



Forum Inżynierii Materiałowej

Materials Engineering Forum

- **The Materials Engineering and Metallurgy Committee of the Polish Academy of Sciences**
- **Polish Materials Science Society**

Functional Biomaterials - from MXenes through Hydrogels and Hierarchical Implants to 3D Bioprinting

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The Biomaterials Team at the Faculty of Materials Engineering and Physics, Department of Materials Engineering, Cracow University of Technology, leads pioneering research in advancing functional biomaterials for medical applications. Our work spans a diverse range of cutting-edge biomaterial technologies, dedicated to developing biomedical materials distinguished by exceptional durability, superior biocompatibility, and elevated bioactivity. Key projects include the OPUS 24 (LAP) initiative, "Next Generation of Bioactive Laser Textured Ti/HAp/MXene Biomaterials," where we are developing a composite material based on titanium and hydroxyapatite (Ti/HAp) integrated with MXenes. Through laser surface treatments, this biomaterial features microstructures that support cell growth and reduce friction, significantly extending implant lifespan. Another flagship development is a high biocompatibility hydrogel created within the SMART-MAT Functional Materials Science Club. This hydrogel, enriched with natural biopolymers similar to those in human skin, earned first place in both the MedBiz Innovations Program and the Green Innovations Challenge in 2023. The OPUS project, "Hierarchical Approaches for Osteochondral Tissue Engineering 'OsteoHierarch'," is pioneering a stepwise synthesis method for a gradient biomaterial system. This hierarchical structure, combining calcium phosphate, a polymer matrix, and bioactive factors, addresses the specific needs of osteochondral implants by mimicking the layered structure of bone and cartilage. The Lider project, titled "Bioactive Composite Granulate with 3D Bioprinting Potential," further showcases our expertise. OsteoKomp, a 3D-printable biomimetic granulate designed for cranial bone implants, offering bioactivity that supports cell growth and a structure that facilitates vascular integration. Through these projects, the Biomaterials Team is dedicated to advancing the science and application of functional biomaterials, with the goal of creating durable, effective, and biocompatible solutions for medical applications.



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Whey Protein Isolate: A Versatile Biomaterial for Hydrogel Formation

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Whey protein isolate (WPI) is an inexpensive by product of the dairy industry and is increasingly used as a high-quality dietary supplement, particularly popular among physically active individuals like bodybuilders.

This paper will present the creation of hydrogels from WPI, which can serve as carriers for both hydrophilic and hydrophobic drugs. Moreover, such hydrogels stimulate adhesion, proliferation, and differentiation of various cell types, making them promising biomaterials for tissue regeneration. The paper will also describe how collaboration with Polish research institutions has played a key role in the development of this research direction.