INRAE UR1268 BIA – BIBS
✉ 3, Impasse Yvette Cauchois
F-44316 Nantes France
https://www.bibs.inrae.fr

Postdoctoral researcher in multimodal and multiscale imaging
to identify markers of biomass properties and reactivity in bioconversion

Keywords: correlative imaging, mass spectrometry, vibrational spectroscopies, AFM, plant biomass

A 24-m fully funded postdoctoral position in the field of multimodal imaging of plant biomass in a context of bioconversion is available at the BIA-BIBS lab, embedded in the INRAE institute in Nantes, France.

JOB DESCRIPTION

In a context of fossil fuel reduction and transition to a circular bioeconomy, converting biomass into biobased products is a major challenge. One avenue of research is the production of biofuels by converting lignocellulosic biomass from agricultural waste (e.g., grass stems). However, many of the mechanisms involved in the conversion of lignocellulosic biomass are still poorly understood. A key issue is the detailed structural characterization of this biomass and the structural parameters that determine its processing capacity. This knowledge is essential to guide and optimize conversion processes towards products with specific properties, and to achieve higher yields.

The postdoctoral work falls within the framework of a PEPR-type programme funded by the French ANR agency (B-Best program, FillingGaps sub-project 2023-2026), which aims to identify relevant markers of biomass properties and reactivity for bioconversion.
(https://www.pepr-bioproductions.fr/projets-finances/caracterisation-de-la-biomasse/fillinggaps)

Our hypothesis is that the fusion of chemical, structural and mechanical information obtained at several relevant scales by different imaging methods will provide new insights into biomass reactivity. For this, we want to setup an unprecedented coupling of **MALDI mass spectrometry imaging** (MALDI-MSI), **vibrational Raman spectrometry** and **atomic force microscopy (AFM)**. The first method will enable us to visualize - through the detection of degradation products - the deconstruction of biomass *in situ*, at tissue level. The second will provide localized information on the main polymer families in the tissue, depending on the degradation observed. AFM will provide information on local mechanical forces. Overall, we believe that the new information provided by correlating these three methods will contribute to "fill the gaps" in the knowledge of biomass structure, and help understand its quality and performance in biotransformation.

The challenge is to implement all three methods on a single object. **Your contribution will be to carry out this novel implementation and collect images from several biomasses to be worked on in the project** (maize and poplar stalks, but also marine biomass).
You will work in collaboration with two other post-doctoral fellows, who will be recruited as part of the project. One will deploy magnetic resonance imaging (µMRI) in order to have a view of water distribution at the tissue scale; the second will work on methods allowing all image modalities to be merged in order to provide an integrative vision of the complementary information they convey.

You will present your results at leading international conferences in mass spectrometry and/or microscopy and/or plant spectroscopy, and will publish in peer review journals.
Your work will be co-supervised by Dr. Angelina D'Orlando and Dr. Helene Rogniaux. The anticipated start date is May 2., 2024, but reasonable accommodations can be made for the right candidate.

Related publications of the group:

1. Fanuel, M.; Grélard, F.; Foucat, L.; Alvarado, C.; Arnaud, B.; Chateigner-Boutin, A.-L.; Saulnier, L.; Legland, D.; Rogniaux, H. Spatial Correlation of Water Distribution and Fine Structure of Arabinoxylans in the Developing Wheat Grain. Carbohydrate Polymers 2022, 294, 119738. https://doi.org/10.1016/j.carbpol.2022.119738.
2. Grelard, F.; Legland, D.; Fanuel, M.; Arnaud, B.; Foucat, L.; Rogniaux, H. Esmraldi: Efficient Methods for the Fusion of Mass Spectrometry and Magnetic Resonance Images. BMC Bioinformatics 2021, 22 (1), 56. https://doi.org/10.1186/s12859-020-03954-z.
3. Arnaud, B.; Durand, S.; Fanuel, M.; Guillon, F.; Mechin, V.; Rogniaux, H. Imaging Study by Mass Spectrometry of the Spatial Variation of Cellulose and Hemicellulose Structures in Corn Stalks. J. Agric. Food Chem. 2020, 68 (13), 4042–4050. https://doi.org/10.1021/acs.jafc.9b07579.

4. Fanuel, M.; Ropartz, D.; Guillon, F.; Saulnier, L.; Rogniaux, H. Distribution of Cell Wall Hemicelluloses in the Wheat Grain Endosperm: A 3D Perspective. Planta 2018, 248 (6), 1505–1513. https://doi.org/10.1007/s00425-018-2980-0.
5. Reynoud, N.; Geneix, N.; D'Orlando, A.; Petit, J.; Mathurin, J.; Deniset-Besseau, A.; Marion, D; Rothan, c.; Lahaye, M.; Bakan, B.: Cuticle architecture and mechanical properties: a functional relationship delineated through correlated multimodal imaging. New Phytologist, 2023, 238(5), 2033-2046. https://doi.org/10.1093/plphys/kiac392
6. Le Bris, P.; Wang, Y.; Barbereau, C.; Antelme, S.; Cézard, L.; Legée, F.; D'Orlando, A.; Dalmais, M.; Bendahmane, A.; Schuetz, M.; Samuels, L.; Lapierre, C.; Sibout, R. : (2019). Inactivation of LACCASE8 and LACCASE5 genes in Brachypodium distachyon leads to severe decrease in lignin content and high increase in saccharification yield without impacting plant integrity. *Biotechnology for biofuels*, *12*(1), 1-11. https://doi.org/10.1186/s13068-019-1525-5
7. Durand, S.; D'Orlando, A.; Mougnard, L.; Bourmaud, A.; Beaugrand, J.: Combining infrared and Raman spectra to assess MDI localization in novel flax-reinforced automotive composites. Composites Part C: Open Access, 2023, 12, 100382. https://doi.org/10.1016/j.jcomc.2023.100382

DESIRED SKILLS AND QUALIFICATIONS

Required:

- A PhD degree in Biology, Chemistry or Physical-Chemistry;
- Lab experience with at least one of the imaging methods to be deployed: mass spectrometry imaging *and/or* vibrational spectrometry (Raman, infrared) *and/or* atomic force microscopy;
- A publishing record with at least one first-author publication;
- Proficiency in English;
- Capacity to quickly acquire new knowledge and master new skills;
- Interest in both hands-on research activities and data analysis;
- Ability to work independently and as a member of a research team;

Preferred:

- Knowledge of plant structures and their preparation for imaging purposes

EMPLOYER

INRAE (www.inrae.fr)
INRAE is a world-leading institute for research on agriculture, food and the environment, with a responsibility to address the global challenges of our time, namely climate change, food insecurity and biodiversity loss. Through an integrated approach, INRAE is able to identify and develop solutions with multiple applications to achieve the agro-ecological, nutritional and energy transitions we need to make.

INRAE is committed to nurturing an inclusive culture and a welcoming atmosphere. The Institute has made the "Social and Environmental Responsibility" a collective priority, in line with its commitment to sustainable development. This strategy should lead the Institute's research and internal practices to converge with ambitious values of environmental responsibility, solidarity and equity.

CONDITIONS OF EMPLOYMENT

Contract: 24-month.
The pay is commensurate with experience and ranges from 2,815 to 3,066 EUR per month.

By joining us, you will benefit from:

- 30 + 15 days of annual leave (for full-time employees, meaning 38.5h/week);
- Support for parenthood;
- Skills development programmes;
- Social support, holiday and leisure services;
- Sport and cultural activities.

APPLICATION PROCEDURE

Interested candidates are invited to submit a cover letter, an up-to-date CV and the contact details of at least one reference to angelina.dorlando@inrae.fr and helene.rogniaux@inrae.fr
Deadline for application: March 1, 2024
Contract start date: May 2, 2024 (Adjustable depending on availability of the selected candidate)