Addressing the spatial and temporal organization of nanoparticles in 3D biofilm structures: A multiscale physico-chemical approach.

Interdisciplinary Laboratory for Continental Environments (LIEC, CNRS-Lorraine University) – Nancy, France

---

The dissemination of pollutants originating from anthropic activities in the environment has modified the physico-chemical functioning of natural aquatic media. In the past decades, numerous studies have been devoted to the observation, understanding and prediction of the toxic impacts of new contaminants, such as nanoparticles (NP), on planktonic micro-organisms (bacteria) living in these environments. However, very few studies have examined so far the more realistic scenario where contaminants interact with living micro-organisms organized according to complex and cohesive 3D-biofilms structure. A requirement to quantitatively understand the mechanisms governing these interactions is the assessment of NPs distribution in the biofilms at various spatial and time scales.

This challenge constitutes the primary objective of the PhD project, at the frontiers between physical-chemistry and microbiology. More specifically, biofilms will be formed from bacterial strains with well-defined cell wall composition that can be tuned upon proper genetic constructions. The structure of the resulting biofilm, as well as the penetration of NPs over time, will be examined by confocal microscopy *via* proper fluorescent labeling of both the NPs and the micro-organisms constituting the biofilms. The detailed distribution of the NPs all across the 3-D structure will be correlated to their molecular interactions with individual bacteria, as measured by various functionalities of the atomic force microscopy (AFM). These results will be further complemented by measurements of the physical-chemical properties of NPs *via* characterization methods routinely employed in the laboratory (dynamic light scattering, electrokinetics). Various types of NPs will be considered in order to cover a large spectrum of colloidal features including size, electrostatic charge or hard/soft property. Finally, confocal measurements will be performed to track the distribution across the biofilm of dyes sensitive to *e.g.* cell membrane damages, to reveal the potential existence of sacrificial biofilm regions dedicated to block the transport and further invasion of NPs. It is expected that the above strategy will serve as a basis to interpret -mechanistically- the relationship

between biofilm structure and spatial distribution of NPs over time as a function of both the (bio)physical cell surface properties and the physico-chemical characteristics of the nanoparticles.

The PhD project will take place in the Interdisciplinary Laboratory for Continental Environments (LIEC, http://liec.univ-lorraine.fr/), in Nancy, France, under the supervision of J.F.L Duval, CNRS research director, I. Bihannic, CNRS research engineer and A. Beaussart, CNRS researcher. The work will involve a strong collaboration with microbiologists from the Genetics of Biofilms Laboratory of the Pasteur Institute, Paris. Candidate should have a strong background and/or expertise in physics or physical chemistry of colloids, surfaces and/or biointerfaces. Skills in microbiology will be appreciated but are not compulsory. The candidate should demonstrate scientific enthusiasm and motivation, curiosity and ability to integrate a research team. Good skills in English are required.

Contacts:

- J.F.L. Duval: Jerome.duval@univ-lorraine.fr, +33(0)3 83 59 62 63
  http://duvaljfl.webnode.fr/
- I. Bihannic: isabelle.bihannic@univ-lorraine.fr, +33(0)3 83 59 62 58
  http://bddc.liec.univ-lorraine.fr/cv/BIHANNIC%20I.htm
- A. Beaussart: Audrey.beaussart@univ-lorraine.fr, +33(0)3 83 59 62 92
  http://abeaussart.webnode.fr/