MATERIAL DESIGN IN HARD TISSUE ENGINEERING

Jian Mariana[1-4], Codrea Cosmin[1-3,5], Spoiala Angela[1-3], Ficai Denisa[1,2,6], Nacu Viorel[4,7], Ficai Anton[1-3,8,]
[1] Science and Engineering of Oxide Materials and Nanomaterials, Faculty of Chemical Engineering and Biotechnology, National University of Science and Engineering POLITEHNICA Bucharest, Romania
[2] National Research Center for Food Safety, National University of Science and Engineering POLITEHNICA Bucharest, Romania.
[3] National Center for Micro and Nanomaterials, National University of Science and Engineering POLITEHNICA Bucharest, Romania.
[4] Laboratory of Tissue Engineering and Cell Cultures, *Nicolae Testemitanu* State University of Medicine and Pharmacy, Chisinau, Republic of Moldova.
[5] "Ilie Murgulescu" Institute of Physical Chemistry, Romanian Academy; Bucharest, Romania.
[6] Department of Inorganic Chemistry, Physical Chemistry and Electrochemistry, Faculty of Chemical Engineering and Biotechnology, National University of Science and Engineering POLITEHNICA Bucharest, Romania.
[7] Human Cells and Tissue Bank, Traumatology and Orthopedy Clinic Hospital, Chisinau, Republic of Moldova
[8]Academy of Romanian Scientists, Bucharest, Romania.

Introduction: Considering the high incidence and the relatively large amount needed, the overall market share of the bone grafting materials is ~49% of the total field of biomaterials and thus many researchers focused their efforts in developing new and improved materials for hard tissue engineering. Considering the evolution of these materials, from morpho-compositional point of view there are 4 major generations: 1st Generation: Metals and Alloys; 2nd generation: Ceramics and Polymers; 3rd generation: Composite and Nanocomposites and 4th generation: Tissue Engineered NanoComposites. Even not yet totally agreed, the 5th generation seems to be the materials obtained by Materials Design and 3D printing is one of the most popular processing technique.
Materials and Methods: the presentation will be focused on the materials design, synthesis, processing and characterization of the composite materials.
Results: This presentation will be mainly focused on the evolution of the materials in the field, from compositional to morphological design including coatings and 3D printed grafts and loading these materials with specific active agents and drugs to use them in specific diseases such as osteoporosis, bone infection and cancer, etc. A special attention will be paid to the composite materials based on collagen and hydroxyapatite highlighting the influence of specific conditions that can alter their properties and certainly, the role of the loading agents. Considering the current trends at EU level, green and sustainability, circularity or blue approach are also exploited in developing bone grafting materials and to improve the properties and performances of the medical products.
Conclusions: the overall performances of the materials used in hard tissue engineering are related to the composition and morphology while the presence of specific biological active agents can be essential in the treatment of specific bone-related diseases.
Keywords: Bone grafting; composite materials; materials design; 3D printing; advanced characterization; biomimetism; circular economy.
Acknowledgement: This research was funded by UEFISCDI and ANCD through the project "Nanostructured Bone Grafts with Predetermined Properties- CollNanoBone" project number **29ROMD/20.05.2024.** The support of the Romanian Government for providing access to the research infrastructure of the National Center for Micro and Nanomaterials through the National Program titled "Installations and Strategic Objectives of National Interest" is also highly acknowledged.