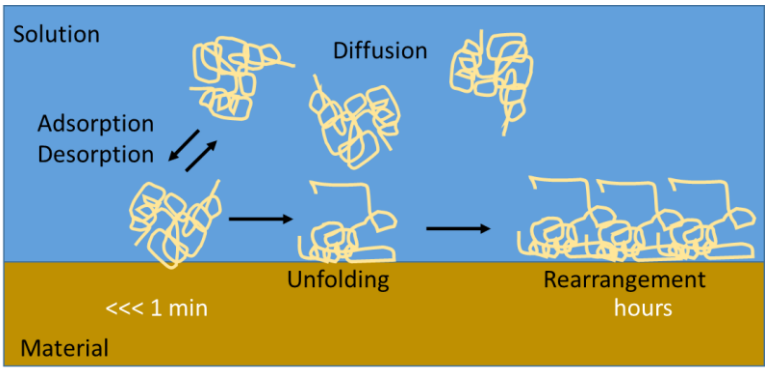
2023-2024 Internship proposal at LMGP Lab.

Protein adsorption on inorganic material surfaces

Abstract

Proteins are amphiphilic molecules that can adsorb non-specifically on numerous surfaces, leading to the establishment of an irreversibly bound protein layer.

In nature this binding capacity is exploited favorably by many organisms to allow strong and permanent anchoring of their bodies on materials (e.g. barnacles) or to fix structures, like spider webs, to surfaces. Bacteria secrete proteins and other molecules to establish biofilms on surfaces, a colonization method that confers them good protection against external stress factors.

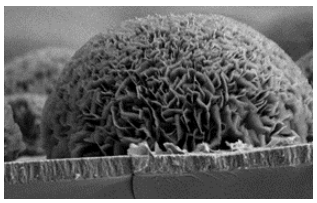


In the medical, environmental and food sector, the colonization (fouling) of surfaces by molecular and cellular adsorption causes numerous problems with wide ranging consequences. Infections caused by catheter colonization with harmful bacteria are an example of an important and recurrent health threat.

At LMGP, we are studying the molecular behavior of proteins at material surfaces in the context of different applications. We investigate the antifouling potential of TiO_2 microstructured thin films for the marine environment (ANR project CleanSea) and are investigating the barrier potential of ceramic thin films on cellulose for the packaging industry (collaboration CILKOA, https://cilkoa.com/).

Project description

In this project, we would like to analyse the adsorption behaviour of model proteins (BSA, Lysozyme, Streptavidin) on different inorganic material surfaces. The surfaces to be analyzed are thin films, that are synthesized at LMGP and CILKOA (see photos). The



TiO_2 microflowers are micrometric and have a large developed surface area due to the numerous nanometric petals. They are obtained by aerosol-assisted MOCVD deposition on glass at LMGP. CILKOA produces nanometric alumina deposits on cellulose fibers.

Left: TiO_2 microflower (courtesy L Deblock and C Poggi)
Right: Alumina thin film on cellulose (https://cilkoa.com/)

The quantification of the adsorbed protein mass is tricky because the amounts can be very small ($ng.cm^{-2}$). Therefore, it is necessary to work with materials that present well developed surface areas (nanometric petals or fibers) and to use techniques with adapted sensitivity. We propose to develop two experimental protocols to quantify protein adsorption:

- End-point quantification of the adsorbed protein mass by fluorescence using streptavidin and a biotin-Qdot conjugate
- Real-time quantification using Quartz crystal microbalance and model proteins (BSA, Lysozyme,…)

The project objectives are the following:

1- Using fluorescence sprectroscopy, develop and optimize a quantification protocol for surface-adsorbed streptavidin using a fluorescent biotin Qdot conjugate (calibration curve, sensitivity, dynamic range, etc). If necessary and when applicable, fluorescence microscopy can also be used.

2- Use the fluorescence assay to quantify the streptavidin mass adsorbed on TiO_2 and CILKOA surfaces

3- Using QCMd, investigate the adsorption/desorption behavior of model proteins (BSA) on quartz sensors coated with TiO_2 thin films and sensors coated with alumina-covered cellulose. The feasibility to deposit inorganic thin films on quartz sensors is currently being investigated.

Scientific environment:

The candidate will work within the LMGP, Materials and Physical Engineering Laboratory, in the IMBM team in collaboration with CILKOA (Frédéric Mercier).

Located in the heart of an exceptional scientific environment, the LMGP offers the applicant a rewarding place to work.

LMGP Web Site: http://www.lmgp.grenoble-inp.fr/

Profile & requested skills:

We look for a highly motivated student (M2 level) with a strong background in biophysics. Basic practical lab skills in protein biochemistry are required. The student should be able to work in a team, have excellent writing skills (reports, presentations…) and a good knowledge of spoken and written English.

Subject could be continued with a PhD thesis: NO funding secured so far

Allowance: Internship allowance will be provided

Duration: Feb-July 2024 (6 months); possibility to start during the winter semester (oct-jan) on a voluntary basis according to study plan

CONTACT : To apply please send a CV and motivation letter to Marianne WEIDENHAUPT , (marianne.weidenhaupt@grenoble-inp.fr) and to Frédéric MERCIER (frederic.mercier@cilkoa.com).