Final Report

Project acronym: *BIOMB*

Project number*: 74*

M-ERA.NET Call *2016*

Period covered: 14/06/2017 to 31/07/2021

Advanced biodegradable materials based on MgB_2 resistant to microbial colonization (BIOMB)

Coordinator:

Dr. Petre Badica
badica2003@yahoo.com
National Institute of Materials Physics, Atomistilor 405A,
077125 Magurele, Romania

Publishable project summary

The novelty of the project is *the first assessment of the possibility of using MgB_2 in medical applications*, although the compound is currently produced and used for superconducting devices. The aim is to obtain new multifunctional composites based on MgB_2 with antimicrobial / anti-fouling properties and to increase the biocompatibility at the material-tissue interface. The mechanical and physico-chemical properties of the new materials in the form of powders, coatings and solid body (sintered or 3D printed) were studied through a complex approach and the biological evaluation includes *in vitro* and *in vivo* tests. The MgB_2-based materials are seen as solutions for controlling the variation of functional properties in time and space for various bio-applications.

In Europe, 25000 people die each year from infections with bacteria resistant to several classes of antibiotics, EU countries spending 1.5 million euros a year on managing these infections. Microbial biofilms have increased resistance to conventional doses of antibiotics and bioacids and to antimicrobials. Approximately 60-70% of nosocomial infections are infections following the implantation / insertion of a medical device. The formation of biofilms on industrial surfaces raises serious problems in different industries (food and packaging, energy, naval).

Prevention of biofilm formation, eradication and control of microbial cells are the main objectives of this project. Four research groups were involved in the project, namely National Institute of Materials Physics (NIMP), University Politehnica of Bucharest (UPB), University of Bucharest (UB-ICUB) and the University of Turin (UniTO). The project proposes for the first time the exploration of the biological properties of magnesium and boron-based materials, focusing on biomedical and bioecological applications (11 ISI articles, 4 patent requests) of the biodegradable compound MgB_2. The project demonstrates the effectiveness of new MgB_2-based antimicrobial materials through *in vitro*, and *in vivo* tests on mouse models. For microbial studies, reference bacteria or bacteria and fungi taken from the clinic and from heritage objects were used. Cytotoxicity tests were also performed on various cell lines.

Among the most interesting results we mention: **(i)** fabrication of composite antimicrobial coatings with release of the active component of MgB_2 that can be deposited on different surfaces (patent application RO A2018 01129, 1 ISI article); **(ii)** the use of MgB_2 as an ingredient in commercial chlorhexidine mouthwashes to achieve an enhanced antimicrobial synergistic effect (patent application RO A2020 00678); **(iii)** the manufacture of polymer-MgB_2 composite filaments and the demonstration of 3D printing of these materials in desired shapes and sizes depending on the applications (patent application RO A2020 00405, 1 ISI article, 1 book chapter accepted); (iv) first trials for the use of MgB2 in vivo, for example for the control of the microbiota with a possible impact on the immuno-oncological system in search of new solutions for the treatment of diseases and cancer (1 ISI article) or as a new candidate material for biodegradable bone implants (patent application RO 2021 A00322); (v) the first study of the dynamic mechanical properties on solid bodies of MgB2 (1 ISI article); (vi) powders or massive, dense, textured, or machinable MgB2 bulks with potential or demostrated antimicrobial activity were obtained (7 ISI articles).

The project attracted the interest of the biomedical industry (a joint PTE project with Biotehnos was awarded, RO) and of University of Agronomic Sciences and Veterinary Medicine of Bucharest, joint experiments being performed. The project also attracted the participation of students (13 BSc, 9 MSc, 1 PhD) from the universities involved. The project contributed to the establishment of the first Laboratory of Materials and 3D Printing at the Faculty of Materials Science and Engineering, UPB. The project was an excellent basis for discussing and initiating other possible collaboration topics / projects between partners from Romania and Italy or from other countries.