

Plastic big Brother: Towards a continuous monitoring and quantitative analyses of microbial plastic degradation

Plastic pollution is one of the major social issues affecting many environments and human health. Over the past twenty years, a great deal of multidisciplinary research has been aimed at combating this plague and developing new materials that are easily degradable or reusable. Here we would like to focus on the microscopic mechanisms of biodegradation in the marine environment of bio-sourced polymers with highly interesting commercial properties: the polyhydroxyalkanoates (PHA). PHA are a family of polymers, synthesized by bacteria, archaea or fungi, and whose characteristics depend of the carbon source used by the microorganism. In the environment, the most semi-crystalline PHAs are more rapidly biodegradable than those with amorphous structures [Derippe et al. 2023], which is not in line with the literature [Zhang et al. 2021]. Recently V. Barbe, S. Bruzaud and collaborators have shown the ability of the marine strain *Alteromonas plasticoclasticus* MED1 to use some specific PHA copolymers as sole carbon source and further analyses of its genome revealed that a secreted enzyme (called depolymerase) is involved in the first step of PHA depolymerization [Barbe et al. 2024].

To the best of our knowledge, there are few experimental approaches for **continuously monitoring *in situ*** the progressive **degradation** of plastics coupled with **bacterial** action [Ali et al. 2021] and little is known about the bacterial spatial development correlated with the local **surface erosion**. By optical technics, we would like to monitor the microbial surfaces colonization and biofilm formation on the one hand, and surface erosion and deep degradation (if any) of plastics on the other. Classical phase contrast microscopy will be used to visualize early bacteria colonizing the plastic surface [Lherbette et al. 2021] while **birefringence signals** will be recorded to follow polymer crystallites over time. Preliminary studies, that include polymer films preparation and characterization, show promising results. All the data collected could be used for modeling surface and bulk erosion, based on previous theoretical work on biodegradable polymer matrices [von Burkersroda et al. 2002].

The **multidisciplinary** project aims to characterize in more details how bacteria invade and erode a semi-crystalline and more amorphous polymeric surface and how different the degradation is from an abiotic medium which just contains soluble extracted depolymerases.

The intern will take part in a collaborative research project, conducted by Valérie Barbe (microbiologist, vbarbe@genoscope.cns.fr) from Génomique Métabolique (UMR8030), CEA-Genoscope Evry with Eric Raspaud (biophysicist, eric.raspaud@universite-paris-saclay.fr) from Laboratoire de Physique des Solides, Paris-Saclay University, and with Stéphane Bruzaud (polymer chemist, stephane.bruzaud@univ-ubs.fr) from the University of South Brittany. At the LPS laboratory, She or He will basically produce PHAs with different crystallization rates, culture *A. plasticoclasticus* MED1 and monitor biodegradation. Other research activities will depend on the intern's skill and motivation.

The intern will benefit from PHAEMM (PHA enzymes monitoring Microscopy) funding, a Biosphera-LSH seed funding program managed by Valérie Barbe. We are looking for a student who enjoys **challenges** and is interested by **interdisciplinary fields**. This internship will help the master student begin the project and potentially candidate to the Ecole Doctorale (ED 2MIB) funding. The PhD student will be co-supervised by the three partners; depending on the results, additional experiments in a sea-side laboratory may be planned.

References

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