



## **Study and development of a flexible and multilayer charger integrated into textiles for the powering of wearable objects**

The Flexible Electronics Department (FEL) in Gardanne is part of the Provence Microelectronics Centre (CMP), one of the five research centres of the Ecole des Mines de Saint-Etienne, itself a School of the Institut Mine Telecom. Its skills include flexible and stretch electronics, heterogeneous integration, energy harvesting and flexible batteries. The department's research is motivated by developing autonomous and communicating electronic systems for the design of sensitive interfaces, electronic skin, medical devices, etc.

The measurement of physiological parameters is useful during training, to improve performance, or in intervention. For this, it is important that the elements necessary for this monitoring have the finest possible textile integration, to adapt as well as possible to the differences in morphology, particularly between men and women, while being imperceptible, so as not to reduce the freedom of movement or to distract the wearer. However, it is necessary to have a power supply for these systems, most often by battery, in rigid modules. These energy sources must be changed or charged regularly, otherwise it will be impossible to use the electronic functions implemented in the textile. This therefore poses a major problem if access to a recharging point is limited or an ecological problem if non-rechargeable batteries are used. In-situ power generation is generally carried out using photovoltaic panels, which have the disadvantage of only operating during the day, in the open air, and in clear weather conditions.

The objective of this project is to develop a flexible autonomous power supply system integrated into the textile, in order to supply low consumption systems, of the order of a few mW in instantaneous, such as long term physiological monitoring. This autonomous system will be composed of a fabric based on tribogenerator textile yarns with its own flexible electronics for passive charging and energy storage.

FEL departement is currently hiring a post-doctoral student to start on the 1<sup>st</sup> of February 2021.

### **Projects:**

#### State of the art on electronic integration technologies in textiles

The first mission will be to establish the state of the art on the latest research done on the integration of electronic functions within textiles. Through this study, it will be important to highlight the limitations of physical interconnections for their use in highly strainable circuits, as well as the impact of deformations on the efficiency of coupling between coils. The latter being used as a transformer in the final charger.

It will also be necessary to establish the latest developments in wireless interconnection based on the use of radio frequencies.

Finally, the conclusion of this bibliographical study should lead to a choice of development of one or more technological building blocks.

#### Charger study and development

The objective is to create a passive charger between a triboelectric generator and a flexible battery. The whole system must be able to be integrated into a garment.

A first study will focus on the charger's transformer. The latter is composed of primary and secondary coils whose inductive coupling will be the key to the efficiency of the charger. Eventually the system will be realized

on ultra flexible substrates. It is initially necessary to evaluate the impact of coil deformation on their coupling and thus the final efficiency of the transformer. To do this, it will be necessary to combine an experimental approach with the characterization of the two coils under calibrated mechanical tests with finite element simulations of the devices.

Finally, this transformer will have to be integrated in the whole charger on flexible substrate. Its integration in the garment and its coupling with the generator and the battery will constitute the last part of this work with the aim of making a complete final demonstrator.

### Skills and Qualifications:

- A thesis degree with a background in physics and/or microelectronics.
- Understanding of the mechanisms involved in inductive phenomena
- Good knowledge of embedded systems.

The candidate will have qualities of autonomy, and will show curiosity and taste for prototyping, in the "maker" culture. He/she will show communication and exchange skills with the different actors.

### Contacts:

To apply, please send curriculum vitae and reference letter to :

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