UPWEARS-NuM

PhD thesis proposal:
Development of digital tools for sustainable textile process & products

1. Background and main scientific questions

The clothing industry is a major contributor to environmental pollution due to issues like dyes, microplastics, poor recycling, and the transportation impacts. In response to this, the European project UPWEARS, which involves 15 international partners, aims to produce prototypes of recyclable smart clothing with limited environmental impact.
One of the primary goals of UPWEARS is to develop digital framework for predicting sustainable European e-textile process outcome and product performance. This objective involves biosourced matrices and composites evaluation, digital twin & cyber physics models, finite element (FE) computations, topology optimisation, and additive manufacturing process simulation.

The main scientific questions are

- How can artificial intelligence and cyber-physical systems be integrated into a numerical framework to optimize composite and e-textile processing for achieving zero-defect products, with respect to performance and durability criteria?
- What are the most effective methods for implementing sensors to proactively control the transformation of biosourced materials in e-textiles, and how do these methods affect overall process optimization?
- How does the variability of biosourced materials influence the multi-scale mechanical behaviour of e-textiles, and how can finite element computations be used to predict and enhance the performance of e-textiles and composites?

The PhD candidate will work in close collaboration with RISE.

2. Main missions

The main tasks are:
— Developing a numerical framework including artificial intelligence and cyber physics for composite and e-textile processing to reach zero-defect products according to performance and durability criteria;
— Contributing to sensor implementation for proactive action on processes to control biosourced material transformation in e-textile;
— Implementing multi-scale and multi-physics finite element computations to predict the performance of e-textiles at different length scales;
— Gaining a deeper understanding of the variability effect of biosourced martials in the behaviour of e-textiles and composites to maximise their performance through predictive approach;
— Optimising control of large-scale AM of recovered polymers from e-textiles using process simulation with respect to energy consumption and part quality. Such optimisation will involve sequential thermal-stress analyses;

— Participating in the consortium meetings, dissemination activities (scientific publications, workshops, science or public fairs, first-hand demonstrators,), and communications towards partners, scientific community, and stakeholders.

3. Environment

By joining INRAE, the PhD candidate will benefit from excellent working conditions facilitated by the Institute's outstanding premises and facilities, cutting-edge technological equipment, and robust social support system, including, health initiatives and opportunities for sports and cultural activities.

The PhD project will be conducted within the multidisciplinary Plant cell wall and polymer (PVPP) team at INRAE-BIA, comprising 15 permanent scientists and technicians. INRAE BIA provides access to all the necessary equipment and methodologies for the study, supported by high performance computation facility. Additionally, long-term visits to RISE in Gothenburg are planned to enhance the research capabilities of the project.

4. Candidate background

We are looking for a highly motivated PhD candidate to work in an international environment with partners in Sweden, Italy, Portugal, Belgium, UK and New Zeeland.

The candidate would preferably possess a strong background in numerical modelling and/or engineering process simulation with an additional expertise in material/mechanical science being advantageous.

In addition, knowledge of textiles, natural fibres and testing techniques dedicated to mechanical, thermal, transfer analysis, as well as large instruments will be much appreciated.

Potential Supervisors: Sofiane Guessasma (INRAE), Mohammad Rouhi (RISE), Erik Marklund (RISE)

Duration: 36 months starting from December 2024

Funding: INRAE/Regional council fully funded position available for qualified candidate.