Bio-inspired antimicrobial coating for antibiofilm surfaces.	
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Biofilms are microbial communities embedded in a protective exopolymeric substances (EPS) and strongly adhered on a surface. They represent major concerns in human health and industries and their removal and eradication remains very hard. Current antibiofilm strategies rely on i) anti-adhesive coatings to prevent microorganisms anchorage, or ii) antimicrobial coatings which consist in functionalizing surfaces with agents that will degrade adhered microbial cells (Fig. 1). However, the perfect coating that would offer a long term and broad spectrum antibiofilm protection does not exist. To obtain such surface protection, coatings with controlled designs and physicochemical properties are needed.

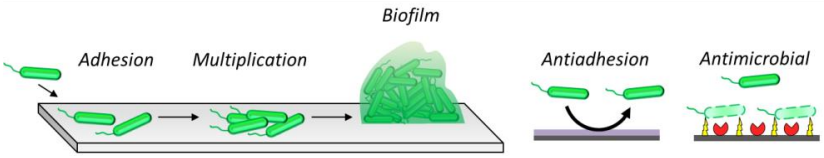

Figure 1: Main steps of biofilm formation and current antibiofilm strategies.

This PhD project will aim to design a new antimicrobial coating based on enzymatic activities for a broad spectrum, long term and renewable antimicrobial protection. Surfaces will be functionalized with antimicrobial enzymes through a reversible biomolecular ligand-receptor interaction (Fig. 2). The advantages of this strategy are that: i) enzymes can face succesive contaminations; ii) the ligand-receptor spacer will limit enzyme denaturation on the substrate; iii) the reversibility of ligand-receptor interaction will offer the unique possibility to renew the antimicrobial activity. The design of this coating will rely on a precise understanding and quantification of the physicochemical mechanisms governing molecular and cellular interactions at the interfaces. Therefore, a multidisciplinary approach based on interfaces chemistry combined to nanotechnologies and microbiology tools will be used. The obtained surfaces will be then exposed to different bacteria species to determine their capability to resist contamination at various spatiotemporal scales (single molecule to bacterial population; ms to h).

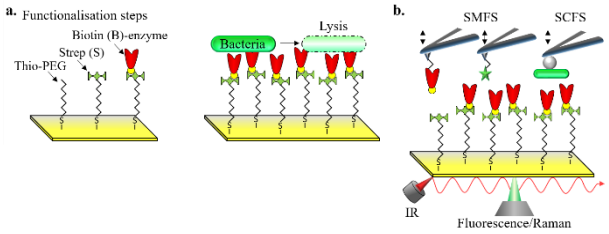

Figure 2 : a. Bacterial lysis and antibiofilm surface protection by enzymes grafted through the ligand-receptor interaction. b. Methods that will be combined for surface analysis: single-molecule and single-cell AFM, vibrational spectroscopy...

The PhD will take place in the CSI group of the LCPME lab, an environment that combines all the multidisciplinary competences needed for the project particularly for interfaces physicochemistry, atomic force microscopy (AFM) and vibrational spectroscopies. Various technics will be applied to precisely characterize the designed surfaces and their antimicrobial effects: infrared and Raman spectroscopies, fluorescence, AFM-based single-molecule and single-cell force spectroscopy and microbiology tests.

We are seeking for a highly motivated applicant with Master degree or engineer diploma in Chemistry or Physical Chemistry. Skills in AFM, vibrational spectroscopy and microbiology will be appreciated but are not mandatory. The candidate will have a strong interest in material sciences and skills to fit in an multidisciplinary lab.

Keywords: biofilm, interface, antimicrobial, enzymes, AFM, vibrational spectroscopies.