Transactions on Additive Manufacturing Meets Medicine
Trans. AMMM, 2025, Vol. 7, No 1, Suppl. 1, Article ID 2095, 1 Page

Infinite Science Publishing

Abstract

Sinter-joined bioceramics for hybrid bone implants

S. Nistler[1,2,3*], C. Hofstetter[1,4], S. Baudis[1,3,5], M. Schwentenwein[1,4] and J. Stampfl[1,2,3]

[1] *Christan Doppler Laboratory for Advanced Polymers for Biomaterials and 3D Printing, Vienna, Austria*
[2] *Institute for Materials Science and Technology, TU Wien, Vienna, Austria*
[3] *Austrian Cluster for Tissue Regeneration, Vienna, Austria*
[4] *Lithoz GmbH, Vienna, Austria*
[5] *Institute of Applied Synthetic Chemistry, TU Wien, Vienna, Austria*
[*] *Corresponding author, email: sarah.nistler@tuwien.ac.at*

Artificial bone implants are used when a bone defect exceeds a critical size, and autografts or allografts are not an option due to insufficient quality or limited availability. Implants must be biocompatible, osteoconductive, ideally bioresorbable, and resistant to mechanical stress during handling and healing [1]. Natural bone is not a homogeneous material but consists of several hierarchically structured phases that cannot necessarily be imitated by one single material. Our approach was therefore to combine two bioceramic materials in one hybrid implant. We used yttria-stabilized zirconia for phases with high mechanical strength and hydroxyapatite for phases that require osteointegration.

As a manufacturing process, we used lithography-based ceramic manufacturing to produce the individual green parts (composite material consisting of photopolymer matrix and ceramic powder) which were combined in a sinter-joining process during thermal post-processing. The sinter-joining concept involves inducing a press-fit between the two parts by precisely controlling the shrinking behavior [2]. To establish process control, we started with a simple ring-in-ring design and progressed to biaxial bending plates to quantify mechanical resistance. We found a significant increase in the maximal measured force in the piston-on-three-balls test set-up from (72 ± 53) N to (366 ± 88) N for a 5% and 10% press-fit, respectively. For further evaluation, we created micrographs and assessed shrinking behavior and deformation. As final step, we designed more complex structures to demonstrate the successful sinter-joining. [3]

This study demonstrated a proof-of-concept for sinter-joining different bioceramics to create hybrid implants that mimic the multi-phase composition of natural bone by combining bioactive with mechanically strong materials. We have published this study in the Open Ceramics Journal [3].

Author's statement

Christoph Hofstetter and Martin Schwentenwein are employed by the company Lithoz GmbH in Vienna. All other authors state no conflict of interest. Acknowledgments: Thanks to Prof. Thomas Konegger at TU Wien who kindly provided the high-temperature dilatometric measurements. Research funding: Funding by the Christian Doppler Research Association within the framework of the "Christian Doppler Laboratory for Advanced Polymers for Biomaterials and 3D Printing" and the financial support by the Austrian Federal Ministry of Labour and Economy and the National Foundation for Research, Technology and Development are gratefully acknowledged.

References

[1] V. Campana *et al.*, "Bone substitutes in orthopaedic surgery: from basic science to clinical practice," *J Mater Sci: Mater Med*, vol. 25, no. 10, pp. 2445–2461, Oct. 2014, doi: 10.1007/s10856-014-5240-2.
[2] J. Schubert, Y. End, V. Schulze, and F. Zanger, "Exploring the Applicability of Sinterjoining to Combine Additively Manufactured Ceramic Components," *Procedia CIRP*, vol. 115, pp. 18–23, 2022, doi: 10.1016/j.procir.2022.10.043.
[3] S. Nistler, C. Hofstetter, S. Baudis, M. Schwentenwein, and J. Stampfl, "Sinter-joining of two different bioceramic materials," *Open Ceramics*, vol. 22, p. 100759, Jun. 2025, doi: 10.1016/j.oceram.2025.100759.

DOI: 10.18416/AMMM.2025.25062095