Cast, skeletal structures for implants

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Abstract

Statement of the Problem: For ages, there has been a quest for biocompatible materials that are harmless to human health, as well as methods for their fixation in human tissues. The issue of compatibility with bodily fluids and acidic environments can be addressed by employing chemically inert metals and alloys, such as gold, silver, titanium alloys, or Vitalium. Another approach involves using protective coatings to form a tight chemical barrier [1, 4]. A current challenge is the permanent embedding of implants in bones. Present coatings are intended to support the adhesion of human tissues to implants, but this is a complex process, and the coatings themselves are susceptible to flaking off and have limited capability to bond with human tissues. Mechanical connections represent another method, which increases the complexity of surgery and necessitates further intervention in the human body. Skeletal, dedicated cast support elements for implants could offer a solution to this problem. The versatility in the use of casting alloys is crucial in this regard. Achievable wall thicknesses with controlled microstructure range from 0.5 to 2.5 mm. The developed surface of the actual component provides opportunities for - firstly, the desired maximization of hydroxyapatite structure deposition surface area, and secondly, maximization of bonding forces with organic tissue, with controlled extra-organismal flora. Basic skeletal structures with variable basic cell geometry are presented. The concept and castings in the form of gyroidal structures are demonstrated. The possibility of reproducing selected macro and microstructures using basic mobile photogrammetry applications was examined. Foundry models were produced using 3D printing; the suitability of readily available mobile photogrammetry applications for casting dedicated elements was verified.

Conclusion & Significance: The freedom to shape the geometric form of cast skeletal structures—especially dedicated ones—offers potential for their manufacturing to meet biomedical needs, including those in dentistry.

Image

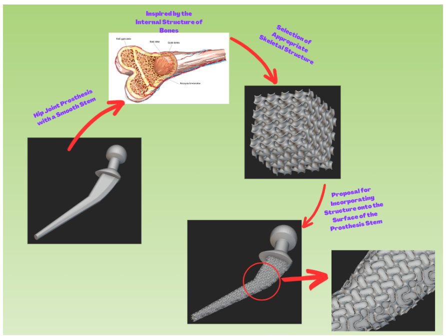

Figure 1. Stages of Developing the Concept of Using Skeletal Structures in Implants:

Recent Publications

1. Cholewa M., T. Wróbel, C. Baron, M. Moris, „Surface Phenomena at the Interface between Silicon Carbide and Iron Alloy", Gliwice 2021
2. Krzysztoforski P., Drukowany, odlewniczy model szkieletu 3D, Engineering project, Silesian University of Technology, Gliwice 2023
3. M. Cholewa, K. Wolny; Measurement and analysis system, multi-point temperature measurement; Selected problems of foundry technologies; monograph. Collective work, notebooks of student scientific works "Sferoid"; 2022, No. 24; pp. 236-246, ISBN 978-83-63605-54-4
4. M. Cholewa, T. Wróbel, M. Morys; Cast Fe-SiCp composite; Solidification and Crystallization of Metals 2023, 63rd International Scientific Conference, Book of Abstracts

Photograph

Biography

Professor Mirosław Cholewa- Discipline: Materials Engineering with specializations in Foundry and Metallurgy, as well as Computational Materials Science, Cast Composites, Ceramics and Refractory Materials, Processing and Application of Plastics. Publication record: Over 300 publications in the field of Materials Engineering including: 80 articles in international journals, 21 publications in JCR-indexed journals, 3 monographs, 19 chapters in monographs, 145 publications in conference materials, co-authorship of 5 academic textbooks. Member of sections in 5 committees of the Polish Academy of Sciences, membership in scientific, industry-related associations, and scientific, editorial committees of international publications and conferences. Member of the Polish Academy of Engineering. Latest publications: M. Cholewa, T. Wróbel, C. Baron; Surface Structure" and "Mobile Applications of Photogrammetry and 3D Printing in Precision Casting Process." Currently, he is pursuing further studies at the Silesian University of Technology in the field of Faculty of Mechanical Engineering, specializing in Foundry, while also working as a designer of special machinery in Macromolds.

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Paweł Krzysztoforski, BSc graduated from the Silesian University of Technology in Gliwice with a degree in Faculty of Mechanical Engineering, specializing in Mechanical Engineering. He wrote a thesis entitled " Printed, casted 3D skeletal model." Additionally, he is a co-author of two articles published in the journal Sferoid titled "Printed Foundry Model of Skeletal.

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