Supervisor Project Idea

Supervisor

Insert a brief CV and/or external link, the total number of publications, the ORCID link, 5 of the most significant/recent publications, and a list of funded projects and awards. max 300 words

Prof. Paolo Mengucci, Ph.D., is Full Professor of Experimental Physics at the Department of Science and Engineering of Matter, Environment and Urban Planning (SIMAU), Università Politecnica delle Marche (UNIVPM), Italy. He leads the group of Physics of Condensed Matter at the Department SIMAU. His research activity concerns the structure characterization at the nanoscale of bulk materials, surfaces, thin films and multilayers by scanning and transmission electron microscopy techniques, energy dispersive microanalysis (EDS), X-ray diffraction (XRD, GIXRD) and X-ray reflectometry (XRR), and the study of structure/properties relationships of materials and the effects of thermal and mechanical treatments on materials nanostructure. The research activity is developed in different research fields, such as: biomaterials, light metal alloys (Al, Ti, Mg), nanostructured materials, materials for additive manufacturing, materials for energy, magnetic materials, scintillating materials.
He is co-author of more 200 publications (Scopus H index = 27, citations 2497; ORCID 0000-0001-9049-8524) and 2 patents. His recent activity deals with the study of biomaterials produced by conventional as well as additive manufacturing technologies and their surface functionalization in perspective of tissue engineering applications.
The research activity has been developed in collaboration with colleagues from UNIVPM and national and international universities and research institutions. He participated to several national and international projects since 1999. Few funded projects concerning the research topics are: PRIN 2004 prot. 2004023079_003, Fondazione Cariverona 2007, FIRB-NANOREST 2010, Fondazione Cariverona 2010, COST-NAMABIO 2011, COST-FAST 2014, EU-H2020-DREAM 2016.

1. M.L. Gatto et al., Materials Science & Engineering C 128 (2021) 112300.
2. S. Ravanbakhsh et al., Bioactive Materials 12 (2022) 64-70.
3. L.M. de Andrade et al, Bioactive Materials 11 (2022) 166–180.
4. A. Gatto et al., Progress in Additive Manufacturing 8 (2023) 843-855.
5. S. Ravanbakhsh et al., Materials Chemistry and Physics 297 (2023) 127342.

Research Group Description

Provide the name the reference department and a brief description of the research group, including external links, and available instrumentations and infrastructures. max 300 words

Reference Department: SIMAU, Faculty of Engineering, UNIVPM. The group Physics of Condensed Matter is formed of 2 full professors, 1 associate professor, 2 technicians and 1 Ph.D. student. The group is skilled in the nanostructure characterization of materials by techniques based on X-ray, electron, and laser sources. Expertise include TEM and SEM based methodologies for nanostructures investigations combining structural and chemical characterization by EDX techniques, theoretical and applied studies on scintillating materials (Crystals, amorphous etc.) for high energy physics and bio-medical applications. Cold crystals recovery by means of Laser Shock Waves. Hybrid scintillators for 3D printing. X-ray diffraction and scattering techniques for the nanostructure characterization of materials. Correlation between nanostructure and macroscopic properties of materials. Study of physical and chemical phenomena occurring at the nanoscale. Metastable state of the materials. Correlation between nanostructure and physical-chemical properties of materials produced by additive manufacturing technologies.
Equipment available at the group laboratory include Bruker D8 Advance X-ray diffractometer, SEM Zeiss Supra 40 + EDX microanalysis, variable pressure SEM Tescan Vega 3 + EDX microanalysis, TEM Philips CM200 Twin, Skyscan Bruker 1174 X-ray microtomograph, optical bench with laser sources. The research activity of this project will be performed in collaboration with the following national and international research groups:
1. Histology Group, Medicine, UNIVPM, lead Prof. Monica Mattioli Belmonte Cima;
2. Dept. of Engineering “Enzo Ferrari”, University of Modena and Reggio Emilia, lead Prof. Andrea Gatto;
3. Laboratory for Biomaterials and Bioengineering (LBB), Department of Mining, Metallurgy, and Materials Engineering, Laval University, Quebec City, Canada, lead Prof. Diego Mantovani.
The collaboration with different research groups is strategic for the development of the innovative and multidisciplinary approach proposed here.

Title and goals

Provide the title of the topic and a short summary of the project idea. max 200 words

MULTIFUNCTIONAL MATERIALS FOR INNOVATIVE REGENERATIVE STRATEGIES

Aim of the proposed fellowship is the 3D printing fabrication of devices with enhanced functionalities, for implants made of bioresorbable materials for dental and orthopedic applications. Surface properties play a crucial role for the clinical success of bone-contact materials. Therefore, this project aims to investigate the relationships between the microstructure, the surface, and the reactions that they generate on the biological surrounding cells and tissues. The personalization of the implant will be fulfilled through the development of multifunctional coatings, i.e. able to show functions on-demand. The rationale behind this aim is to develop a personalized approach to the different parts of the implant, that are in contact with different tissues and environments. The final validation of the materials and the surfaces developed by this approach will consist in assessing their biological performances through standardized cytocompatibility, hemocompatibility, and bacterial tests.

The research activity will be carried out in collaboration with colleagues from Dept. DISCLIMO-School of Medicine of UNIVPM (biological characterization), Dept. of Engineering of UNIMORE (3D printing and mechanical characterization) and the LBB at Laval University in Canada (surface functionalization), while the nanostructure characterization will be performed by using the laboratory equipment available at SIMAU and at the European large scale facilities (synchrotron radiation and neutron sources).

Contact details (*including email address of the supervisor*)

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