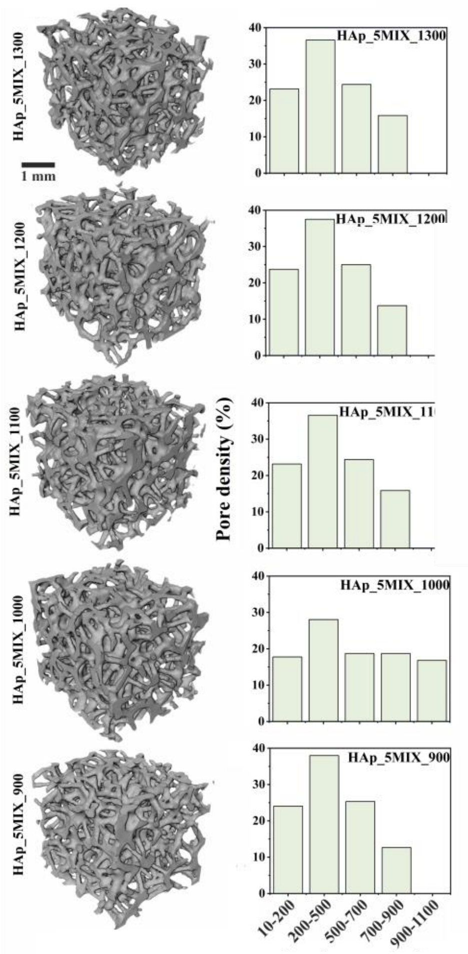
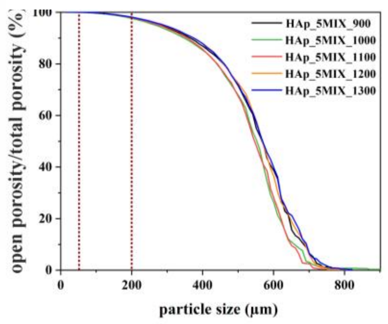
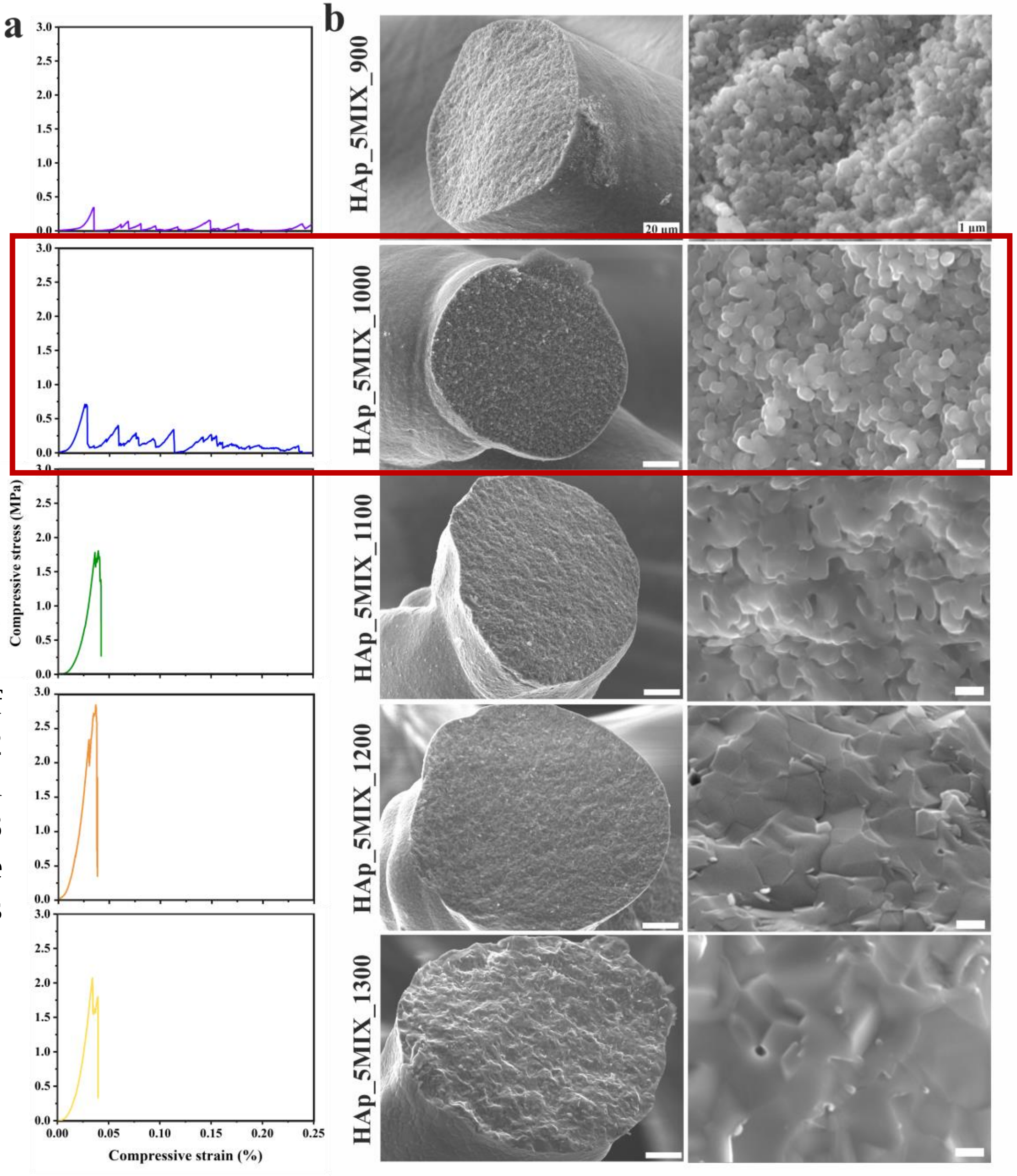


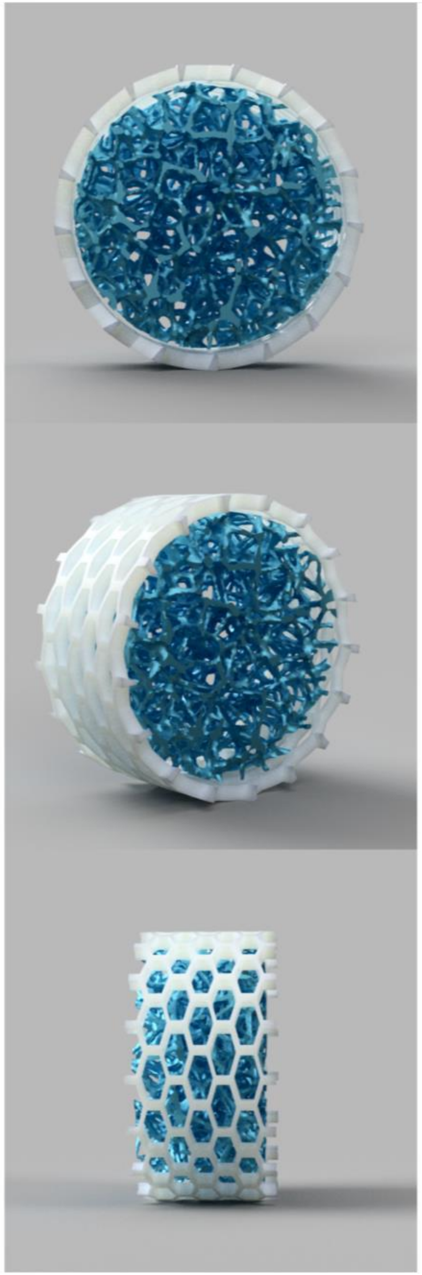




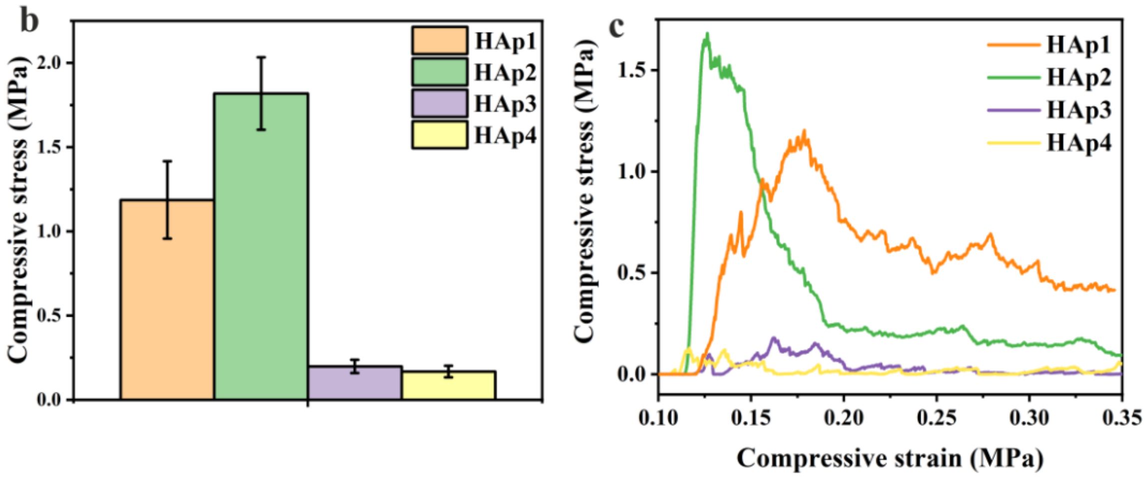


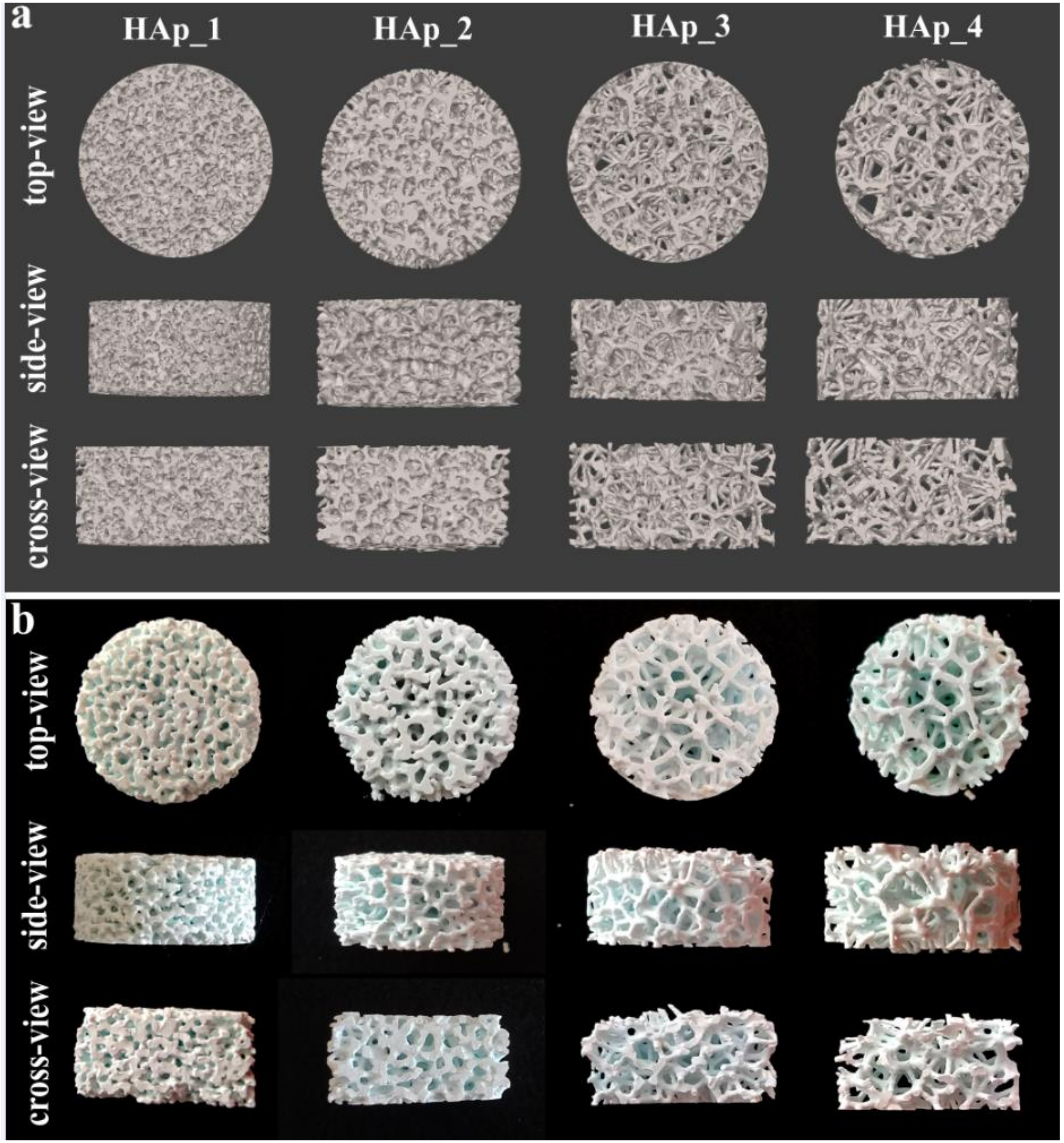
The total porosity of scaffolds was 76.24 ± 1.32 vol% and an average wall thickness of 217.03 ± 8.98 µm, closely resembling the morphology of cancellous bone tissue.

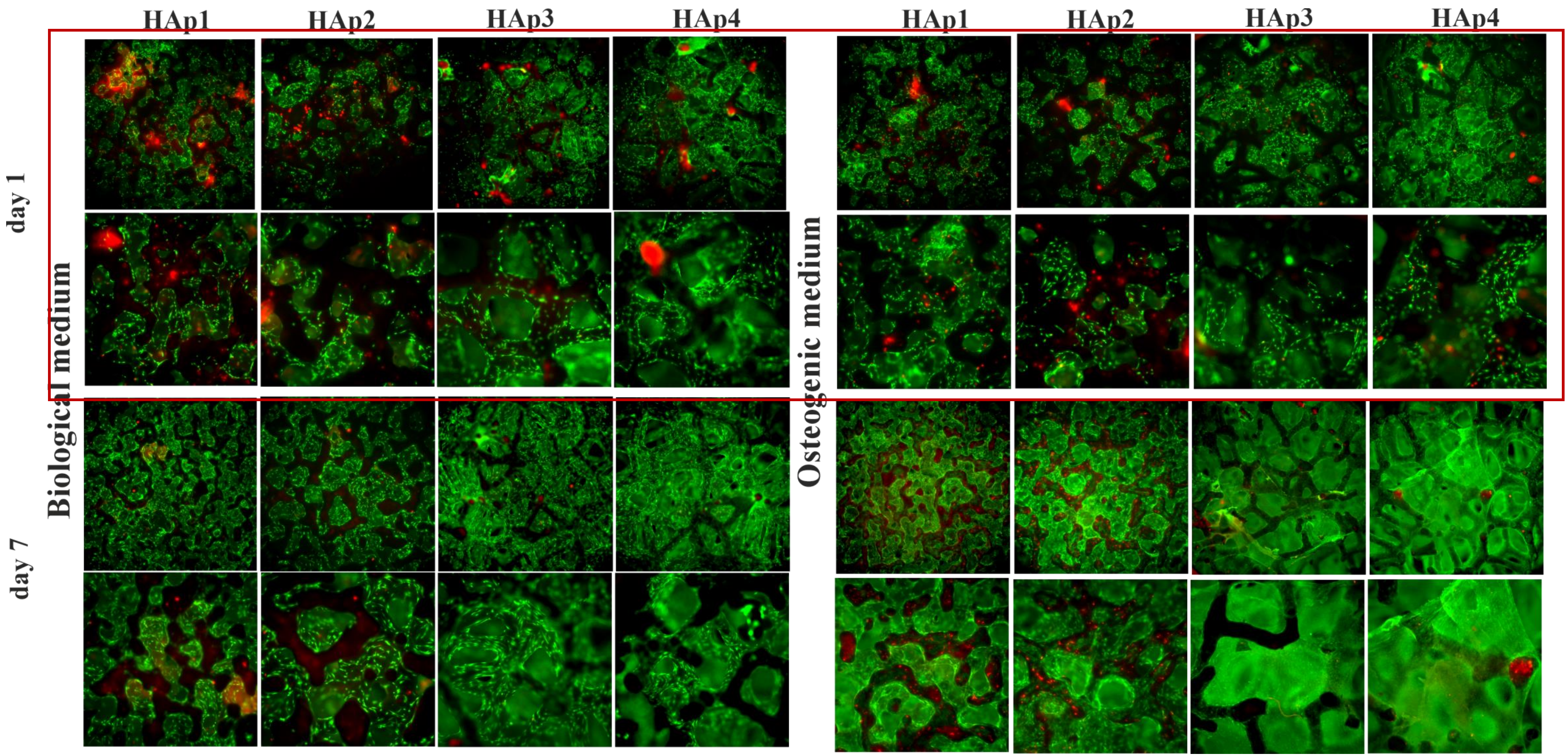


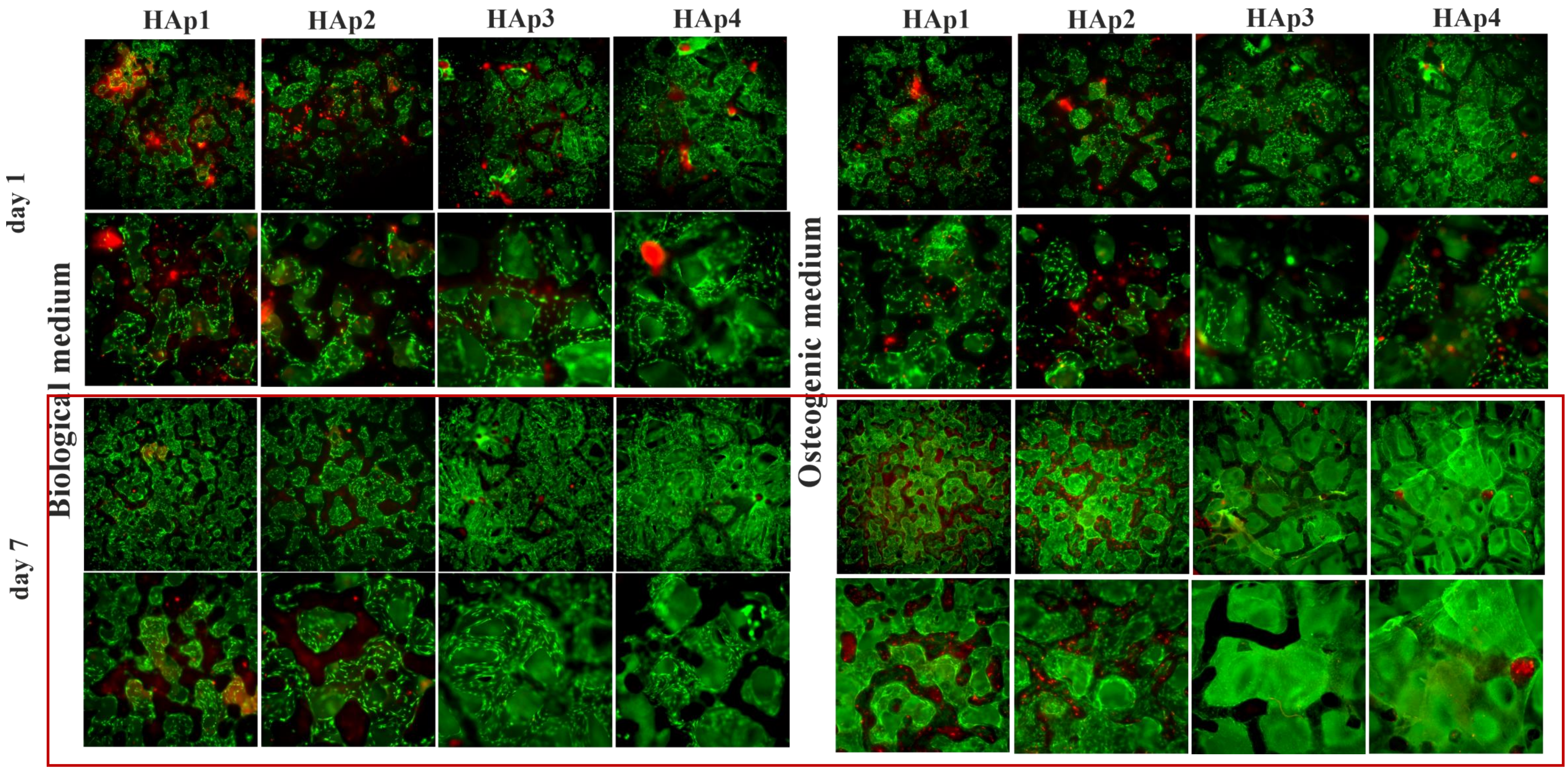


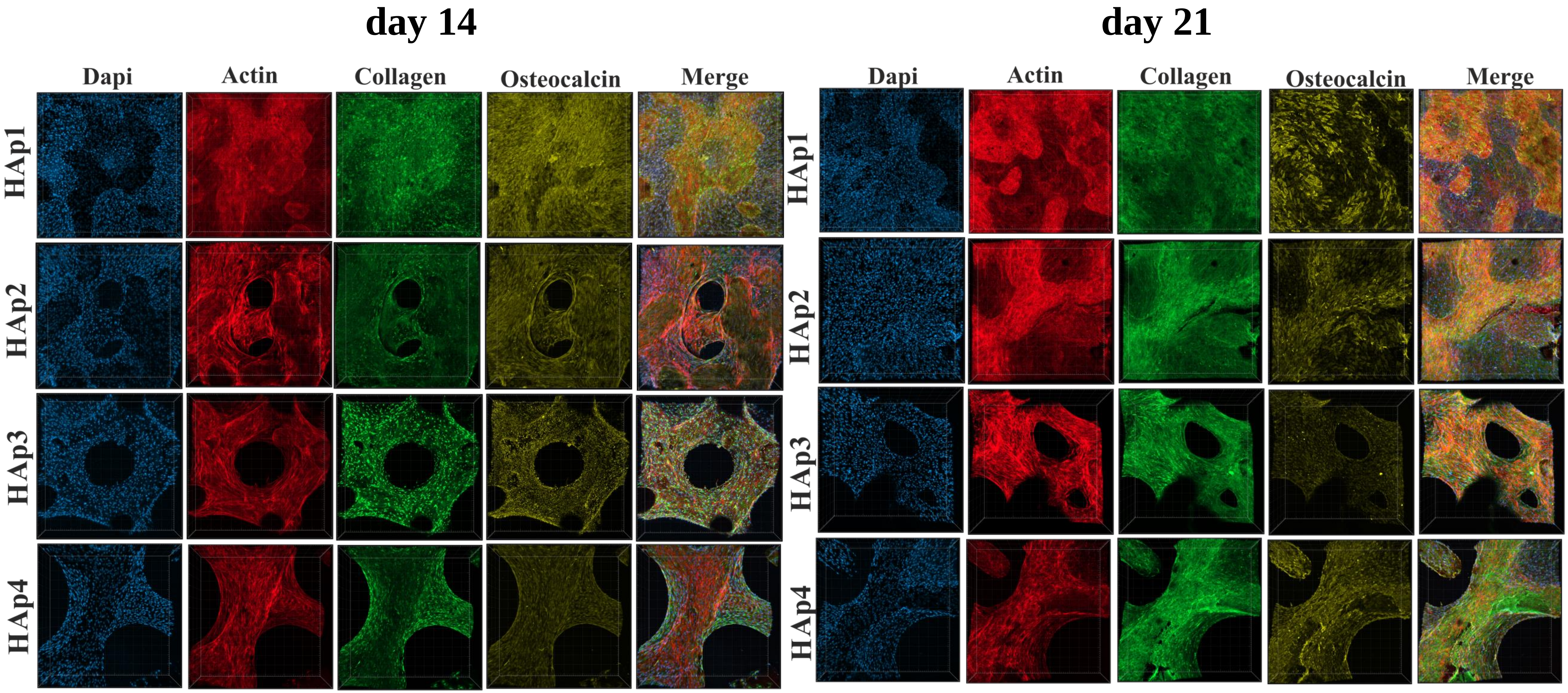
Effect of pore size and porosity






HAp1
HAp2
HAp3
HAp4
HAp1
HAp2
HAp3
HAp4
day 1
day 7
Biological medium
Osteogenic medium


HAp1
HAp2
HAp3
HAp4
HAp1
HAp2
HAp3
HAp4
day 1
day 7
Biological medium
Osteogenic medium


day 14
day 21
Dapi
Actin
Collagen
Osteocalcin
Merge
HAp1
HAp2
HAp3
HAp4

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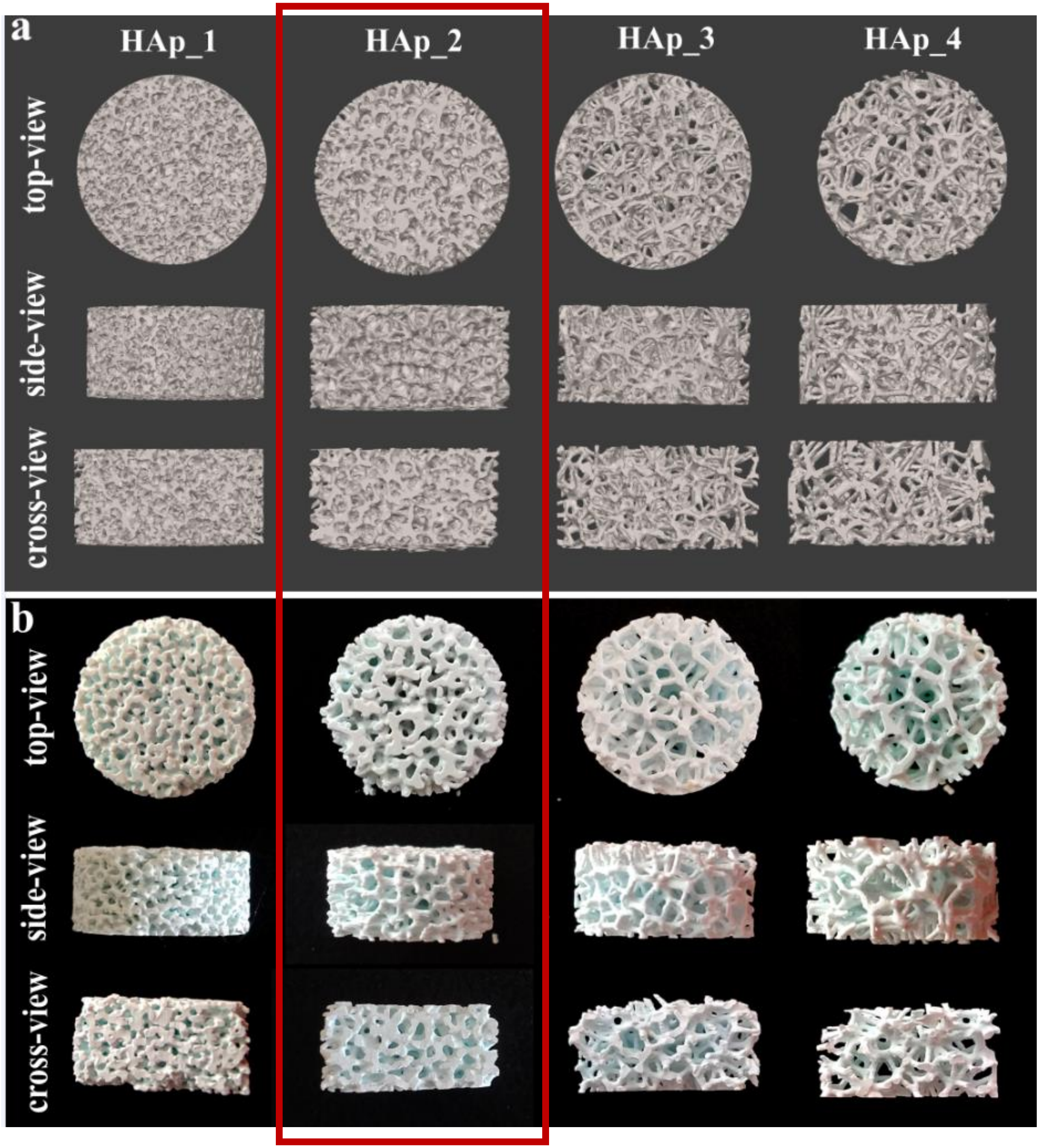
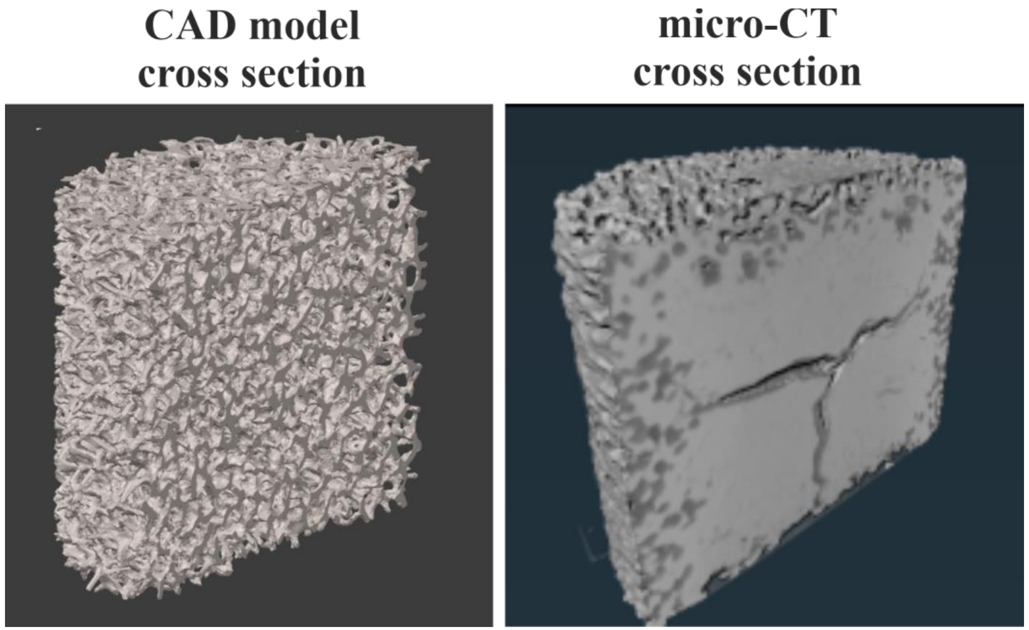
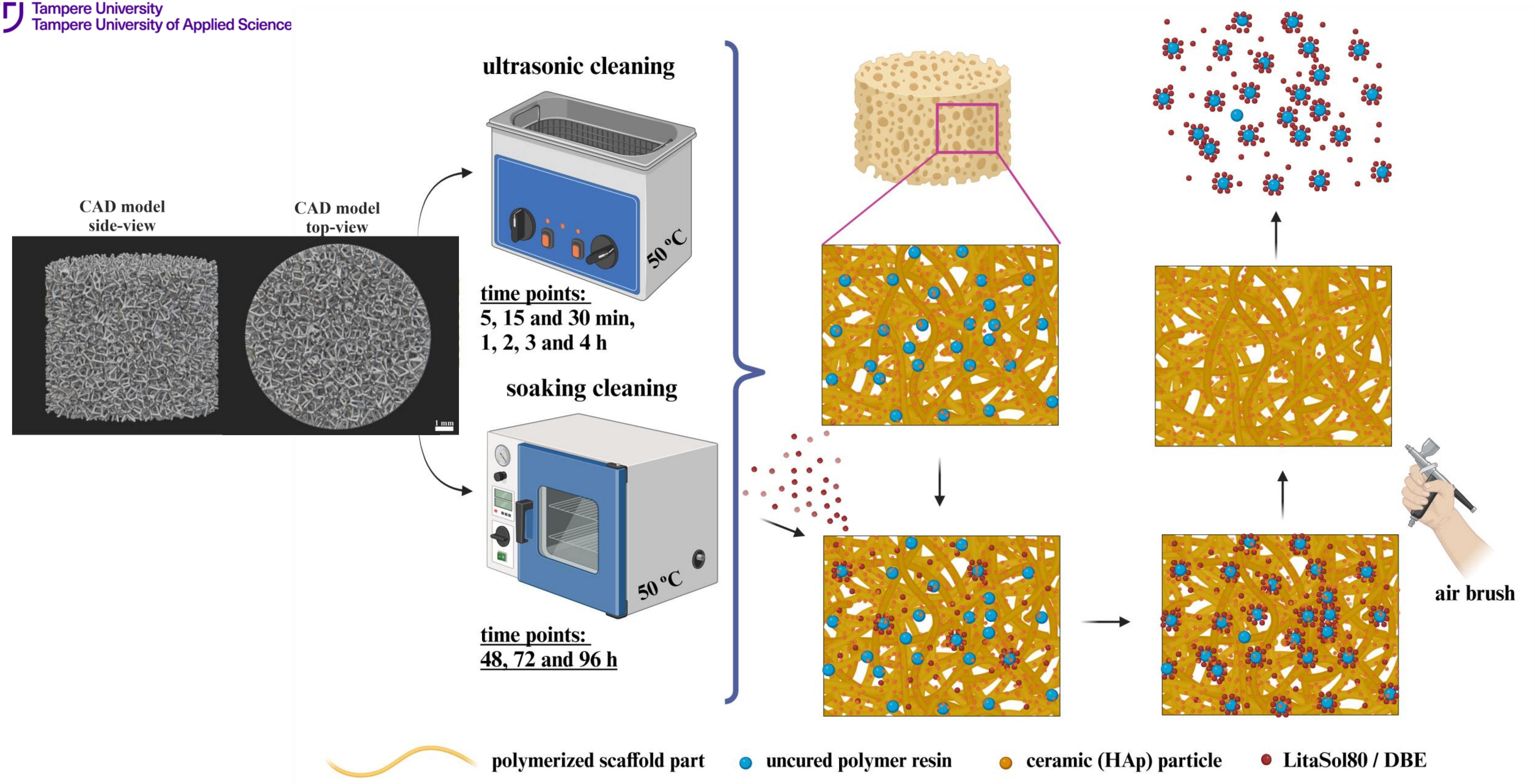
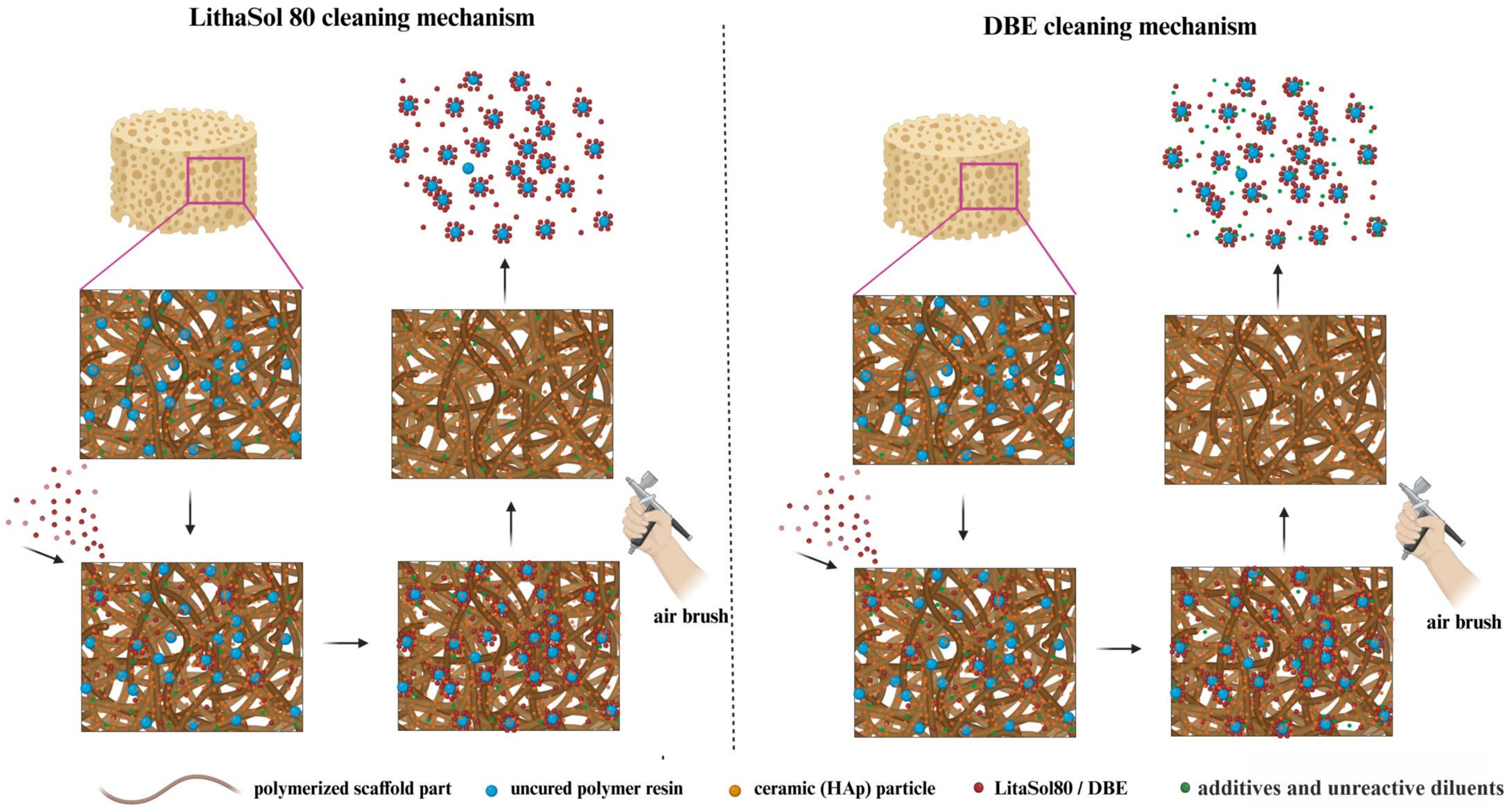


Cleaning challenge of porous scaffolds

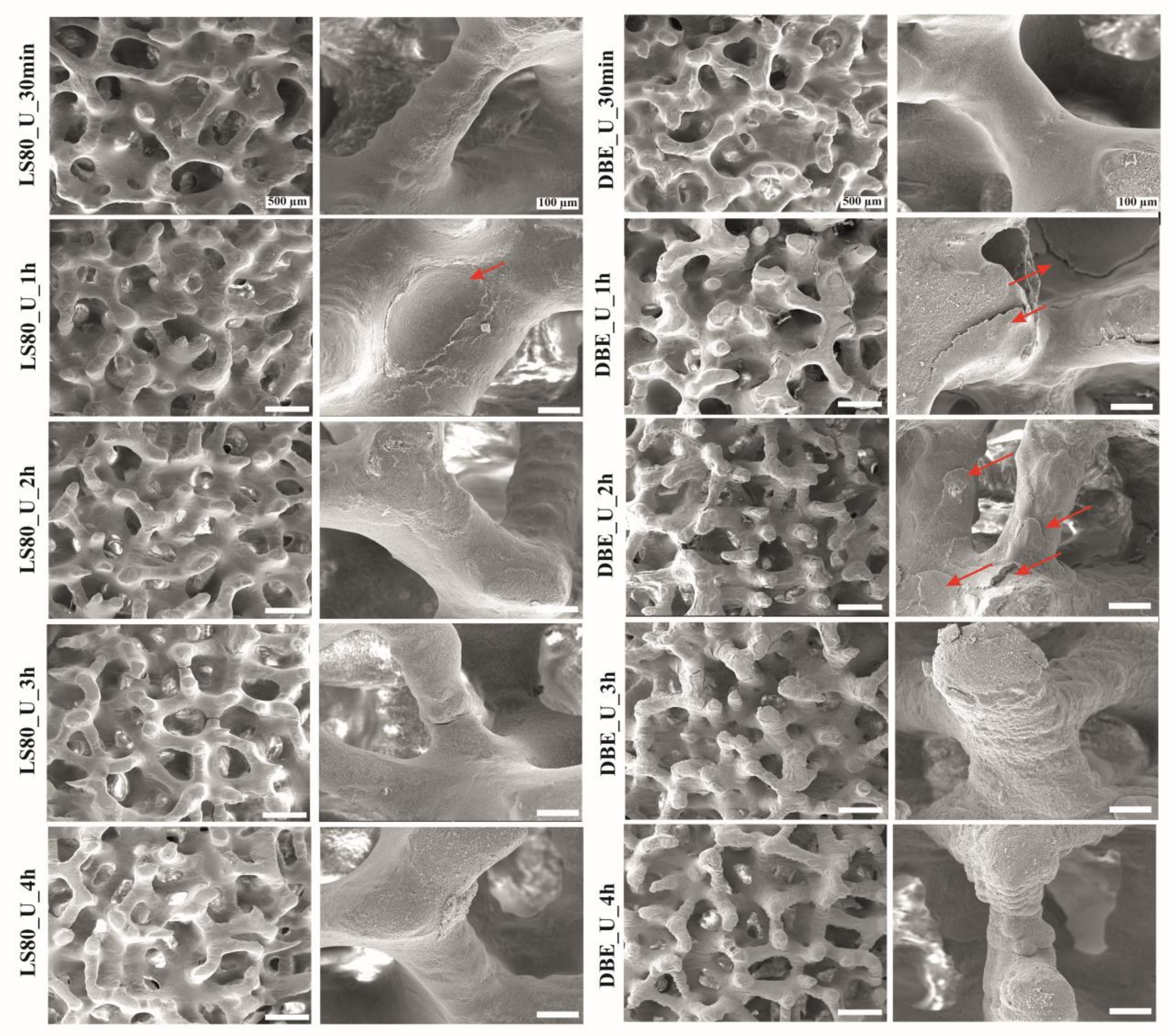
- porous structures where the interconnected pores are intentionally designed to remain uncured
- the uncured slurry in these porous regions can become intricately trapped between the cured layers, complicating the cleaning process
- effectively removing the uncured slurry from within the intricate and porous geometries of the printed structures becomes a critical task as the presence of residue within the structure can obstruct pores during sintering
- biomedical implants → pore characteristics are crucial for tissue integration and substance exchange.

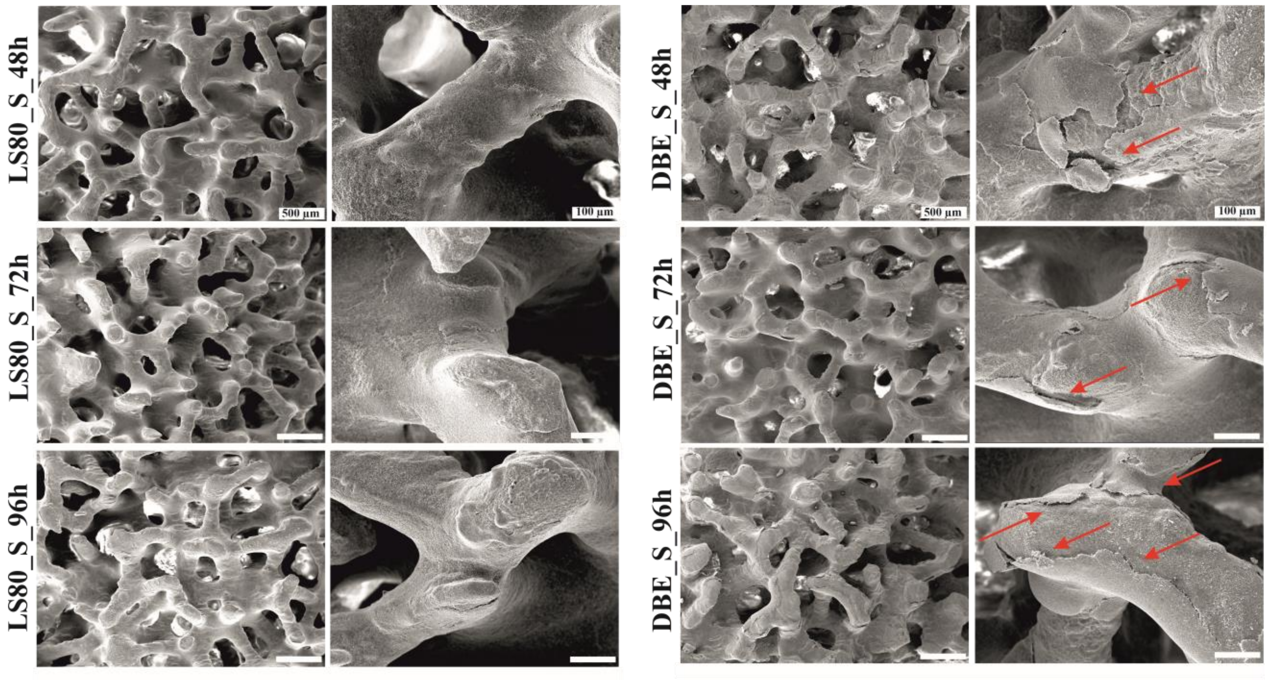



CAD model
side-view
CAD model
top-view
1 mm
ultrasonic cleaning
50 °C
time points:
5, 15 and 30 min,
1, 2, 3 and 4 h
soaking cleaning
50 °C
time points:
48, 72 and 96 h
air brush
polymerized scaffold part
uncured polymer resin
ceramic (HAp) particle
LitaSol80 / DBE


LithaSol 80 cleaning mechanism
air brush
DBE cleaning mechanism
air brush
polymerized scaffold part
uncured polymer resin
ceramic (HAp) particle
LitaSol80 / DBE
additives and unreactive diluents

Morphological characterization – sintered samples





Conclusion…

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Thank you for your attention!

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