THE CHALLENGES OF PRINTED ELECTRONICS ON CELLULOSE

TOWARDS A SUSTAINABLE APPROACH

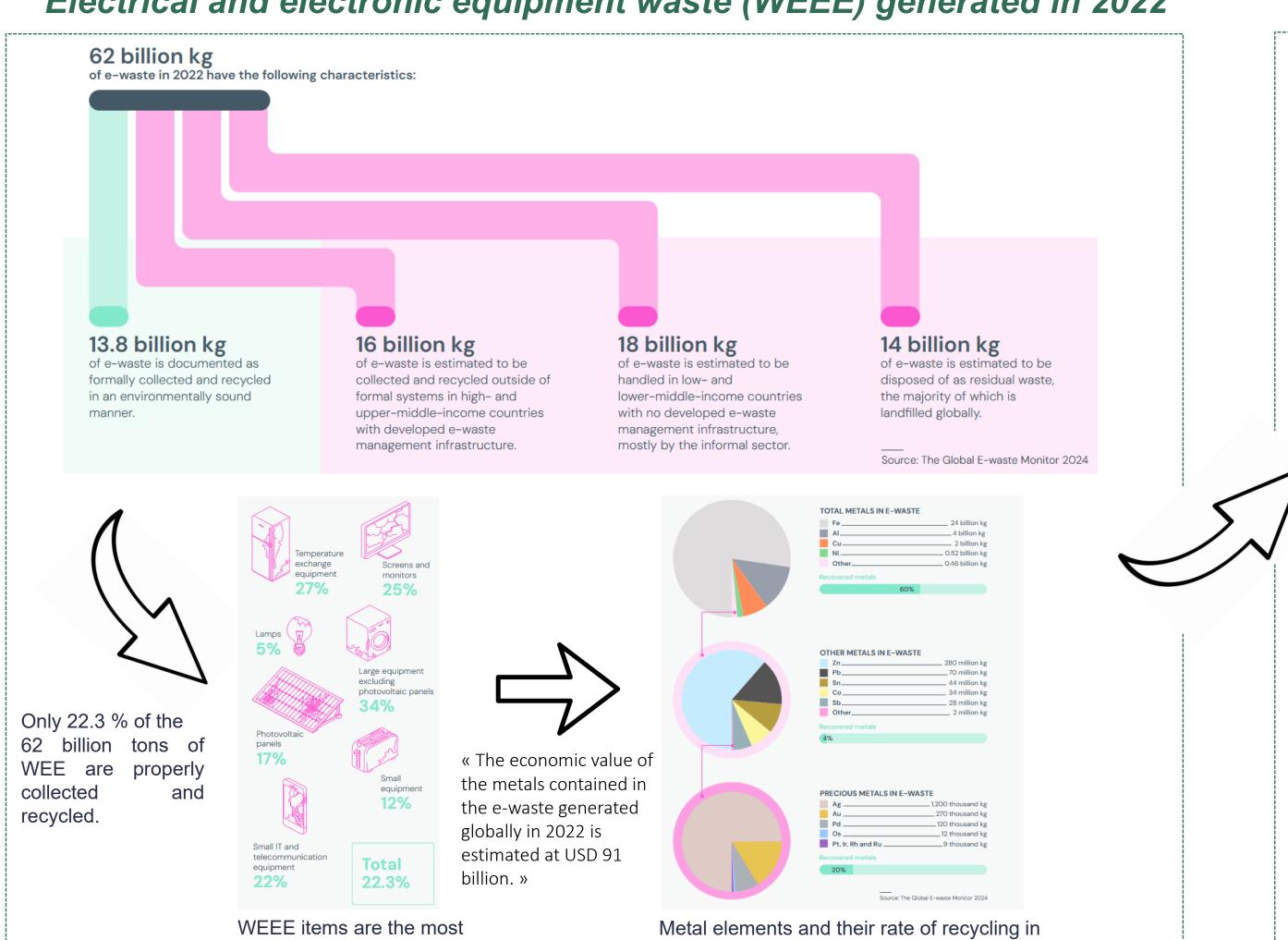
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Context

Electrical and electronic equipment waste (WEEE) generated in 2022

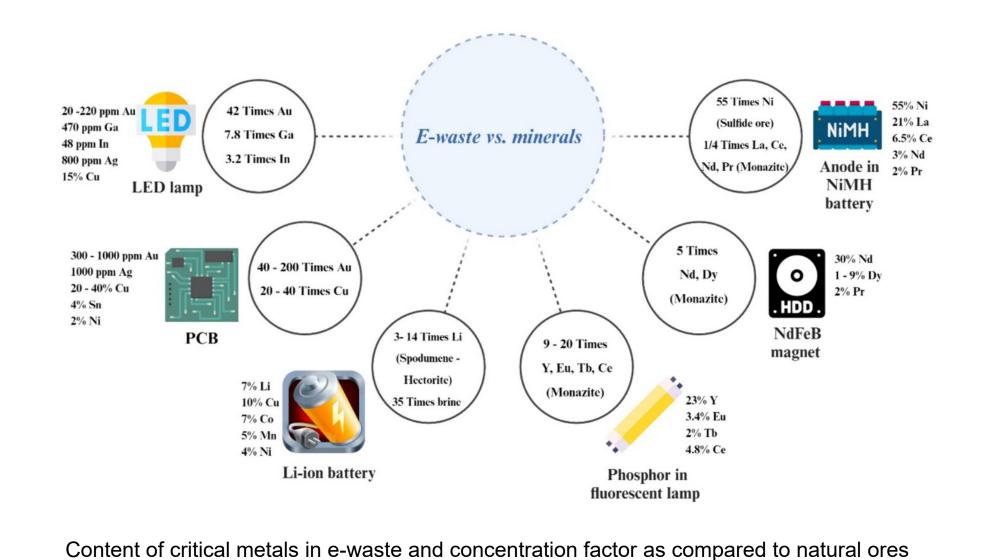


Why should printed circuit boards (PCBs) be recycled?

Of this e-waste, printed circuit of all WEEE). However, PCBs of which are precious: Ag, Au, Post The substrate of PCBs is gentled the makes their physical/chemical/ thermal

Of this e-waste, printed circuit boards account for a small quantity (between 3 to 7 % of all WEEE). However, PCBs contain a high proportion of conductive metals, some of which are precious: Ag, Au, Pd, etc...

The substrate of PCBs is generally fibre-glass impregnated with epoxy or phenolic resin which makes their recycling difficult. It requires pre-treatments, physical/chemical/ thermal treatment and purification. It also emits secondary pollutions such as toxic metal solutions, residues, exhaust gases and wastewater.



Despite that, e-waste is of economic as well as ecological interest. In some cases, this waste contains more valuable elements than the ores themselves.

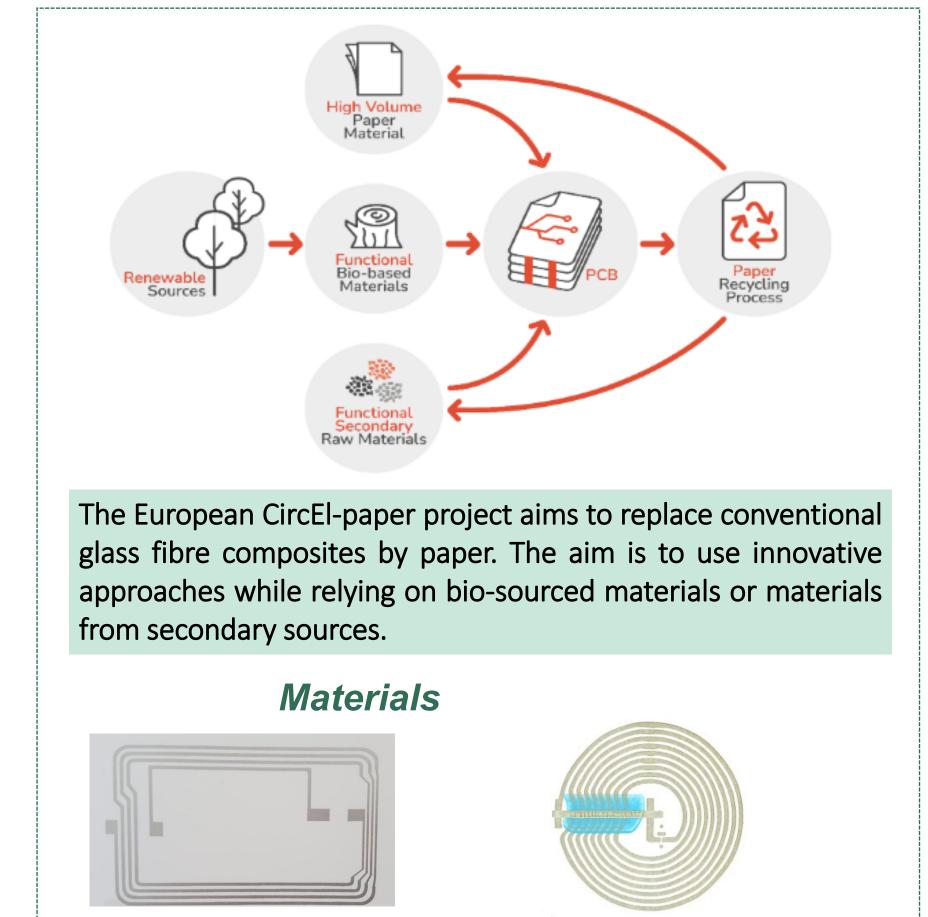
Objectives

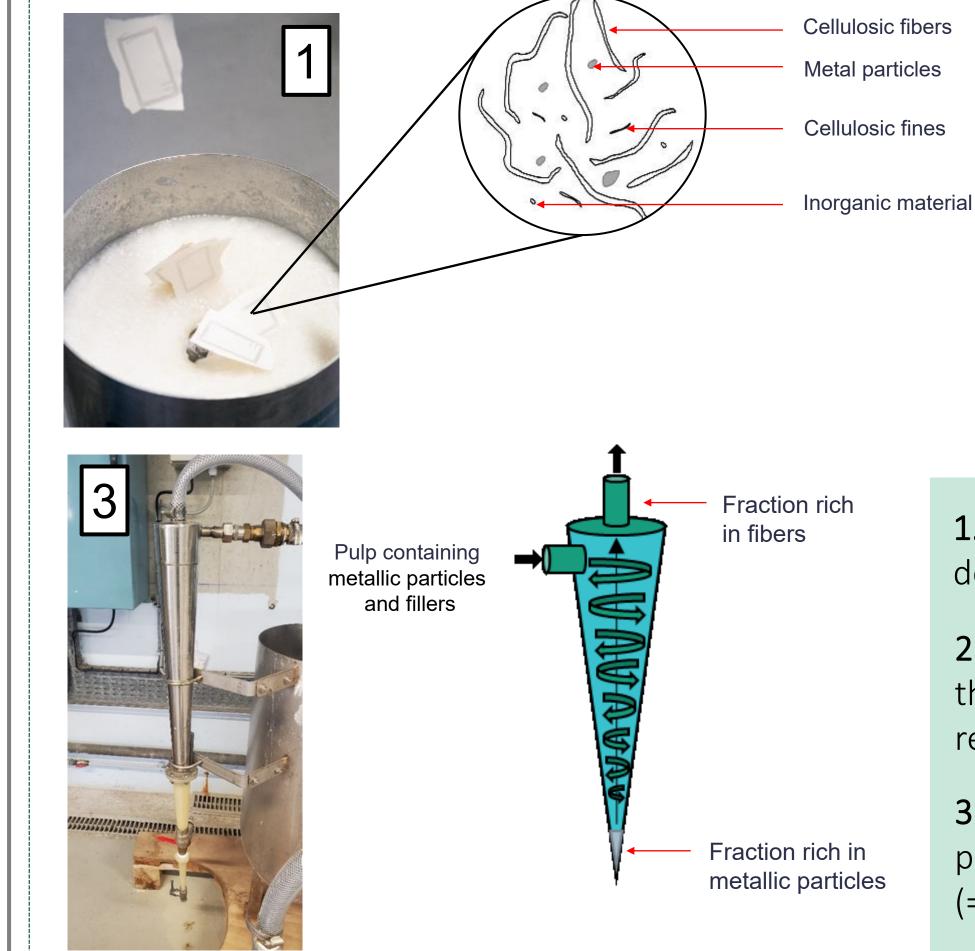
recycled waste in the world

Experimental

the WEEE

Unit operations for paper PCB recycling





Fibers flocs

Individual fiber

Metal particles

Slotted screen

- **1. Pulping**: breaks the bounds between cellulosic fibers and detaches printed material from the fibers
- **2. Screening**: separation process of contaminant particles from the fibers depending on their dimensions. Larger particles are retained, smaller pass through the screen.
- **3. Centrifugal cleaning:** based on density difference (heavier particles collected at the bottom (=silver), lighter ones at the top (=fibers).

Results

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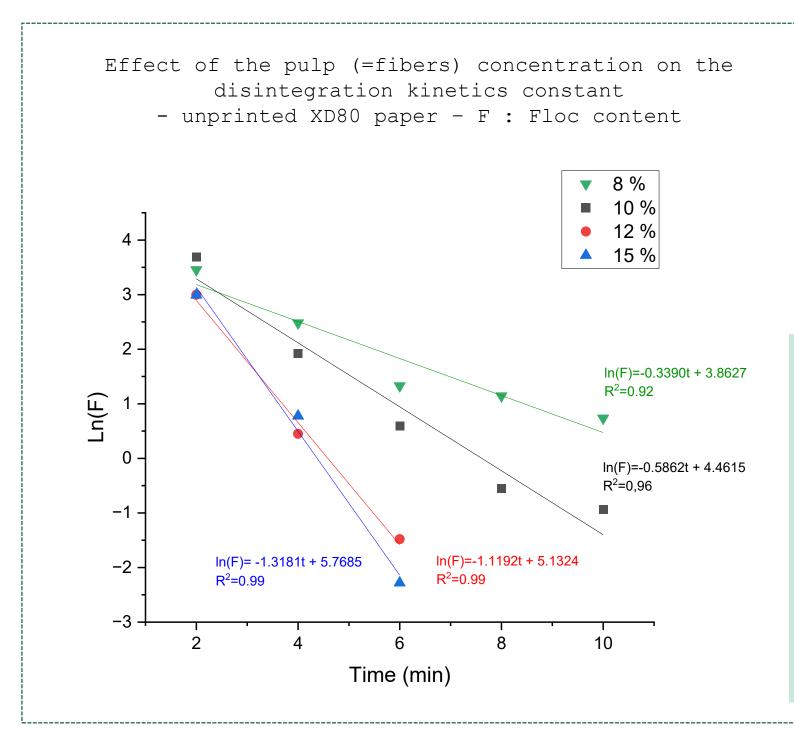
Silver-based antenna printed

on XD200 POWERCOAT® paper

Pulping optimization

Silver-based antenna printed

on XD80 POWERCOAT® paper



The study of the kinetics associated to defibration for each tested type of paper was performed using different rotor speeds, consistencies and rotor shapes. As it has been shown in previous studies defibration follows a first-order kinetics (Vilaseca et al., 2011).

The fraction that is not properly defibrillated, i.e. fibrous aggregates, is established as follows:

$$\frac{dF}{dt} = -K_d.F$$

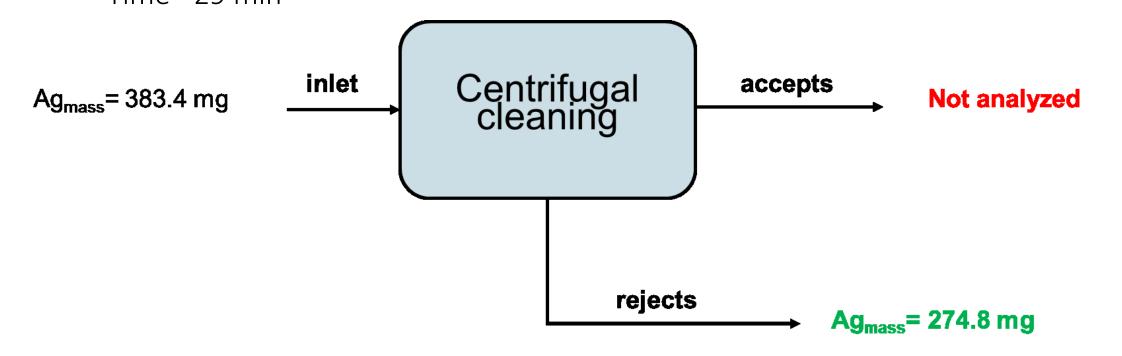
F: Floc index, fraction of fibrous aggregates (%)

- t: pulping time (s)
- K_d: kinetic constant of disintegration

Matter mass balance and silver recovery of centrifugal the cleaning operation

It has been established that the pulping conditions which result in maximum silver content in the rejects from the cleaning operation are:

- Cp = 10 % w/w
- Sodium hydroxide= 0.7 % w/w
- Sodium Silicate = 2.5 % w/w
- Time= 29 min



While 71.6 % of the silver is recovered in the reject fraction

Conclusion & perspectives

- The core of the project is to find alternative to petroleum based PCB to enhance their recyclability. Paper is chosen as an alternative support for PCB technology because it is suitable for printing electronic, biodegradable and widely recycled.
- The centrifugal cleaning operation has shown good ability in the separation of metallic particles (Ag) from the paper pulp since 72 % of silver is recovered in the reject fraction.
 - The presented results are obtained by recycling relatively simple tags. In the future, papers with silicone, resins or flame-retardant compounds will be studied.

Acknowledgments

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