"Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world.

LOUIS PASTEUR

UNIVERZITA
PAVLA JOZEFA ŠAFÁRIKA
V KOŠICIACH

Univerzita Tomáše Bati ve Zlíně
Centrum polymerních systémů

MŰEGYETEM 1782

UNIWERSYTET MEDYCZNY W LUBLINIE

https://biomatv4net.science.upjs.sk

BioMatV4NET

Biodegradable metal development and surface functionalization V4 network

supported by

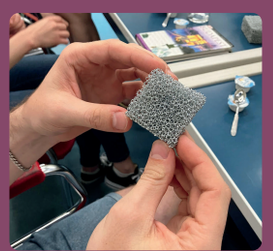
Visegrad Fund

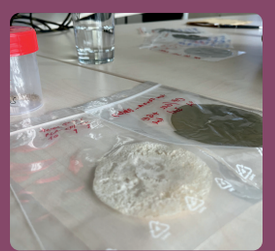
V4 project story

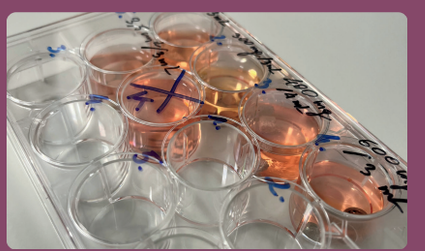
What is the main issue that our project focused on?

Almost three million patients a year suffer from femoral shaft fractures in accidents alone. Together with osteoporotic fractures and those caused by sports or diseases, a significant part of the population will encounter this condition during their lifetime. Life expectancy and demand for an active life are increasing and so is the need to develop new **internal fixation devices**. The most used fixing devices are made of titanium, chromium cobalt alloys, or stainless steel. Inert materials have an undeniable place in the clinical practice of treating orthopedical injuries, however, they are facing several drawbacks: long-term stay in the body causing inflammatory reactions, non-compliance with the mechanical properties of natural bone tissue that may lead to tissue necrosis, and the need for secondary surgical interventions to explant the implant from the patient's body. An alternative that brings solutions to these problems is a group of new materials called **biodegradable metals** (BMs). Their main role is to support the damaged tissue as the new tissue grows and the implant degrades directly in the patient's body.

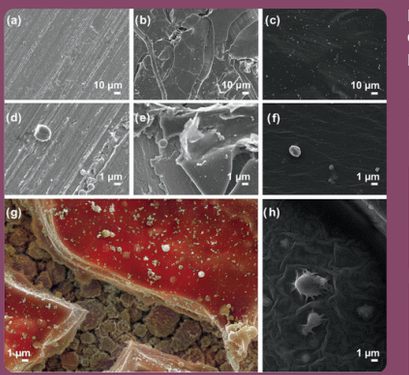
Due to the wide range of areas involved in the BMs development, research **accelerating collaboration** between experts in these areas is essential. Our main goal is to share knowledge among scientists and youngsters from the V4 countries in the process of new metal-based BM development. In addition, we aim for the active involvement of students from all participating countries to encourage their interest in studying natural sciences.







OUR achievements

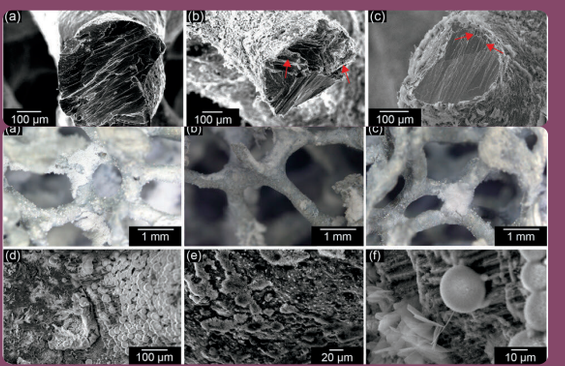


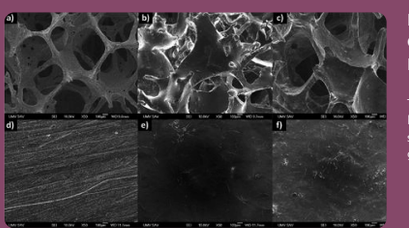
Mechanical and Degradation Behavior of Zinc-Based Biodegradable Metal Foams *(paper)*

Compressive properties and corrosion behavior in simulated body fluids are studied to determine the map of the most relevant parameters that influence the degradation properties.

Fucoidan- and Ciprofloxacin-Doped Plasma-Activated Polymer Coatings on Biodegradable Zinc: Hemocompatibility and Drug Release *(paper)*

Poly(lactic) acid (PLA) or polyethylenimine (PEI) was selected as a polymeric matrix for further doping with antibiotic ciprofloxacin (CPR) and marine-sourced polysaccharide fucoidan (FU), which are known for their antibacterial and potential anticoagulant properties, respectively.





Effect of Gentamicin Sulfate and Polymeric Polyethylene Glycol Coating on the Degradation and Cytotoxicity of Iron-Based Biomaterials *(paper)*

The work is focused on the degradation, cytotoxicity, and antibacterial properties, of iron-based biomaterials with a bioactive coating layer. The foam and the compact iron samples were coated with a polyethylene glycol (PEG) polymer layer without and with gentamicin sulfate (PEG + Ge).

Dozens of new materials samples tested for biological properties

4 international workshops for scientists and students

PhD and Master´s student involvement in meetings and workshops

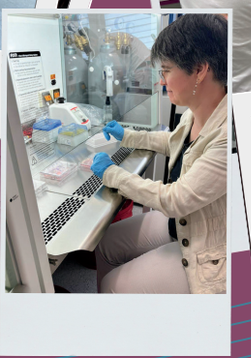
Development and testing of new types of zinc-based biodegradable materials

Results presented in international conferences for broad scientific community

Establishement of strong V4 scientific cooperation

Kick-Off
Budapest 9/2023

NFA 2023 Conference
High Tatras 10/2023



Workshop on
Mechanical testing
Budapest 12/2023

Workshop on Surface
funcionalization
Zlín 3/2024

Workshop on Biological testing
Lublin 6/2024

Workshop on Corrosion / Final meeting
High Tatras 10/2024

PROJECT
roadmap

SLOVAKIA, KOŠICE
Pavol Jozef Šafárik University in Košice (UPJS)

The Faculty of Science of the Pavol Jozef Šafárik University in Košice assumes the role of the principal investigator in the project. Thanks to the high number of scientific outputs and successes in solving scientific grant projects, PF UPJŠ is ranked among the leading scientific faculties in the Slovak Republic.

Department of Physical Chemistry, home workplace, is focused on the development of research and educational activities in the field of electrochemistry, materials chemistry and nanotechnologies. Research at the department is mainly oriented at the development of biodegradable materials, electrochemical detection of biomolecules, electrochemical reduction of hydrogen and research into a new type of batteries.

Head of the team: Dr. Radka Gorejová

CZECHIA, ZLÍN
Tomas Bata University in Zlín (TBU)

Tomas Bata University (TBU) is an open and flexible higher education institution in the center of the regional city of Zlín. We decided to collaborate with the laboratories of TBU due to their expertise in the field of polymer engineering, surface functionalization, and material characterization.

At the same time, top-class TBU research units offer optimum facilities and opportunities for the provision of classes to students as well as for collaboration with companies and institutions. Several successful researchers and student mobilities took place between the partner and coordinating organization leading to the preparation of various currently submitted scientific projects.

Head of the team: Dr. Kadir Özaltin

HUNGARY, BUDAPEST
Budapest University of Technology and Economics (BME)

The research group at Budapest University of Technology and Economics is the leading team in metal foam research and has broad experience both in manufacturing and mechanical testing of metal foams of various metal.

The head of the team was an invited speaker at the Cellular Materials 2020 (CellMat2020) conference, one of the most prestigious conferences on metal foams. The first collaboration has started in the spring of 2022 that resulted in a joint participation on CellMat2022.

Head of the team: Assoc. prof. Csilla Wiener

POLAND, LUBLIN
Medical University of Lublin (UMLUB)

Research team of Medical University of Lublin possesses great experience at engineering of biomaterials and regenerative medicine. The team has well-documented skills at fabrication of biomaterials as well as within the use of in vitro cellular models in preclinical studies, including preliminary evaluation of biocompatibility of novel implantable biomaterials. The team developed many bone implants and wound dressings.

The head of the team (prof. Agata Przekora-Kuśmierz) has strong background related to biological characterization of the biomaterials (72 articles in JCR journals with total IF=361.251, h-index = 19). The team of prof. Przekora-Kuśmierz will perform comprehensive biological characterization (experiments with the use of in vitro cellular models) of the bone implants to confirm biocompatibility of the novel biomaterials.

Head of the team: prof. Agata Przekora-Kuśmierz

What should be done to address this issue/problem?

Regional collaboration between the research and educational facilities located in V4 countries characterized by shared roles and responsibilities, resulting in a different and complementary way of thinking, can play an important role in this process. We believe that by promoting **strong cooperation** between partners which will enable the effective transfer and sharing of knowledge, we will be able to address several issues at the same time.

The **development of a new BM based on biocompatible metals** (like zinc and Zn-based alloy) with desirable corrosion, mechanical and biological properties functionalized with degradable polymer (PEG, PLA...) coatings with enhanced antibacterial and anticoagulant properties

Secondly, in the process of developing new biomaterials, we provided and carried out several **students and research mobilities** and meetings aimed at sharing knowledge and ideas as well as presenting the results achieved

Great emphasis was be placed on **student involvement** supported by the organization of **practical demonstrations for young biomaterial researchers** to disseminate and consolidate the knowledge acquired during the project. The decreasing number of natural sciences students problem can be addressed by increasing students' engagement by involving them in research in research groups and by making interaction with fellow students available

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