PhD OFFER

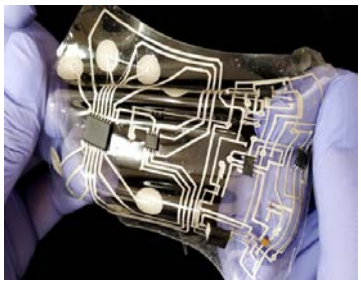
Design and Formulation of Sustainable Functional Inks for Stretchable Printed Materials in Smart Textiles

Location of PhD project:
Laboratory : LGP2 Laboratory – *Laboratory of process engineering for biorefinery, bio-based materials and functional printing – MatBio and FunPrint ResearchTeam*
461 rue de la Papeterie - Domaine Universitaire - 38 400 St Martin d'Hères (Grenoble, France)
https://lgp2.grenoble-inp.fr/en

Duration of the Thesis: 36 months from December 2026

PhD Supervisors: Aurore Denneulin (LGP2) – Nadege Reverdy-Bruas (LGP2)

Background and objectives of the project:



The development of smart textiles and wearable electronic systems offers new opportunities for continuous health monitoring and biomechanical assessment under real-life conditions. However, the integration of electronic functionalities into flexible textile platforms remains challenging, particularly in terms of electrical performance, mechanical compliance, durability and environmental sustainability. Conventional printed electronics often rely on silver-based conductive inks and petroleum-derived polymer matrices, while the resulting multilayer structures may exhibit limited stretchability, poor resistance to repeated deformation and washing, and insufficient recyclability.

The European project SHEMOVES (Smart Health Monitoring and Optimized Validation for Ergonomics in Women's Sports) aims to develop a new generation of sustainable, flexible and stretchable smart textile systems for monitoring physiological and biomechanical parameters during cycling, with a particular focus on women's health and ergonomics. Within this project, the development of innovative advanced materials is essential to ensure reliable sensing performance while meeting the mechanical and environmental requirements of wearable applications. Sustainable conductive inks, functional coatings and flexible transfer substrates must combine suitable electrical properties with controlled rheology, good printability, strong interfacial adhesion and stability under mechanical deformation and environmental exposure.The use of bio-based polymer matrices, including nanocellulose and cellulose derivatives, together with conductive fillers such as carbon-based nanomaterials and copper, offers promising opportunities to develop functional materials with a reduced reliance on critical raw materials. However, controlling filler dispersion, ink rheology, film formation and ink–substrate interactions remains a major challenge in achieving reproducible printing processes and reliable functional performance.

The objective of this PhD project is to develop sustainable functional inks and printed material systems for stretchable electronics integrated into smart textiles. The research will investigate the relationships between formulation, material structure, printing processes and the electrical and mechanical properties of printed layers. Particular attention will be paid to the development of bio-based formulations, the optimisation of printing and coating processes, and the design of material interfaces to improve adhesion, flexibility and durability. The compatibility of the developed materials with reusable and potentially recyclable transfer substrates will also be investigated.

The PhD will be conducted within the European SHEMOVES project, in collaboration with partners working on functional materials, flexible sensors, textile integration and wearable systems. The research will contribute to the development of sustainable printed materials suitable for integration into smart textile demonstrators.

Main activities:

The scientific program for the PhD is organized in 4 main tasks:

WP0 – Literature review and scientific monitoring

Conduct an in-depth literature review on sustainable functional inks, bio-based polymer matrices, conductive fillers, stretchable printed electronics and smart textile applications. Analyse current challenges related to ink formulation, rheology, printing processes, mechanical stability and recyclability.

WP1 – Development and formulation of sustainable functional inks (LGP2)

Develop functional ink formulations based on bio-based polymer matrices, including nanocellulose and cellulose derivatives, incorporating conductive fillers such as graphene, carbon nanotubes, carbon black and copper-based materials. Investigate the influence of formulation parameters, filler content, dispersion quality and matrix composition on rheological behaviour, electrical conductivity and mechanical properties. Optimise ink stability and printability for different deposition techniques.

WP2 – Printing processes, substrate compatibility and characterisation of printed materials (LGP2)

Investigate printing and coating processes, including screen printing and flexographic printing, to produce functional layers on flexible and stretchable substrates. Study the influence of printing parameters, drying conditions and substrate surface properties on layer morphology, uniformity, adhesion and electrical performance. Characterize the printed materials regarding the rheological, electrical, morphological, surface and mechanical aspects. Explore different substrate and substrate pretreatments and interfacial strategies to improve ink–substrate compatibility (and support the development of flexible transfer systems).

WP3 – Optimisation of material performance, durability and textile integration (LGP2 and SHEMOVES partners)

Optimise the most promising formulations and printing conditions based on their functional performance and compatibility with wearable applications. Investigate the stability of printed layers under mechanical deformation, cyclic loading and relevant environmental conditions, including exposure to perspiration and repeated washing. Analyse the relationships between formulation, processing, adhesion and performance. Contribute to the selection and validation of sustainable printed materials for integration into the SHEMOVES smart textile platform, considering durability, reusability and end-of-life considerations.

Required skills:

A taste for multidisciplinary research, together with strong motivation and scientific curiosity, will be important selection criteria.

The expected skills for the candidate are:

- Autonomy, rigour and a strong capacity for experimental work.
- Interest in both fundamental and applied research.
- Strong inclination for materials formulation, experimental characterisation and data analysis.
- Knowledge of materials science, polymer science or colloidal systems.
- Interest in sustainable materials, functional inks and printed electronics.
- Knowledge of rheology, dispersion and formulation characterisation techniques.
- Experience with printing, coating or deposition processes would be an advantage.
- Fluency in English, both written and spoken.

Previous formation, diplomas:

Master's Degree

Graduate Engineering Degree (*Diplôme d'Ingénieur*)

Research internship

For any further information and to apply for this offer, please send a CV with a cover letter to
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