Master 2 Sciences et Génie des Matériaux

Stage de recherche / Année 2025-2026

Groupe(s) d'accueil de l'IRCER (cocher la case correspondante) :

[] Axe 1 [x] Axe 2 [] Axe 3 [x] Axe 4

Bioactive/antibacterial coatings by atmospheric plasma spray (APS) for medical applications

NOMS DES RESPONSABLES :

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COLLABORATION INTER-UNITES DANS LE CADRE DE LA FEDERATION MATV2L (oui/**non**)
Dans l'affirmatif, indiquer le(s) nom(s) du(des) laboratoire(s) et responsable(s) impliqué(s) autre que l'IRCER :

CONTEXTE ET OBJECTIFS DE L'ETUDE :

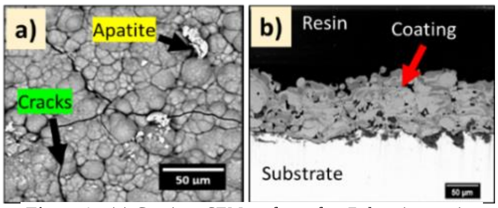

Figure 1 : *(a) Coatings SEM surface after 7-days immersion in simulated body fluid, and (b) SEM cross-section of the APS ceramic coating on Ti-alloy substrate* **[1]**.

The growing demand for orthopedic and reconstructive surgery is a consequence of bone trauma caused by the increase of road accidents, degenerative diseases, and pathogen infections. Grafts have excellent mechanical and biological properties to address trauma problems. However, due to supply difficulties, acquisition costs, and the risk of disease transmission, these grafts are gradually being replaced by artificial biomaterials. Over the years, the prosthetics industry (orthopedics and tissue) has explored around a hundred materials to replace and repair load-bearing bone tissue. Initially, inert bone substitutes (alumina, zirconia, metal alloys) were used, with high acceptance rates by the body. These materials remain 'bioinert' (no interaction with living tissues) unlike 'bioactive' materials such as bioactive glass (BG) or hydroxyapatite (HA) which generally exhibit an excellent biological response similar to natural bone tissue. Thus, much of the research today is based on improving the bioactivity of metallic implants through the deposition of ceramic on the metal, combining both excellent mechanical properties and remarkable bioactivity. Thermal spraying, and in particular Atmospheric Plasma Spraying (APS), has proven to be one of the most widely used processes for coating metallic prostheses. The technique is based on particle melting in a high-temperature plasma and their 'splash' on a cooler substrate surface, forming lamellae. However, even though plasma-sprayed ceramic films exhibit remarkable bioactivity, some undesirable characteristics related to adhesion, porosity, mechanical properties, or a possible reduction of bioactivity by dopants, remain present. Furthermore, due to the low radiopacity of ceramics upon X-ray exposure, medical imaging becomes more challenging on coated implants compared to uncoated implants, due to insufficient contrast for detection. In a previous study, in collaboration with *G. Clavijo Mejia et al.* from FunGlass institute in Slovakia, bioactive glass-based coatings were successfully elaborated by APS (**Figure 1**) **[1]**. Other studies with MSU-IIT in Philippines (*Rolando Candidato et al.*) are also on going to deposit bioactive ceramics on polymer substrates. The main objectives of this study are **(1)** to optimize the porosity/mechanical properties compromise of the ceramic coatings, and **(2)** to optimize the coating composition and structure in order to obtain the best bioactive and antibacterial behavior. Such a response is crucial to avoid bacterial proliferation in case of infection and ensure good ion release when in contact with physiological fluids. Acellular assays in Simulated Body Fluid (SBF) and cell medium will be performed. Biocompatibility and antibacterial tests will be conducted in parallel to the coating's optimization.

[1] E. Bussy, 'Analysis of the influence of Atmospheric Plasma Spraying (APS) parameters on the physical-chemical properties of radiopaque bioactive glass coatings', Master internship from Limoges University 2023, in collaboration with GA Clavijo Mejia and M. Michalek (FunGlass, Slovakia).