PhD Position Available

Assessing the molecular mechanisms behind nanoparticle toxicity towards microalgae: an approach by AFM and confocal micro-spectroscopy

Place: Laboratoire Interdisciplinaire des Environnements Continentaux (LIEC), UMR 7360, Vandœuvre-lès-Nancy

https://liec.univ-lorraine.fr/

Starting date: September 1st, 2020.

Supervisors:

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Summary of the thesis project:

The exponential increase of nanoparticles (NPs) like Quantum Dots (QDs) in industrial production entails their discharge in the environment where their behaviour, fate and effect on the different biological organization levels remain potentially hazardous. In aquatic ecosystems, microalgae lie at the lowest trophic level and constitute the basis for food chains. They are largely employed in various industrial processes such as aquaculture, human nutrition, animal feed, biofuel and they can also be beneficial for remediation of wastewaters. Considering their well-documented sensitivity to environmental pollution, their short growth period and their ease to be cultivated, green algae have served as suitable models to evaluate the toxicity of fresh water contaminants [1]. Algae deploy an arsenal of defence strategies against NP stress, which includes the activation of their oxidative defence systems to eliminate ROS, the production of surface biomolecules that form a protective layer, and the intracellular transformation of contaminants [2]. Despite increasing knowledge in the field, a detailed understanding of the microalgae/NPs interaction mechanisms and of the associated biological response would benefit from methodologies enabling the determination of physico-chemical and biological proxys relating toxicity at the molecular and cellular levels and homeostasis of the exposed microalgae.

The main objective of this PhD thesis is to decipher the toxicity mechanisms of QDs with controlled composition and size, on microalgae using novel molecular and cellular approaches based on photonic and atomic force microscopies. More specifically, the influence of QDs on algal cell wall structures, metabolism and photosynthesis will be identified in conjunction to QDs partitioning in the intracellular space and at the microalgae/solution interface. A particular attention will be given to the relationships between physico-chemical features of the QDs, their bio-partitioning over time, and different toxicity parameters, may the latter be structural, physiological or linked to the photosynthesis yield.

To this end, atomic force microscopy (AFM) and confocal microscopy will be used, in order to address, *in fine*, the mechanisms controlling QDs toxicity and their detrimental implications on the microalgal surface and on key intracellular compartments.

This PhD project, at the interface between physical chemistry and microbiology, follows recent results obtained by our team with use of original methodologies to apprehend NPs/microorganisms interactions from the solution scale [3] to the single NP scale [4,5]. The project will benefit from the last developments in AFM (multiparametric imaging, single-molecule force spectroscopy with functionalized tips), and from confocal micro-spectroscopy, *via* the photonic platform, unique in France, recently installed in our lab.

Required knowledge and application

It is expected that the candidate has a solid experience in photonic microscopy and/or AFM. Applications of candidates with a strong background in instrumentation will be further considered. Knowledge in microbiology is not a prerequisite, knowledge in physical chemistry of surfaces, interfaces or biointerfaces is an advantage.

To apply, send an email to jerome.duval@univ-lorraine; isabelle.bihannic@univ-lorraine.fr and audrey.beaussart@univ-lorraine.fr including:

- a curriculum vitae,

- a recommendation letter,

- a copy of the results obtained in the Master's degree or Engineering School,

- a copy of the last internship report.

[1] F. Wang, W. Guan , L. Xu, Z. Ding , H. Ma, A. Ma and N. Terry, Applied Science, 2019, 9(8), 1534.
[2] F. Chen, Z. Xiao, L. Yue, J. Wang, Y. Feng, X. Zhu, Z. Wang and B. Xing, Environmental Science: Nano, 2019, 6, 1026.
[3] E. Vouriot, I. Bihannic, A. Beaussart, Y. Waldvogel, A. Razafitianamaharavo, T. Ribeiro, J.P.S. Farinha, C. Beloin and J.F.L. Duval, Environmental Chemistry, 2019, 10.1071/EN19190.
[4] A. Beaussart, C. Caillet, I. Bihannic, R. Zimmermann and J.F.L. Duval, Nanoscale, 2018, 10, 3181.
[5] A. Beaussart, C. Beloin, J-M Ghigo, M-P Chapot-Chartier, S. Kulakauskas and J.F.L. Duval, Nanoscale, 2018, 10, 12743.