Pearl Programme for EArly-stage Researchers in Lille

Title of the thesis	FLexible fabric-based fIre Retardant BATteries for applications in smart TEXtiles
Acronym	FLIRBATTEX
Reference number	005

Hosting institution	**Employer**
To be defined (Univ. Lille or Centrale Lille) Website: https://www.univ-lille.fr/home/	ENSAIT Website: http://en.ensait.fr/
Hosting research unit 1	**Hosting research unit 2**
Name: Laboratoire de recherche textile Acronym: GEMTEX Identification number: EA 2461 Address: ENSAIT 2 allée Louise et Victor Champier BP 30329 59056 ROUBAIX CEDEX 1 – FRANCE Website: http://www.gemtex.fr/	Name: Unité Matériaux Et Transformations Acronym: UMET Identification number: UMR 8207 Address: Université de Lille Cité scientifique Bâtiment C6 59655 Villeneuve d'Ascq Website: http://umet.univ-lille1.fr/
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Thesis information

Keywords	flexible battery, smart textile, self-stratifying coating, fire retardancy, hydrophobicity
Abstract	A three year PhD position is available from September 2021 at the Ecole Nationale des Arts et Industries Textiles (ENSAIT), located in Roubaix, France. The project entitled "*Flexible fabric-based fire retardant batteries for applications in smart textiles*" is a joint-PhD degree between 2 Universities (Centrale Lille Institute and UCLouvain) and involves three Laboratories: GEMTEX@ENSAIT (http://www.gemtex.fr/), UMET@Université de Lille (http://umet.univ-lille1.fr/) and IMCN@UCLouvain (https://uclouvain.be/en/research-institutes/imcn) as well as a Belgian company (ABEE, Avesta Battery and Energy Engineering). The PhD student will be involved in the Graduate Programme "Information and Knowledge Society" and also associated with the Graduate Programme "Science for a Changing Planet". Wearable electronic devices are a rapidly growing consumer market and can be considered in military and civilian applications. Smart textiles have the advantages of flexibility and can be an integral part of clothing. Further integration can be achieved by developing a power source that is also part of the fabric. The main challenges with integrating lithium-ion batteries (LIBs) into smart textiles are their sensitivity to air and water and the danger of flammable solvents required for their operation. Increased attention should be placed on batteries that are flexible and can be directly

	integrated in the textile without rigid casing and that do not present safety issues such as fire hazards. In this project, we propose to design flexible textile-based batteries with improved safety using LIB materials with gel electrolytes. These batteries aim at being integrated in smart textiles to provide a power supply to different embedded sensors and computational modules. Two original concepts will be investigated: - **Integration of the textile as an active element of the battery:** textile will play the structural roles of either the separator or the current collector. A three-layer design will be considered. The middle layer will be constituted of electrically insulating textile and the two outer electrically conductive textiles will be used as a scaffold for the synthesis of either the cathode or the anode of the textile battery. - **Utilization of self-stratifying coatings as precursors of electrodes and fire-retardant/water-repellent sealing layers:** a self-stratifying strategy that will lead during curing to two distinct layers will be used during the preparation of the cathode and anode. The bottom layer will impregnate the electrically conducting textile and will contain an ionically-conducting network as well as either anode or cathode electrode particles and conducting carbon species. The top layer will show fire-retardant and waterproof properties, allowing efficient protection of the electrode materials and preventing further casing.
Expected profile of the candidate	Highly motivated candidates with an academic degree at the Masters level in materials science, chemistry and/or chemical engineering are invited to apply for this position. Candidates should have a real interest for experimental science and must show teamwork and organizational skills as well as a sense of initiative. Previous experience in textile design, batteries and/or surface treatments will be considered strong assets. The knowledge of English is mandatory. Spoken and written French is an asset. Open communication, reporting and presentations skills will be necessary to succeed.
Application procedure & Eligibility criteria	The application procedure and eligibility criteria are detailed on the European doctoral programme PEARL website www.pearl-phd-lille.eu. The funding is managed by the I-SITE ULNE foundation which is a partnership foundation between the University of Lille, Engineering schools, research organisms, the Institut Pasteur de Lille and the University hospital. The application file will have to be submitted before March 31, 2021 (10:00 AM - Paris Time) and emailed to the following address : international@isite-ulne.fr.
Net salary and Lump Sum	A net salary of about €1,600 + €530 per month to cover mobility, travel and family costs.