

# Biomedical Applications of Additively Manufactured Lattice Structure

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## Abstract

**Statement of the Problem:** Lattice structures are topologically ordered complex structures based on one or more interconnected repeating porous unit cells [1]. They feature an exceptional strength-to-weight ratio and can have interesting mechanical and morphological properties. In recent years, the application of lattice structures has been made possible in several fields thanks to advances in additive manufacturing (AM), which has enabled the fabrication of complex functional objects from multiple materials with customizable mechanical and morphological properties inaccessible with conventional manufacturing methods. The use of this disruptive technology has made it possible to manufacture complex lattice structures with predefined properties. These controlled lattice structures have had numerous applications, particularly in the biomedical field. In this field, additive manufacturing techniques have enabled the fabrication of complex porous structures with an extraordinary array of mechanical, mass transport and biological capabilities used for prostheses, orthoses, tissue engineering scaffolds and so on... The aim of this conference is to show the interest of lattice structures for biomedical devices, as well as the constraints and limits. Finally, research, development and expected technological breakthroughs are presented.

**Conclusion & Significance:** Although lattice structures have shown great potential in the biomedical field, challenges such as precision, porosity control, surface finish problems, resolution limits, material constraints and high costs need to be overcome if its application is to be widespread and effective in this area. Researchers are actively working on perfecting AM processes and exploring new materials to unlock the full potential of applying these structures for biomedical purposes.

## Image

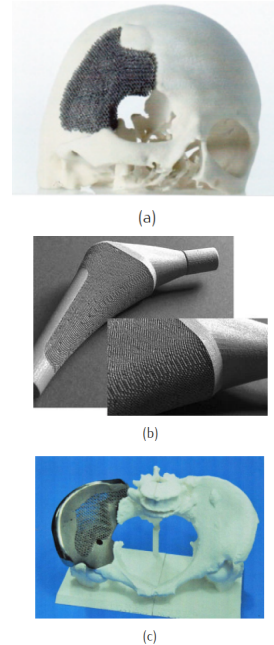
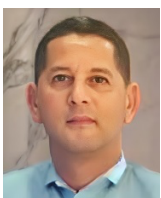


Figure 1: Orthopedic implants with lattice structures for (a) skull [2], (b) femoral stem [3] and (c) hip [2].

## Recent Publications

1. S. Ataollahi (2023), A review on additive manufacturing of lattice structures in tissue engineering, *Bioprinting* 35 (2023) e00304.
2. L.E. Murr, (2017), Open-cellular metal implant design and fabrication for biomechanical compatibility with bone using electron beam melting, *Journal of the mechanical behavior of biomedical materials*, vol 76 (2017) 164–177. <http://dx.doi.org/10.1016/j.jmbbm.2017.02.019>
3. A. A Zadpoor, J. Malda, (2017), Additive Manufacturing of Biomaterials, Tissues, and Organs, *Ann Biomed Eng*, vol 45(1):1-11. doi: 10.1007/s10439-016-1719-y.

## Photograph



## Biography

Khalid ZARBANE is a professor at the Ecole Supérieure de Technologie, Hassan II University of Casablanca (Morocco). In 2009, he obtained his PhD from the University of Poitiers (France). Head of the Advanced Mechanics and Intelligent Factory team, Laboratory of Advanced Research on Industrial and Logistics Engineering (LARILE). He is also the Vice-president of the Moroccan Association of Additive Manufacturing and 3D Printing (AMFAIM3D). Khalid ZARBANE is a member of the editorial board of the "Materials Engineering" section of MDPI's *ENG* journal, a member of the "Editorial Key Reviewers Committee" of the *Journal of Achievement in Materials and Manufacturing Engineering (JAMME)*, since 2022, He is also associate editor of the "Archive Materials Science and Engineering (AMSE) Journal", since 2022 and a member of the editorial board of the "Special issue: Additive Manufacturing in Africa" of the *Scientific African Journal*. In 2022, Pr. Khalid ZARBANE received an Honorary Diploma from AMME WORLD ACADEMY (World Academy of Materials and Manufacturing Engineering) of Poland for his cooperation with the Polish academic community in the field of materials science. Pr. Khalid ZARBANE is co-author of the Springer Handbook of Additive Manufacturing published in 2023. He is also co-editor of the Proceeding of CASICAM, 2022. He has produced over 50 publications, including 5 scientific chapters and 22 Scopus-indexed papers.

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