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Ph.D. thesis (2023-2026)
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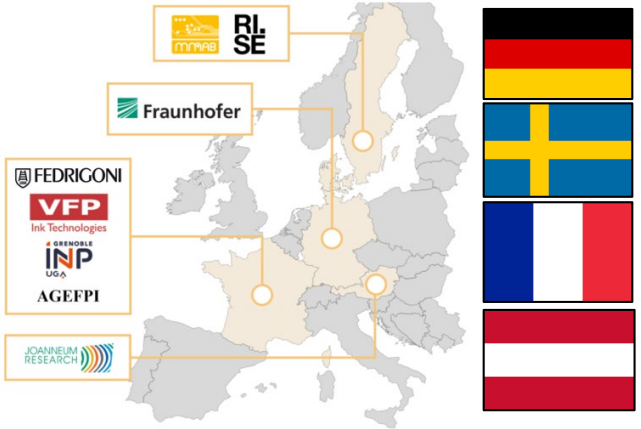
Recycling of multilayered electronic devices printed on cellulosic substrates

Etude de le recyclabilité de modèles complexes d'électronique imprimée sur papier par adaptation de lignes de recyclage papier existantes.

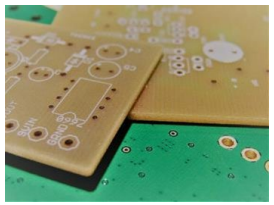
Biochip / FunPrint

Context / Objectives

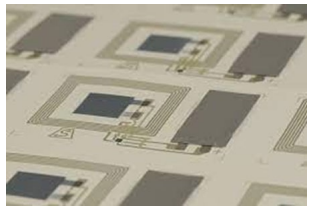
European Circel-paper project



Only **17.4 %** of the e-waste is documented to be collected and formally recycled worldwide.



FR4 PCB



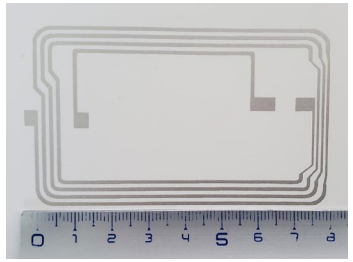
Paper PCB

- Challenges:

1) Recover the fiber fraction with minimum contaminants.
2) In a second fraction recover functional materials.

Methods

1. Paper printed electronics



Powercoat XD200
- Silver conductive Ink
- Coated paper
- 200 g/m²

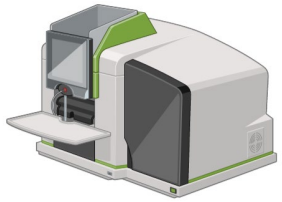
2. Conventional paper recycling line

Pulping → Screening → Centrifugal cleaning → Flotation

Units are optimized individually and tested sequentially as part of the process.

3. Atomic Absorption Spectroscopy (AAS)

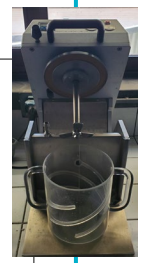
Objective: silver tracking

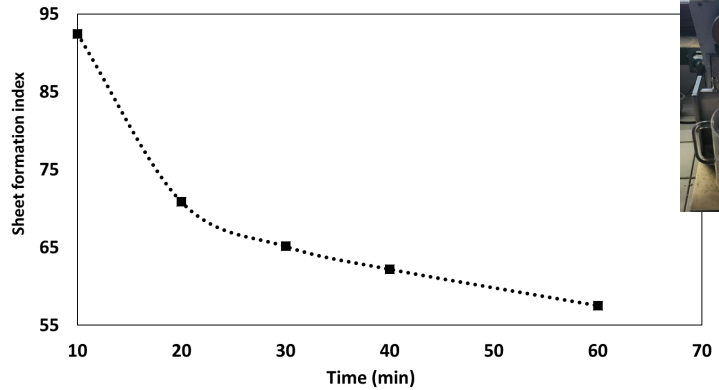


Ash + silver
↓ Leaching in Nitric acid
Solvated silver Ag^+

Results

1. Pulping optimization





The optimization involves monitoring the properties of handsheets as they vary with several parameters.

2. Silver Recovery

Centrifugal cleaning emerges as a highly promising unit operation for the separation of silver from fibers.

Ag= 100 % → inlet → **Centrifugal cleaning** → accepts → Ag= 2-3%
Centrifugal cleaning → rejects → Ag= 90 %

→90 % of the silver can be recovered from the pulp.