

## **M1 (or equivalent) internship offer: Recycling of electronic devices printed on paper substrate - Development of an efficient silver recovery method based on hydrometallurgical approach**

### **Internship context:**

This internship offer is part of ANR REVeBIO project including four French academic partners namely: LGP2 (Grenoble), LEPMI (Grenoble), ISCR – ENSCR (Rennes) and RAPSODEE (Albi). The project is focused on the “End-of-life of electronic devices printed on cellulosic substrates”, with a special focus on “Recycling and valorization of biosourced materials and functional inks”. The REVeBIO project aims to address the following scientific and technical challenges:

1. To adapt the conventional separation processes used for graphic paper recycling to this new material.
2. To develop a battery of analyses in order to fully characterize the fractions originating from the separation process (fibrous fraction, a solid mineral reject and a liquid reject containing soluble materials) and to monitor the fate of value-added products.
3. To extract efficiently the metals (namely silver) from the generated waste stream.
4. To produce new eco-sorbents (biochars) made from REVeBIO process waste for the treatment of refractory molecules dissolved in waste waters.
5. To develop new eco-absorbent materials from REVeBIO waste fractions for the elimination of liquid and gaseous pollutants emitted by the pulp and paper industry.

### **Internship description:**

A complete pathway for silver recovery from printed prototypes has been recently developed in LEPMI laboratory in collaboration with LGP2 laboratory. This pathway is based on leaching of the reject fraction generated during the cyclonic separation of cellulosic fibers and Ag inks and mineral fillers. The leaching step is followed by Ag microparticles synthesis. This synthesis is based on several precipitation, purification and reduction steps. Depending on the applied experimental conditions different morphologies and granulometry of synthesized Ag particles may be obtained.

Based on the LEPMI's recent work, the candidate will focus on the optimization of the whole recovery process. The efficiencies of each individual separation step should be determined together with determination of the global efficiency of the process. The mass balance of each operation should also be established. Obviously, thorough characterizations of the solid samples (XRD, SEM, XRF, ATG, etc.) will be systematically carried out in parallel.

The internship will therefore involve successive stages:

- 1) Literature review of recent advances on silver recycling from various matrixes.
- 2) Optimization of the silver particles synthesis from the solid reject fraction (based on recent work carried out in the laboratory). In particular, high global efficiency of the recovery process will be

targeted together with well controlled morphology and narrow particle size distribution of the synthesized particles.

3) Determination of the composition of all generated solid and liquid samples using various available analytical techniques (AAS, ICP-MS, XRD, SEM, XRF, TGA, etc.) in order to guarantee their full characterization, to assess their quality and determine the mass balances and the corresponding efficiencies.

### **Internship location:**

The candidate will work under the supervision of L. SVECOVA and M. LUPSEA, specialized in recycling processes development. The research work will be performed at Electrochemistry and Physical Chemistry of Materials and Interfaces Laboratory (LEPMI, <https://lepmi.grenoble-inp.fr/>) located at Grenoble University Campus (Saint Martin d'Hères). Interactions with the consortium members, namely N. REVERDY-BRUAS and N. MARLIN (Laboratory of Process Engineering for Biorefinery, Bio-based Materials and Functional Printing - UMR 5518, Grenoble INP-UGA, <https://lqp2.grenoble-inp.fr/en>), experts respectively in printed electronics and recycling processes will be organized regularly.

**The internship will start in April 2025 for a duration of 3 to 4 months.**

### **Skills to acquire and/or develop:**

The candidate should be in master 1 - or equivalent - and have a solid knowledge in inorganic chemistry, organic chemistry, solution chemistry, analytical chemistry and unit operations. The candidate should have a strong aptitude for experimental work and be able to work independently. Solid writing skills will also be required.

During the internship, the candidate will develop the knowledge of:

- Analytical chemistry applied to complex matrices,
- Analysis of metallic solutions using atomic absorption spectroscopy and inductively coupled plasma mass spectrometry techniques,
- Synthesis of metallic particles of controlled size,
- Mass balance calculations.

### **How to apply?**

Send your CV, motivation letter and master transcript (marks) to:

Lenka SVECOVA → [lenka.svecova@grenoble-inp.fr](mailto:lenka.svecova@grenoble-inp.fr)

Marie LUPSEA → [maria.lupsea@grenoble-inp.fr](mailto:maria.lupsea@grenoble-inp.fr)

**The deadline to apply is 29/02/2025**