

PhD Position (M/W) - Le Mans University

Design of composite materials with complementary antibacterial activity for biomedical applications

Place : Institute of Molecules and Materials of Le Mans (IMMM) – Le Mans University

Funding : Le Mans University

Fixed-term contract : 01/10/2024 - 30/09/2027 (36 months)

Gross monthly salary : 2200 €

Keywords : Materials for Health; Inorganic Chemistry; Nanoparticles

Context of the PhD position

Bacterial pathogens causing nosocomial infections pose increasing challenges to hospitals, both in the clinical treatment of patients and in the prevention of their person-to-person transmission. The bacteria *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*) alone are responsible for more than 1/3 of nosocomial infections in France [1]. These bacteria have developed strong resistances towards multiple antibiotics due to their misuses. The emergence, evolution and spread of resistance in pathogenic bacteria are considered in 2021 as a major and serious public health issue by the European Centre for Disease prevention and Control (ECDC) and the World Health Organization (WHO) [2]. Indeed, the ECDC estimated that 52.3% and 17.2% of *E. coli* and *S. aureus* isolates respectively were resistant in 2021 to at least one class of antibiotics marketed in Europe, which is truly worrying. Due to the permanent adaptation of bacteria to the new antibiotics, complementary solutions to fight NIs are needed. The IMMM host team led by Gwenaël CORBEL has been conducting research for several years into copper-based materials capable of killing these bacteria. This work has led to the publication of several articles in high-impact journals in the field (see <https://immm.univ-lemans.fr/fr/recherche/materiaux-inorganiques/axis-3-materials-for-the-environment-and-health.html>).

[1] Enquête nationale de prévalence des infections nosocomiales et des traitements anti-infectieux en établissements de santé, mai-juin 2017. Saint-Maurice : Santé publique France, 2019. 270 p, 1-270.

[2] WHO/ECDC, World Health Organization Regional Office for Europe / European Centre for Disease Prevention and Control. Antimicrobial resistance surveillance in Europe 2023 – 2021 data.

Aim of the thesis

The aim of the proposed thesis is to synthesise composite materials combining copper-based inorganic nanoparticles with bio-sourced organic molecules. As the two entities have antibacterial activity separately, their combination should make it possible to obtain original and high-performance disinfecting agents. The PhD student will be responsible for synthesising and characterising the composite nanoparticles (crystalline structure, chemical composition, size and morphology) using the equipment on the IMMM platforms. The bactericidal activity of the materials will be assessed by collaborators from the PHarmacology of Antimicrobial Agents and AntibioResistance laboratory (PHA2R, INSERM U 1070) at the University of Poitiers. In order to elucidate the bactericidal mechanism at play and to determine the bactericidal kinetics, the PhD student will carry out at the IMMM a complete study of the stability of composite nanoparticles in contact with culture media as a function of time.

Environment of the PhD position

The Institute of Molecules and Materials of Le Mans (IMMM) is one of six joint research units associated with the CNRS (UMR-6283 CNRS) at Le Mans University. The Institute has 61 teachers-researchers, 9 CNRS researchers, 25 engineers, technicians and administrative staff, around 50 PhD students, around 30 Masters students and an annual flow of around ten post-doctoral fellows and 20 visitors and guest professors. IMMM's research activities are divided into 4 priority scientific themes: Organic Synthesis (OS), Inorganic Materials (IM), Physics of Confined Systems (PCS) and POLymers (POL). IMMM has a large number of platforms with state-of-the-art equipment for the synthesis and characterisation of materials and molecules, such as microscopy, diffraction, spectroscopy and chromatography (see <http://immm.univ-lemans.fr/fr/index.html>). In-depth studies can be carried out on site, such as those envisaged as part of the proposed thesis.

Candidate profile

The candidate must hold a master 2 or an engineer degree in chemistry, physical chemistry or materials science. The candidate must have a strong interest in a PhD project that combines bench work, the use of a wide range of characterisation equipment and the analysis of the measurements made. The student will need to be dynamic, rigorous and scientifically curious in order to successfully complete this interdisciplinary PhD project. A good knowledge of solid state chemistry and analytical chemistry techniques such as X-ray Diffraction (XRD), thermal analysis, Atomic Emission Spectroscopy (AES), Infrared Spectroscopy, solid state NMR, Chromatography (gas and liquid phase), characterisation of specific surface area by gas adsorption (BET) and analysis of particle morphology and size by Electron Microscopy (SEM, TEM) would be highly appreciated.

How to apply

Applications should be sent to <https://theses.doctorat-bretagneoire.fr/3mg/campagne-2024>. The application file must include the following documents (in French or English): 1) a detailed curriculum vitae, 2) a letter detailing the internship(s) carried out in a research laboratory or in industry, explaining the reasons for the application and specifying the post-doctoral career plan, 3) copies of the master's and engineer's diplomas, transcripts (12/20 requested) and rankings for each academic year of the master's (M1 and M2) or engineer's school. The applicant must also provide the names of referees with their contact details (laboratory, E-mail address and telephone number) or provide letters of recommendation from them.

Contacts

Gwenaël CORBEL – Chargé de Recherche au CNRS

E-mail : gwenael.corbel@univ-lemans.fr Tel. : +33 2 43 83 26 48

Arnaud MARTEL – Professeur des Universités

E-mail : arnaud.martel@univ-lemans.fr Tel. : +33 2 43 83 34 23