“PRO INVENT” RESEARCH CONFERENCE–24.03.2016

Project title:

Research regarding customized implants manufacturing by using AM technology from composite materials reinforced with metallic structures

Titlul proiectului:

Cercetări privind fabricarea implanturilor personalizate prin tehnologii AM din materiale compozite armate cu structuri metalice

Project manager:

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Foreword/Summary:

The project presents the design and manufacturing of customized implants from biocomposite materials reinforced with metallic structures. The novelty consists in the development of a customized implant obtained by combining reinforcements made by material addition (Additive Manufacturing technology), with uncontrolled/controlled (lattice type) porous metallic structure, and applying a new viscous polymeric biocomposite by injection. The penetration of the composite in the reinforcement will be achieved in a silicone rubber mold manufactured by Rapid Tooling technology (RT). This method allows obtaining any anatomic shape. The porous metallic structures (contact regions and reinforcement), as well as the non-metallic ones (biocomposite) of the new implant will allow the mass integration of anti-inflammatory or anti-tumor drugs before the surgical intervention. The implant will reproduce as well as possible the characteristics of the human bone.

The research has a novelty character both at national and international level. Solving such a problem means an important step towards the development of a new implant generation. On the other hand, this research facilitates an interdisciplinary cooperation between engineers, chemists and physicians with the aim of obtaining a new implant with high biocompatibility, superior physical and mechanical properties as compared to classic implants, with a decreased weight and allowing a quicker osteo-integration.

Descrierea proiectului:

Proiectul prezintă proiectarea şi fabricarea implanturilor personalizate din materiale biocompozite armate cu structuri metalice. Noutatea constă în dezvoltarea unui implant personalizat, rezultat prin combinarea armăturilor, fabricate prin adăugare de material (tehnologia Additive Manufacturing), cu structură metalică poroasă necontrolată şi/sau controlată (de tip lattice) şi aplicarea unui nou biocompozit polimeric vâscos prin injectare. Pătrunderea compozitului în armătură se va realiza într-o matriţă din cauciuc siliconic realizată prin tehnologii de fabricaţie rapidă a sculelor (Rapid Tooling), fapt ce asigură obţinerea oricărei forme anatomice. Structurile poroase metalice (zonele active şi armătura) şi nemetalice (biocompozitul) a noului implant vor permite integrarea în masa lui, înainte de protezare, de medicamente antiinflamatorii sau antitumorale. Acest implant va reproduce în cât mai mare măsură caracteristicile osului uman.

Cercetările au un caracter de noutate nu numai naţională dar şi internaţională. Soluţionarea unei astfel de probleme înseamnă mult pentru o nouă generaţie de implanturi. Pe de altă parte, această cercetare deschide calea unor colaborări interdisciplinare care va implica ingineri, chimişti şi medici. Astfel, în final se va obţine un nou implant cu o biocompatibilitate ridicată, cu proprietăţi fizico-mecanice superioare unui implant clasic dar cu o greutate mult redusă şi care va permite un proces de osteointegrare mai rapid.

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Objectives:

The main objective:
Developing a customized implant manufactured by AM technology from composite material reinforced with metallic structure.

Specific objectives (Work Plan):
WP1. Designing and modelling several experimental implants made by biocomposite material reinforced with metallic structure;
WP2. Experimental models manufacturing;
WP3. Elaborate and study the behavior of the biocomposite material in connection with enforced material;
WP4. Case studies - Manufacture and simulate the behavior of the implant for the active and passive zones of the human orthopedic apparatus.

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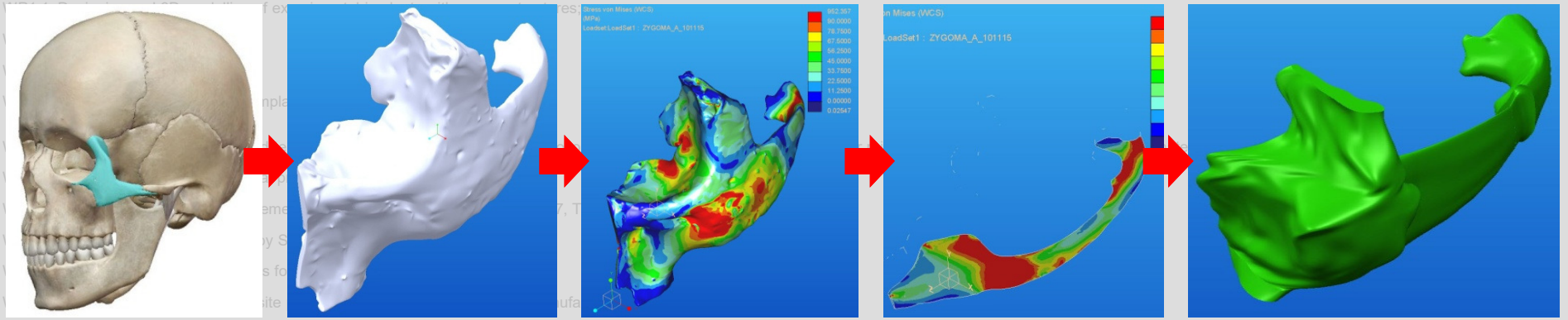
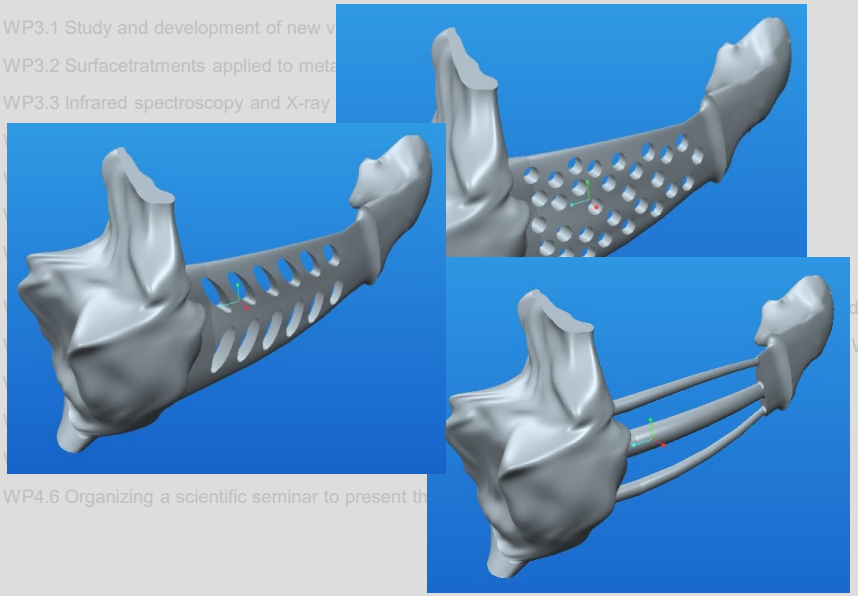
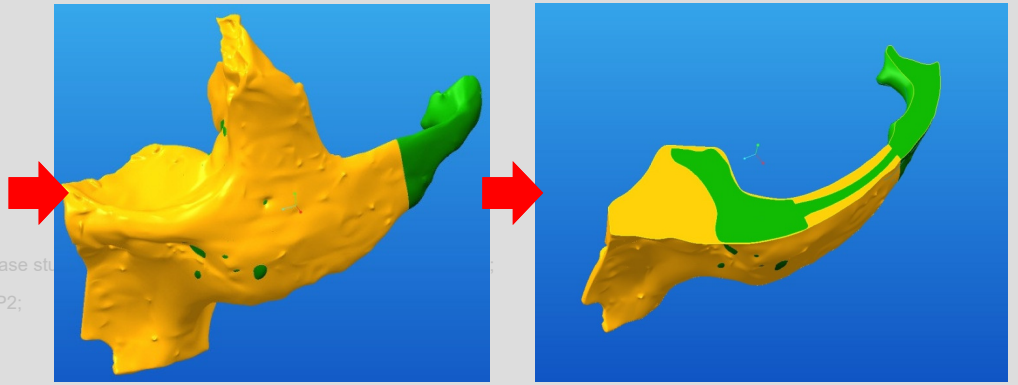
Activities / Milestones / Challenges







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Activities

WP1.1. Designing and 3D modelling of experimental implants with porous structures;

WP1.2. Kinematic simulations;

WP1.3 Finite Element Analysis (FEA);

WP1.4 Redesigning of experimental implants;

WP2.1 SLM manufacturing of standard test pieces with porous structures from biocompatible metals, similar to those used for reinforced by CoCr, CoCrWMo, Inox316L materials;

WP2.2 Testing the physical-mechanical properties of standard specimens;

WP2.3 SLM manufacturing of reinforcements for experimental implants from Ti67, Ti pure, CoCr, CoCrWMo, Inox316L;

WP2.4 Preparing and manufacturing by SLS of master experimental implants;

WP2.5 Achieving silicone rubber molds for fabrication of experimental implants;

WP2.6 Injection molding of biocomposite paste in to silicone rubber molds to manufacture the experimental implants;

WP3.1 Study and development of new viscous biocomposite material;

WP3.2 Surface treatments applied to metallic reinforcements used to experimental implants;

WP3.3 Infrared spectroscopy and X-ray diffraction;

WP3.4 Scanning Electron Microscopy for inorganic powders and implants;

WP3.5 Determination of water absorption in the composite material;

WP3.6 Adhesion tests of the biocomposite and reinforcement assembly;

WP3.7 Mechanical tests of the biocomposite (tensile, bending and compression);

WP4.1 Medical image processing (CT) and achieving virtual model of customized implants for proposed case studies (orthopedic implants and maxillofacial implants);

WP4.2 The design and manufacture of customized implants following the steps presented in WP1 and WP2;

WP4.3 Kinematic simulation of new implants to similar attempts with those specific to daily activities;

WP4.4 Finite element analysis (FEA) of the new implants;

WP4.5 Physical tests on orthopedic and maxillofacial implants (compression and shock);

WP4.6 Organizing a scientific seminar to present the results of strategic relevant beneficiaries.

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Results:

Estimated:

- **2 scientific papers published in ISI;**
- **4 scientific papers published in BDI or ISI;**
- **two chapters in the PhD thesis;**
- **3 diplomas works / dissertation;**
- **a patent proposal;**
- **team members contributions to a specialized / technical book.**

Realized:

- **3 scientific papers accepted Journals (2 ISI, 1 BDI);**
- **two chapters in the PhD thesis (work in progress);**
- **2 diplomas works (work in progress);**
- **team members contributions to a specialized / technical book.**

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Next steps:

- **3 scientific papers BDI / ISI (2 to complete, 1 to go);**
- **two chapters in the PhD thesis (to complete);**
- **3 diplomas works / dissertation (2 to complete, 1 to go);**
- **a patent proposal (1 to go);**

- **Perspectives …**

Thank you for your attention!

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