

Offre de thèse

UNITE D'AFFECTATION

Code unité : Nom de l'unité : Département scientifique :

Directeur de l'Unité :

Personne à contacter (Nom, qualité, adresse mail) :

CARACTERISTIQUES DU POSTE

Type de contrat

Doctorant / Offre de thèse :

Intitulé du poste :

Date de recrutement : Durée du contrat : Quotité de travail :

Rémunération :

Niveau d'études souhaité :

Responsable scientifique :

Informations à compléter pour mémoire, à reporter le cas échéant dans la rubrique compétences

Langues (à préciser) :

Niveau : Lu : Parlé : Ecrit : Technique :

Autres langues :

Niveau : Lu : Parlé : Ecrit : Technique :

Informatique – Logiciels demandés :

Intitulé du diplôme requis ou domaine :

Description du sujet de thèse :

Title of the project: FUNCTIONALIZATION OF TITANIUM SURFACE FOR BIOMEDICAL APPLICATIONS

Context and description of the project

The project deals with the design of new titanium (Ti)/co-polymer/titanium hybrid sheets for biomedical applications, typically for craniofacial and mandible surgery: controlling their interface and adjusting their mechanical properties and shaping behaviour. The proposed systems have several advantages compared to the classical materials used for prosthesis. The lightweight multilayer system with graded strength conditions and improved thermal and acoustic properties with respect to titanium alone, and with mechanical properties designable in the range of bones' properties.

The main goal of this **bilateral thesis (IPCMS-UNISTRA and LBPS/CSPBAT- PARIS 13)** is developing new strategies to design P/Ti interfaces free of epoxy resins (not biocompatible), often used as adhesive agents in sandwich sheets (SMs). The goal is to employ surface-confined, resin free compatible polymer layers as adhesives for a strong bond between the polymer and the Ti for final shaping the sandwich without delamination. Therefore, creating adhesion between the materials, using the "grafting from" and "grafting to" methods, is foreseen. These methods allow a larger choice of monomers.

“Grafting from” – IPCMS - to produce Ti/P/Ti SMs with modulated properties in polymer by designing the glass transition temperature of the selected polymer. A polymerization initiator will be grafted at NaOH modified-Ti surface via a phosphonate anchor. Linear polymer chains of various molar masses, as homopolymers or copolymers types will be grown from the initiator using a controlled radical polymerization process. The monomers used will be of the methacrylic or acrylic series as methyl methacrylate (MMA), *n*-butyl methacrylate (*n*BMA) and methyl acrylate (MA). A mixture of monomers will be used for the synthesis of random copolymers. SMs will then be prepared at IMET (Germany) by bonding modified-Ti sheets and e.g. a PMMA foil of defined thicknesses.

“Grafting to” –CSPBAT - for bioactive thick polymer layers on Ti of homo and copolymers of sodium 4-styrenesulfonate (NaSS) and MA. A readily accessible anchor incorporating both an anchoring group (catechol), capable of forming - under mild conditions - a robust, stable monolayer, and a clickable function allowing the modular and efficient post-functionalization of the Ti surface will be used. In parallel, polymers or copolymers bearing thiol end groups will be attached using thiolene click reaction onto the monolayer. Linear polymer chains of various molar masses, as homo-polymers or co-polymers types will be synthesized by a controlled radical polymerization to give thiol-ends. In order to obtain thiol end polymers or copolymers, addition-fragmentation transfer (RAFT) polymerization will be chosen. The monomers used will be NaSS and/or MMA and a mixture of monomers to synthesize statistical copolymers.

Funding

The PhD fellowship is fully funded through the granted ANR –DFG (ACRONYM: BIOSMS, “Titanium/polymer sheets designed for biomedical applications” (Project Coordinators: Pr. A. Carrado (France) and Pr. H. Palkowski (Germany)).

Bibliography

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Contexte de travail :

This BILATERAL thesis is between the Institut de Physique et Chimie des Matériaux de Strasbourg (IPCMS)-Université de Strasbourg (UNISTRA) and the Laboratoire de Chimie, Structure et Propriétés de Biomateriaux et d’Agents Thérapeutiques (LBPS/CSPBAT) – Université Paris Nord - Paris 13.

The PhD candidate will be enrolled at the Doctoral School of Physics and Physical Chemistry (ED182) and will carry out his/her doctoral work at the IPCMS under the supervision of Prof. A. CARRADO (DSI), Dr. P MASSON (DMO) and Dr. G. POURROY (DCMI), and at LBPS/CSPBAT- PARIS 13 under the supervision of Prof. V. Migonney.

The PhD candidate will spend six months at IPCMS-UNISTRA and 6 months at LBPS/CSPBAT- PARIS 13.

Collaborations with research partners located also in other countries are currently ongoing and this will allow the PhD student to carry out short research stays abroad at universities of Claushal- Zellerfeld (Germany) and Mainz (Germany) and Università La Sapienza (Rome, Italy).

The IPCMS is an interdisciplinary Mixed Research Unit (University of Strasbourg – CNRS) composed of 5 departments and of about 240 employees of which *ca.* 80 researchers and teacher-researchers and *ca.* 60 technical staff members. The IPCMS is a renowned research centre in the field of nanomaterials, nanoscience and functional materials that located at the Cronenbourg Campus in Strasbourg.

Contraintes et risques :

Risks linked to chemical synthesis, chemical manipulation, UV light irradiation and SEM cross section preparation.

Informations complémentaires :

The candidate should have earned a Master 2 Level (or equivalent) in Chemical Sciences or Materials Science.

We are looking of a highly motivated PhD candidate with a very solid background in material science and polymer science as well as characterization techniques. He/she should be able to work with independence in a multidisciplinary environment and possess a curiosity-driven attitude. Good knowledge of written and spoken communication skills in English is required. Knowledge of French will be a plus. The candidate must provide a letter of motivation, a detailed CV including the list of marks and the contact details of one (or two) reference(s).