arjowiggins

Intelligent Packaging by printing sensors on paper

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Arjowiggins Structure

Leader in creative, technical, translucent, packaging and specialty papers

4 production sites

800 employees

More than 300 years of *savoir-faire*

Creative Papers
Luxury Packaging
& Labels
arjowigginscreativepapers.com

Covering and Bookbinding Papers
guarrocasas.com

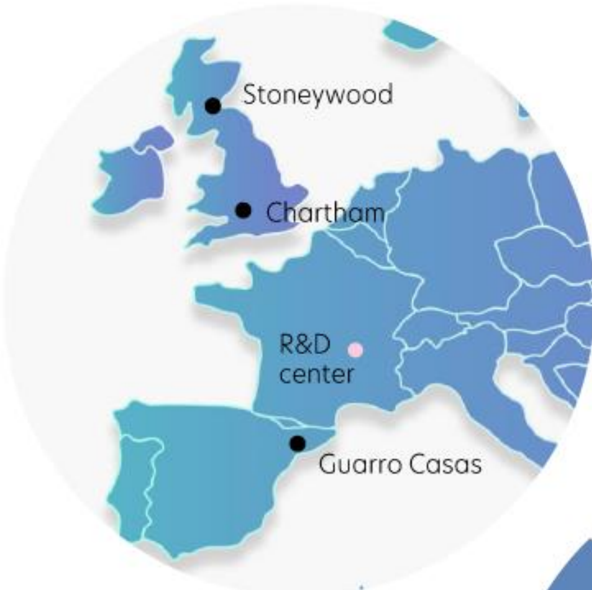
Translucent Papers
arjowiggins-translucentpapers.com

Security Papers
Website under construction

Smart Papers
powercoatpaper.com

Transfer Papers
Website under construction

Arjowiggins' Mills



FSC

ISO 14001

ENVIRONMENTAL MANAGEMENT

All 4 production sites are FSC™ license holders and ISO 14001 certified

Stoneywood, Scotland

Chartham, England

Guarro Casas, Spain

Quzhou, China

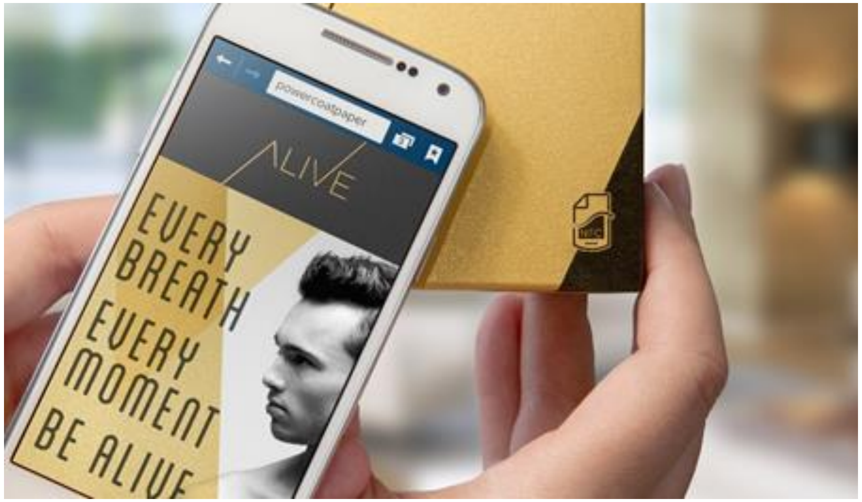
How the story started : Customer's demand

- Our existing customers are in the packaging area (luxury, vines and alcohols, commodity…) and in labels

- They asked for more intelligence in the products (10 years ago) :
  - Can we check that it is not a counterfeited product ?
  - Can we check that it has not been open ?
  - Can we add interaction with customers ?
  - Can we follow the temperature during shipment ?
  - Can we follow the shock during shipment ?

- We decided to build a research plan to check the feasibility of these systems :
  - Made first prototypes (NFC tags on paper) in the lab in 2013
  - Evaluation of the cost to produce in our facilities at industrial scale : 2014
  - Conclusions were :
    - If we print the antenna by screen printing and pick &place the chip in bare die it will cost twice the price of plastic inlay with aluminum foil etched by chemicals produced in ASIA
    - But no plastics inside, no chemical etching, better for the environment (?)
  - Decided to go in production

First available products 2015

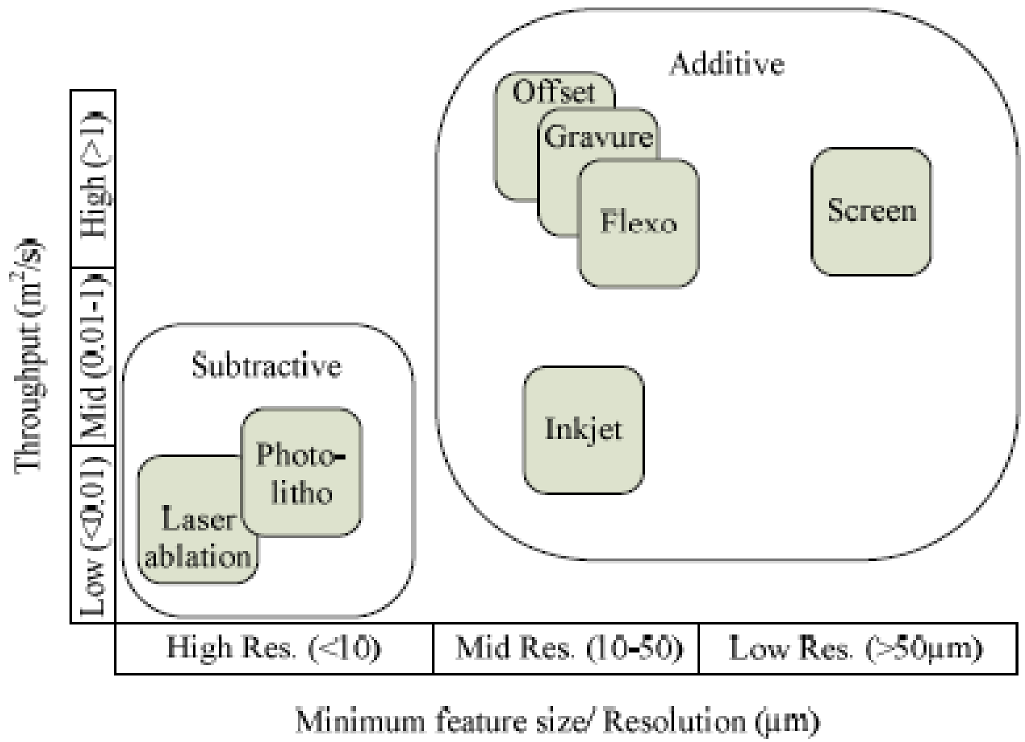


How it was made ?

For audacious printers, branding specialist, packaging creatives, graphic designers and millennials, PowerCoat® Alive is the new Arjowiggins Creative Papers product which allows end-users to connect and engage with you or your brand in new exciting ways.

PRINTING PROCESSES

- Various printing processes could be used (additive) :
  - Inkjet
  - Screen printing
  - Flexography
  - Gravure
  - Offset
  - …



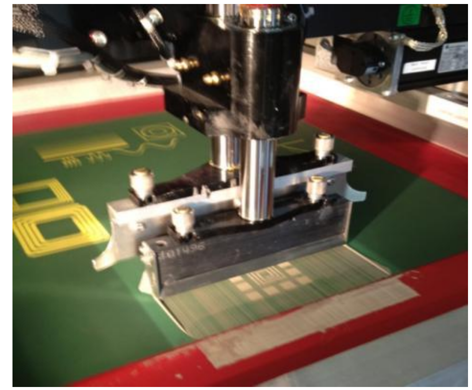
Chang, J., et al., "Challenges of Printed Electronics on Flexible Substrates."

Each process is specific in terms of ink thickness, printing resolution, throughput, …

Printing processes selected

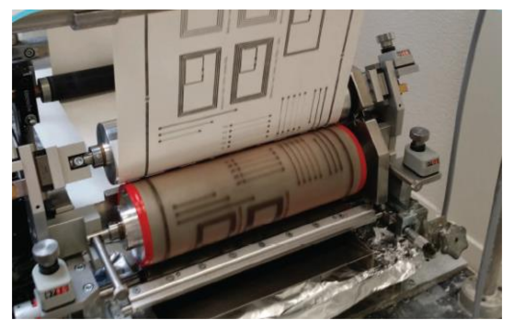
Screen printing

- Printing speed : medium
- Resolution ≈ 80 µm
- Inexpensive inks
- Ink thickness : 2 – 100 µm
- Well suited process for RFID



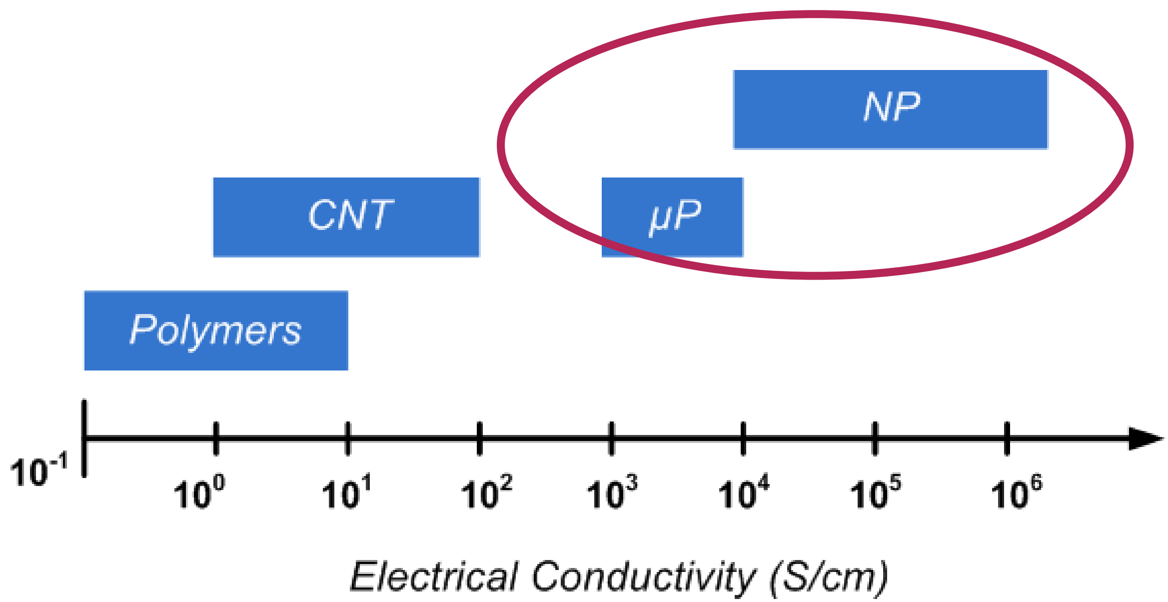
Flexo

- Printing speed : high
- Resolution : 30 – 75 µm
- Ink thickness : 0,5 – 8 µm



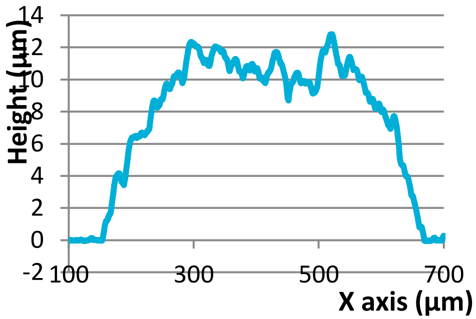
Conductive inks

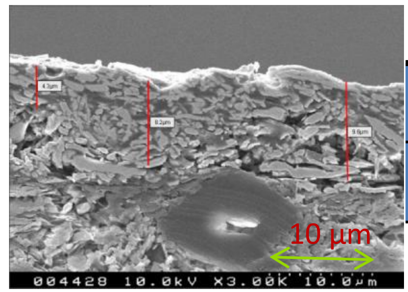
- Various types of conductive inks can be used:
  - Conductive polymers (Pedot:PSS, Polyaniline, …)
  - Carbon/graphite/graphene
  - Metal particules (Ag, Cu, …)



MICRO VS. SUBMICROPARTICLES (SCREEN PRINTING)

Profilometer and **SEM** cross-sections for micro-flakes on paper

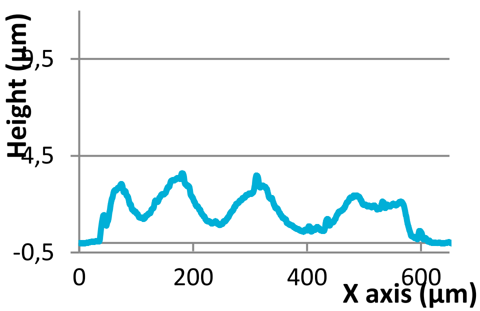


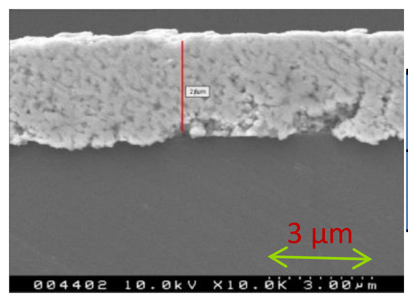


		Average ink thickness (µm)
Microflakes ink	PET	8.7
	XD paper	7.1

Average thickness based on 10 mechanical profiles + SEM observations

Profilometer and **SEM** cross-sections for submicro-ink on PET

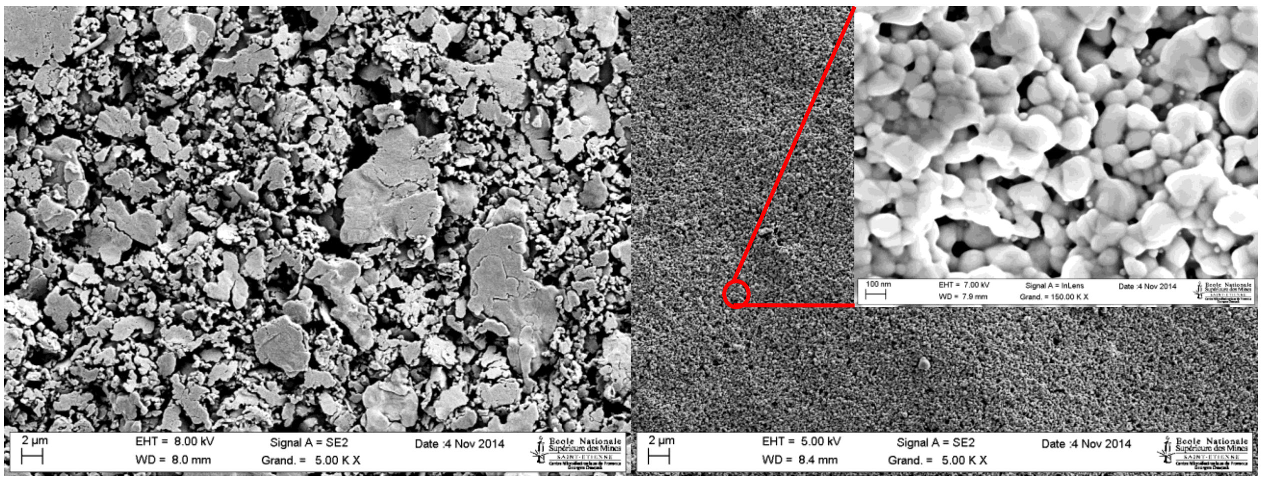




		Average ink thickness (µm)
Nano ink	PET	1.6
	XD paper	1.9

Micro vs. Submicroparticles (screen printing)

SEM pictures on printed Powercoat Paper



Size of the micro-flakes is between **1 and 10 µm**

Submicro-particles are about **100 to 150 nm** after sintering step

MICRO VS. SUBMICRO – ELECTRICAL PERFORMANCE (OVEN)

Resitivity [µΩ.cm]	PET (150°C – 15 min)	XD Paper (180°C – 5 min)
Microflakes ink	33.1	**23.1**
Nano-ink	9.9	**7.1**

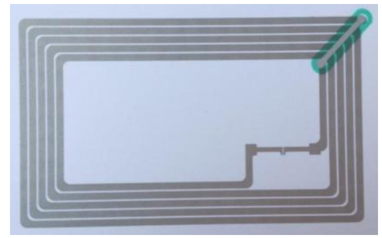
•Due to higher sintering temperature on paper substrates electrical performances are **30 % better** than on PET

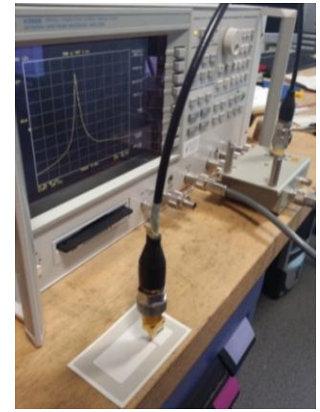
•Nano-ink resistivity is more than **3 times better** than microflakes ink

MICRO VS. SUBMICRO – NFC ANTENNAS

NFC antennas charaterisation

on impedance analyser





	PET				Powercoat XD Paper			
	R [Ω]	L [µH]	C [pF]	$Q_{13.56}$	R [Ω]	L [µH]	C [pF]	$Q_{13.56}$
Microflakes ink	56.6	1.9	10.2	**7.6**	45.5	1.9	10.0	**9.6**
Nano-ink	80.5	1.9	10.8	**5.2**	57.3	1.9	10.1	**7.6**

Use of paper instead of PET leads to **20 to 30% gain** on Q factor

Among best Q factor reported in litterature

Costs decrease

- Change of process : from Screen printing to flexo printing (4 heads)

- NFC tags are printed in a single pass

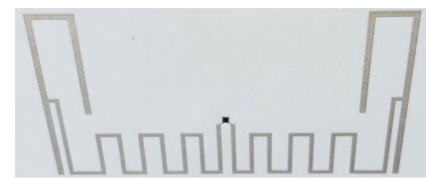
- Less ink is needed to reach the same QI (micro to submicro silver inks)

Paper Inlay manufacturing (in production)

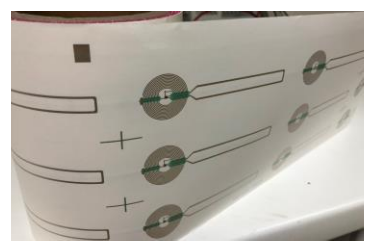
Roll (35 cm of width), printed with 4 heads Flexo machine
with comptetitive prices

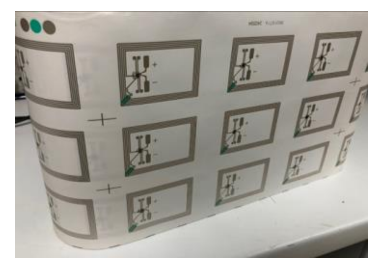
NFC tags :

- Different size of antenna : 25 mm, 30 mm, ID1,…
- Different chips : NTAG, Mifare UL, ULC, DESFIRE, DNA,….
- Different chips inductance
- Different position of tags on the roll



UHF : Different distance of reading
Dual NFC/UHF



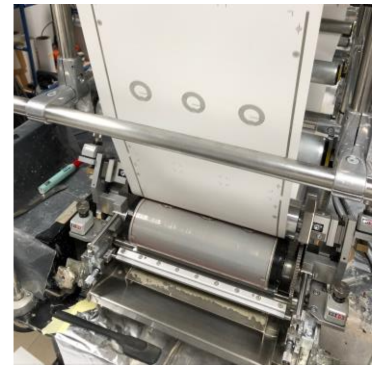


Passive sensors : Open detection,
Temperature

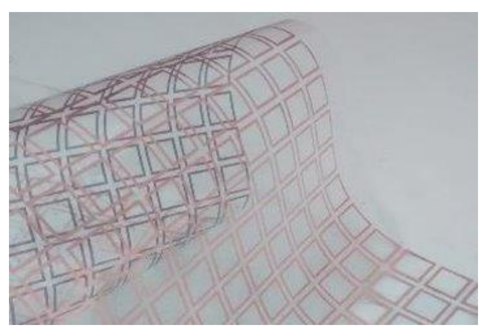
GenCert™

Paper Inlay manufacturing (in R&D)

At lab and pilot scale (flexo and screen printing)



- Electrochromic display
- Battery (Zn/MnO2)
- Active temperature sensors
- Other printed sensors :
  - Shock
  - Humidity
  - Ph
- Smart textile
- Selective EM shielding
- Selective EM amplification



E-waste issue

Facing the e-waste problem through the replacement of metals and plastics by paper as (functional) part of electronic components or devices.

> 50 million tons/year of e-waste in the world!!

Recyclability of the e-waste is very low (<10 % ?)

Plastic issue

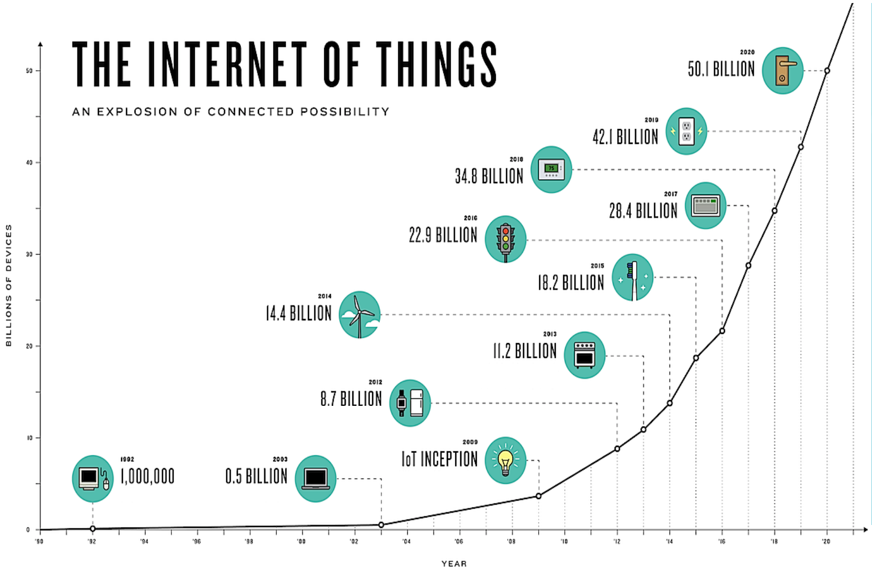
In 2015, of all plastic waste ever been produced (1) :

- 9% had been recycled
- 12% incinerated
- 79 % accumulated in natural environment

1 : Geyer R. et al "Production, use and fate of all plastics ever made", Science Advances 3, el700782 (2017)

THE chalenge of IOT

More and more connected object…



The Internet of things is the **internetworking** of physical devices, vehicles, buildings, and other items - embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. It includes everything from cell phones, coffee makers, washing machines, headphones, lamps, wearable devices

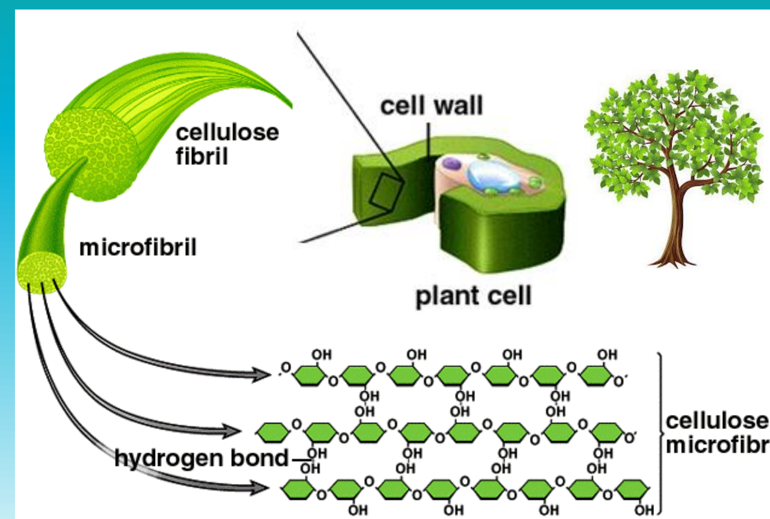
… will lead to Environmental issues

Why paper could be a solution ?

- ✓ **Sustainable**
- ✓ **Biodegradable**
- ✓ **Renewable**
- ✓ **Recyclable (80 % of paper is recycled in Europe)**
- ✓ **Cheap**
- ✓ **Flexible**
- ✓ **Essential economic importance in Europe** (30% of the world's total production)

✓ **Cellulose:** Earth's major biopolymer

(e.g. 50% in wood; 90% in cotton)



+ There is an existing process to recycle paper and paper packaging

Study of Recyclability and Life Cycle Analysis

- Work done during a project named SUPERSMART funded by EIT Raw Material

- LCA was carried out by Edis Glogic and Guido Sonnemann (from University of Bordeaux). Article submitted for ACS Sustainable Chemistry & Engineering: Development of eco-efficient smart electronics for anti-counterfeiting and shock-detection based on printable inks, Edis Glogic, Romain Futsch, Victor Thenot, Antoine Iglesias, Blandine Joyard-Pitiot, Gael Depres, Aline Rougier, Guido Sonnemann

This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

Recyclability of paper packaging

STANDARD EN 13430

- More of 50% of the product is composed of cellulose
- Does not disturb a recycling process
  - Good mechanical and optical properties of the recycled paper
  - Good process yield
  - No/little rejects of hazardous contaminants

Relatively vague sentence

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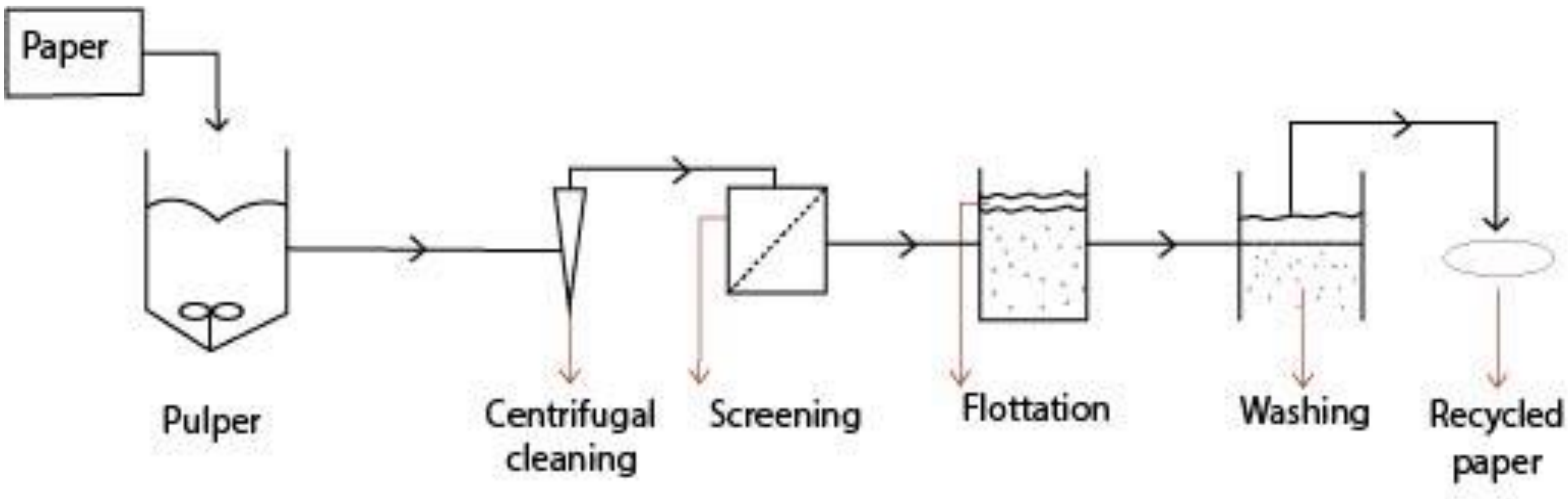
Recycling Process simulation



For the paper with Electronics printing, the goal of this study is to follow during the recycling process all the components

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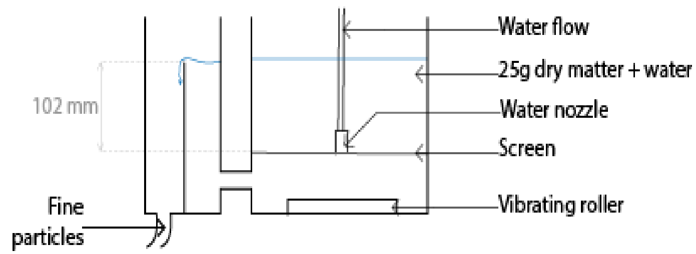
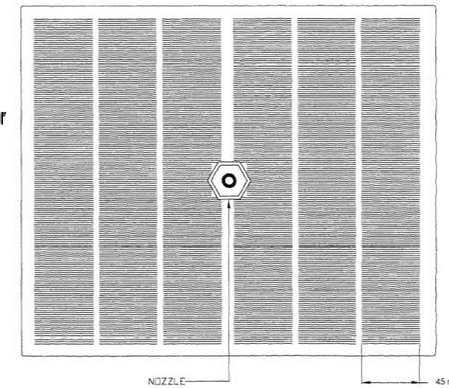
Recycling process

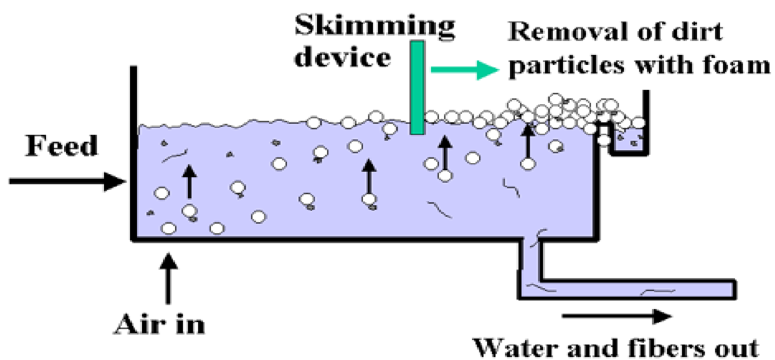
Lab Pulper





Somerville screening with 150 µm slot gap

De-inking apparatus



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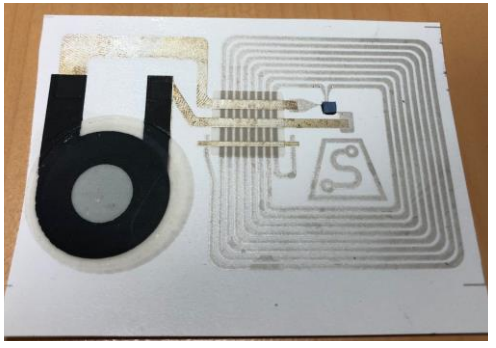
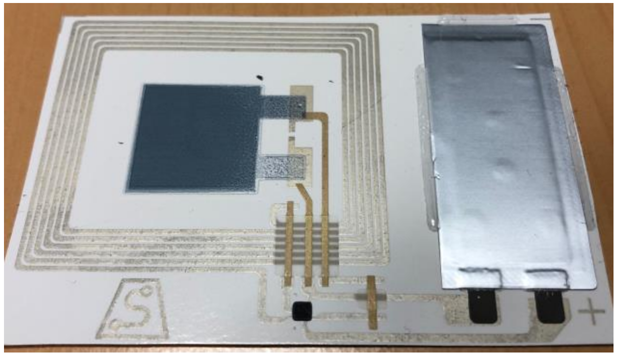
Materials used

- 2 complex prototypes



Anticounterfeiting label

(in partnership with Luquet Duranton and University of Bordeaux)



Shock detection tag

(in partnership with CEA, VTT, Fraunhofer, Johanneum Institute and Arkema)

Battery is removed is the rest of the study

- Common plateform is used (NFC antenna, chip (AMS AS39513))
- For shock, electrodes are made of PEDOT/PSS and active material is PVDF/TrFe from Arkema Piezotech

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Printed tags

First steps : Each material in printed on Powercoat XD Paper at a 4 % dry weight versus paper (4 % is the ratio of ink vs paper for a printed NFC antenna) :

- silver inks (micro and nano)
- Carbon ink
- Pedot/PSS
- Piezoelectric polymer (PVDF/TrFe from Arkema)
- Electrolyte (display)
- UV Curable polymer ink
- Bare die silicon chips

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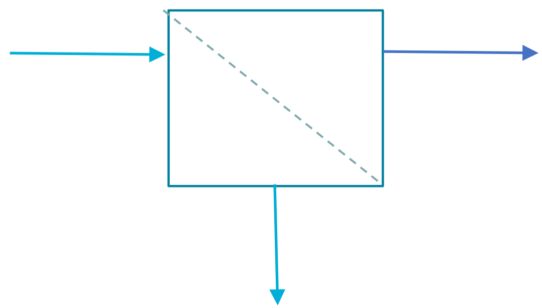
Components tracking

For each component, we follow each process and weight the accepted and the rejects, as well as the weight of the ashes in the rejects



$$M(e)=Mp(e)+Mc(e) \quad (1)$$

$$M(r) = Mp(r)+Mc(r) \qquad (2)$$

Where Mp(e) is the mass of paper at the entrance, Mc(e) is the mass of the component at the entrance, Mp(a) the mass of the paper accepted, Mc(a) the mass of the components accepted, Mp(r) the mass of the paper rejected and Mc(r), the mass of the components rejected.

If we burn the rejects to have the weight of the ash Ma(r), it is the sum of the weight of the ash the paper Map(r) and the weights of the ash of components Mac(r).

$$Ma(r)=Map(r)+Mac(r) \qquad (3)$$

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Components tracking

As we know, with preliminary tests, the ash content of the paper Ap(r) and of the components Ac(r) at the reject :

Ap(r)=Map(r)/Mp(r) (4)

Ac(r)= Mac(r)/Mc(r) (5)

By combining all the equations, when Ac(r)≠Ap(r), we have the reject ratio of the component:

$$Tc(r)=\frac{\mathrm{Mc(r)}}{Mc(e)}=\frac{(Ma(r)-M(r).Ap(r))}{Mc(e).(Ac(r)-Ap(r))} \qquad (6)$$

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Results of single components

Shock detection	Reject Somerville (%)	Reject Deinking (%)	Total Reject ratio [%]
Powercoat XD80	1,2%	22,0%	22,9%
Silver PF-410	5,0%	48,0%	50,6%
UV 5018A	100,0%	100,0%	100,0%
PEDOT:PSS	43,6%	65,2%	80,4%
PVDF	100,0%	100,0%	100,0%
Chip	100,0%		100,0%

Anti-Counterfeiting	Reject Somerville (%)	Reject Deinking (%)	Total Reject ratio [%]
Powercoat XD125	1,2%	22,0%	22,9%
Silver PF-410	5,0%	48,0%	50,6%
UV 5018A	100,0%		100,0%
PEDOT:PSS	43,6%	65,2%	80,4%
Carbon 965SS	12,0%	60,0%	64,8%
Liquide ionic + UV	17,0%	39,0%	49,4%
Chip	100,0%		100,0%

Most of the components are separated and are extracted by filtration or by deinking which leads to rather high reject ratio. For more, these experiments are in batch processes and higher values should be obtained with continuous

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Multi components tracking

Reject rate	Somerville		Deinking	
	Reject rate (%)	Ash Content in reject (%)	Reject rate (%)	Ash Content in reject (%)
Shock Detection	2,8%	38,4%	10,0%	14,4%
Anti-Counterfeiting	8,2%	44,4%	9,1%	18,2%

2 approaches were considered :

1/ the ash content of the ink (Ac(r)) is calculated knowing the ash content of each component (Ai) previously measured and the weight of each components (Mi) in the ink considering that the composition of the ink stay the same between the entrance and the reject. In other words, considering Ac(r)=Ac(e)

$$Ac(r) = \frac{\sum Ai * Mi(e)}{\sum Mi(e)} \qquad (7)$$

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Multi components tracking

2/ In second approach, we could take into account the reject ratio of each component of the ink (Ti(r)=Mi(r)/Mi(e)) calculated from the results of single components tracking, considering that there are no interactions between the components. In this case, Ac(r) is calculated following this equation :

$$Ac(r) = \frac{\sum Ai.Mi(r)}{\sum Mi(r)} = \frac{\sum Ai.Ti(r).Mi(e)}{\sum Ti(r).Mi(e)} \qquad (8)$$

The results of the ash contents of each demonstrators for each processes are summarized in the table below (for the 2 hypothesis):

Component's ash content in the reject Ac(r)	Somerville		Deinking	
	Ash Content Components (%) with equation (7)	Ash Content Components with equation (8)	Ash Content Components (%) with equation (7)	Ash Content Components with equation (8)
Shock Detection	72,3%	39,7%	72,3%	63,0%
Anti-Counterfeiting	70,0%	36,7%	70,0%	60,2%

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Results of multi components tracking

Finally, the results of the reject rates of each step are summarized in the table below :

Reject rate of the ink Tc(r)	Somerville		Deinking		Total		
	Reject rate Ink with equation 7 (%)	Reject rate Ink with equation 8 (%)	Reject rate Ink with equation 7 (%)	Reject rate Ink with equation 8 (%)	with (7)	with (8)	Average
Shock Detection	16,6%	64,6%	0,0%	0,0%	17%	65%	**41%**
Anti-Counterfeiting	83,0%	100,0%	3,8%	4,6%	84%	100%	**92%**

Rejects of the Somerville for SDT (left) and ACL (right)

rejects of the deinking for SDT(right) and ACL (left)

For the ACL, more than 90 % of the ink is removed by the recycling process

For the SDT, only 40 % of the ink is removed, mainly by screening.

For both, we can say that ink is well separated from fibers (which is recycled) and extracted by the existing processes, without disturbing it. Thus, it can be considered as recyclable.

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Conclusions of recyclability

We developed methods to track the components during the existing recycling process of paper packaging.

We then carried out trials by testing the main components printed on paper : we can conclude that the fibers are recyclable even when printed with the components and that most of the components printed or glued are quite well stopped or removed in the recycling process.

Thus, printed electronics on paper can be considered as recyclable following the standard of paper packaging

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Life Cycle Assessment

1. Hotspots analysis for shock detection tag and anticounterfait label
   I. Contribution of main device processes and/or components
   II. Contribution of main processes for screenprinting of electrochromic display and piezo sensor
2. Comparison between screen printing and flexo-printing of shock detection tag and anticounterfait label*

3. Comparison between plastic substrate and paper substrate

*silver antenna is printed by flexography and the rest of the device by screenprinting

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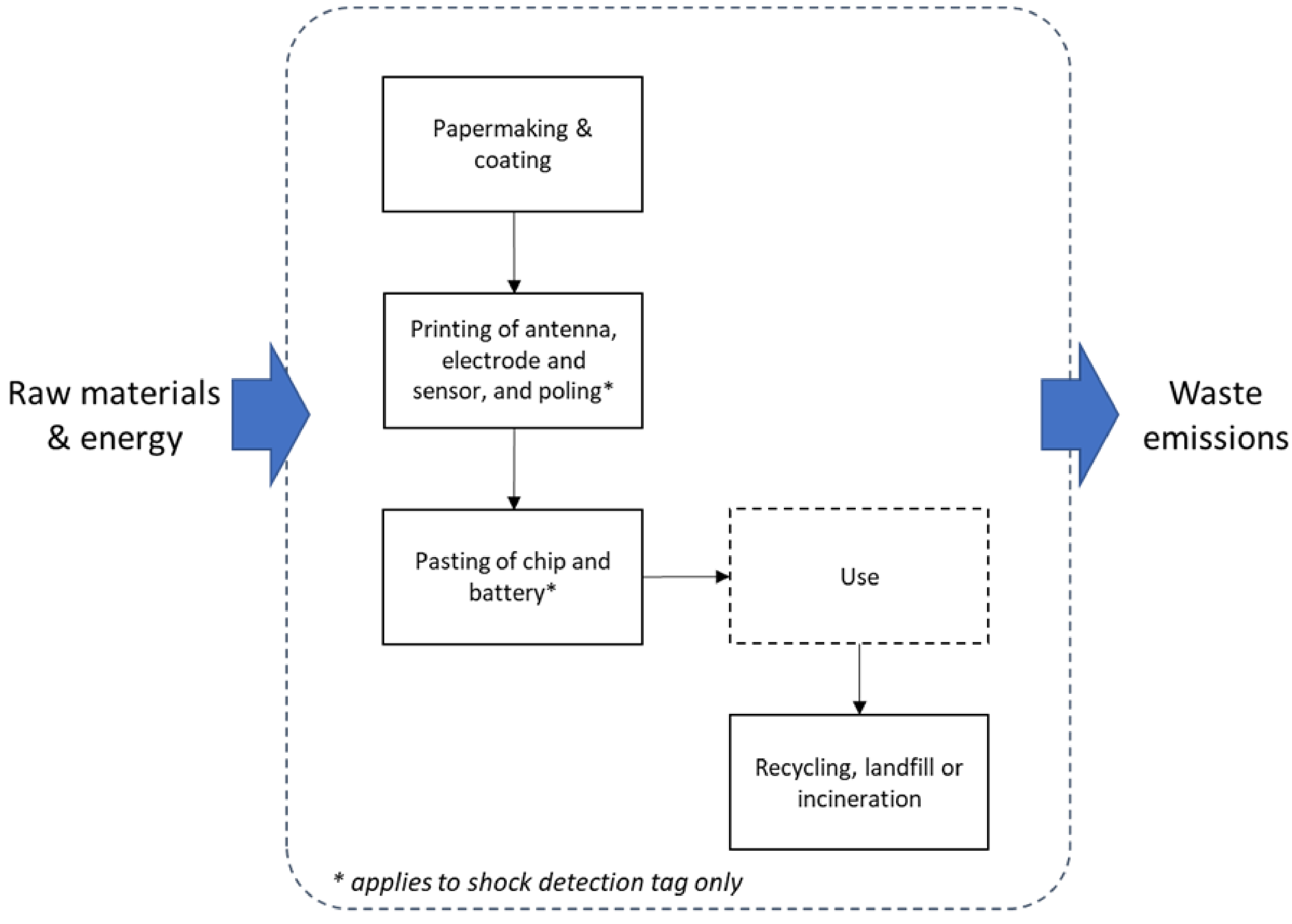
System boundaries



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Impact categories of ReCiPe Midpoint (H)

Impact categories	Reference units
Agricultural land occupation	m^2*a
Climate Change	kg CO_2 eq
Fossil depletion	kg oil eq
Freshwater ecotoxicity	kg 1,4-DB eq
Freshwater eutrophication	kg P eq
Human toxicity	kg 1,4-DB eq
Ionizing radiation	kg U235 eq
Marine ecotoxicity	kg 1,4-DB eq
Marine eutrophication	kg N eq
Metal depletion	kg Fe eq
Natural land transformation	m^2
Ozone depletion	kg CFC-11 eq
Particulate matter formation	kg PM10 eq
Photochemical oxidant formation	kg NMVOC
Terrestrial acidification	kg SO_2 eq
Terrestrial ecotoxicity	kg 1,4-DB eq
Urban land occupation	m^2*a
Water depletion	m^3

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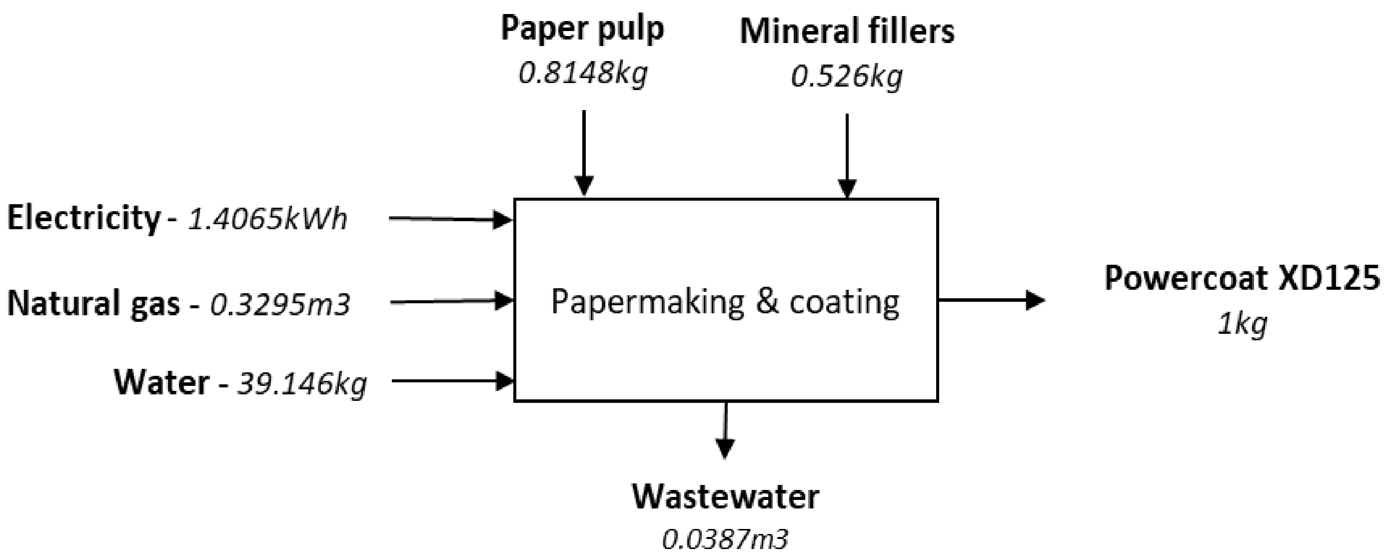
Material and energy flows in production of Powercoat paper XD125



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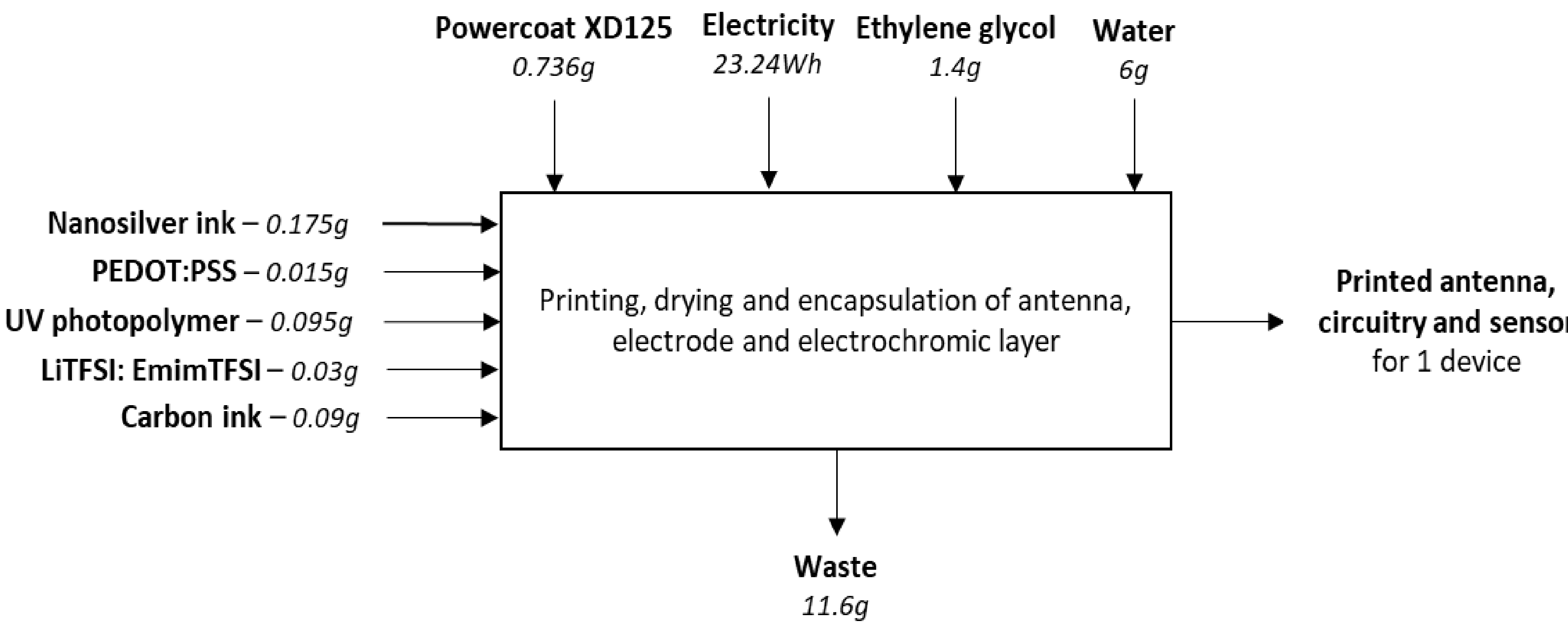
Material and energy flows in printing of antenna, electrodes and electrochromic display



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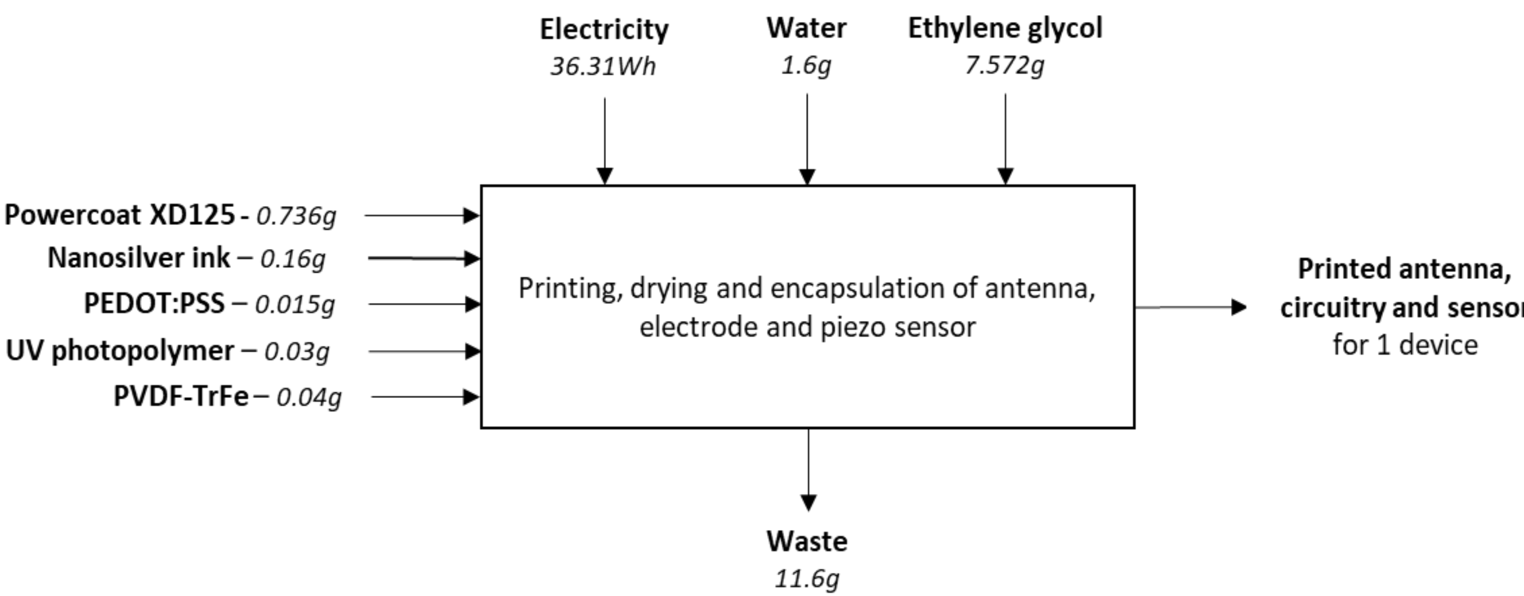
Material and energy flows in printing of antenna, electrodes and piezo sensor



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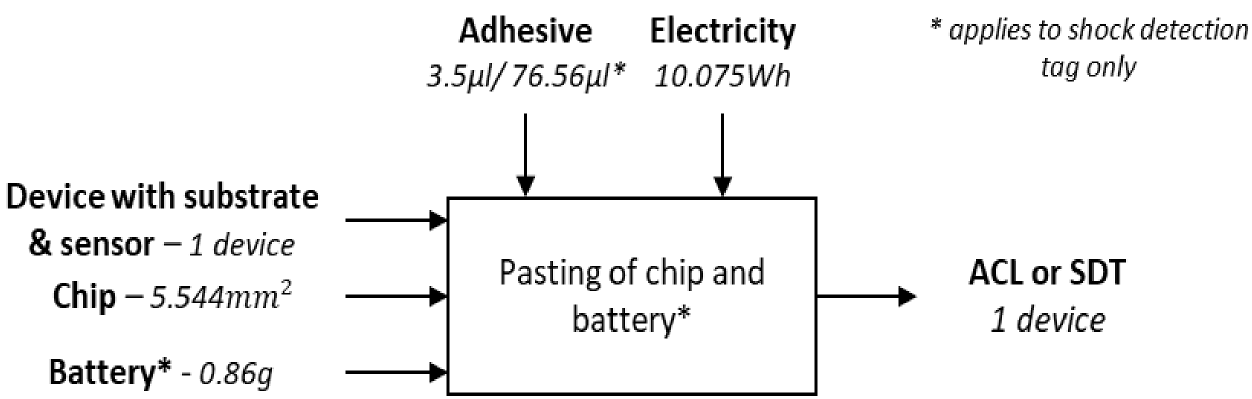
Material and energy flows in pasting of the chip and battery



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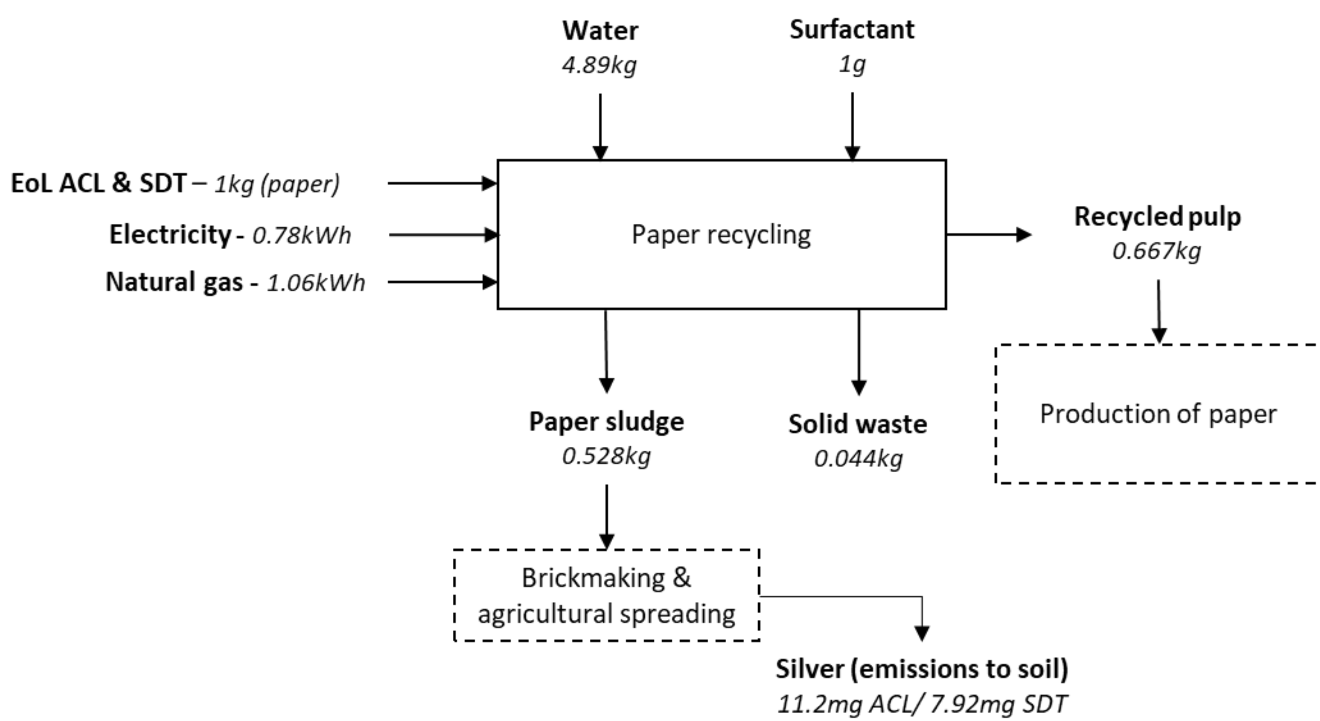
Material and energy flows for recycling paper component of ACL and SDT



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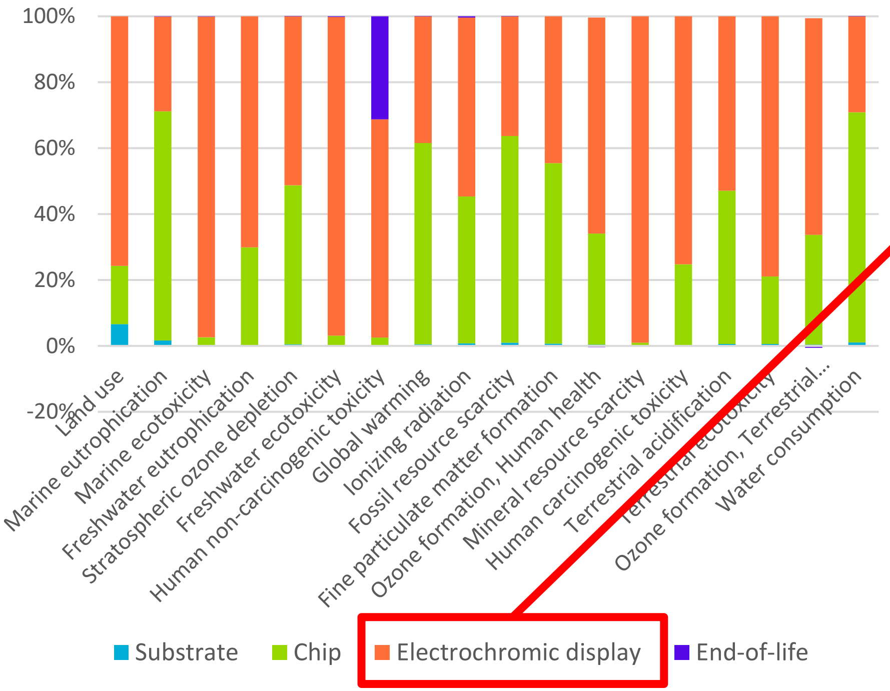
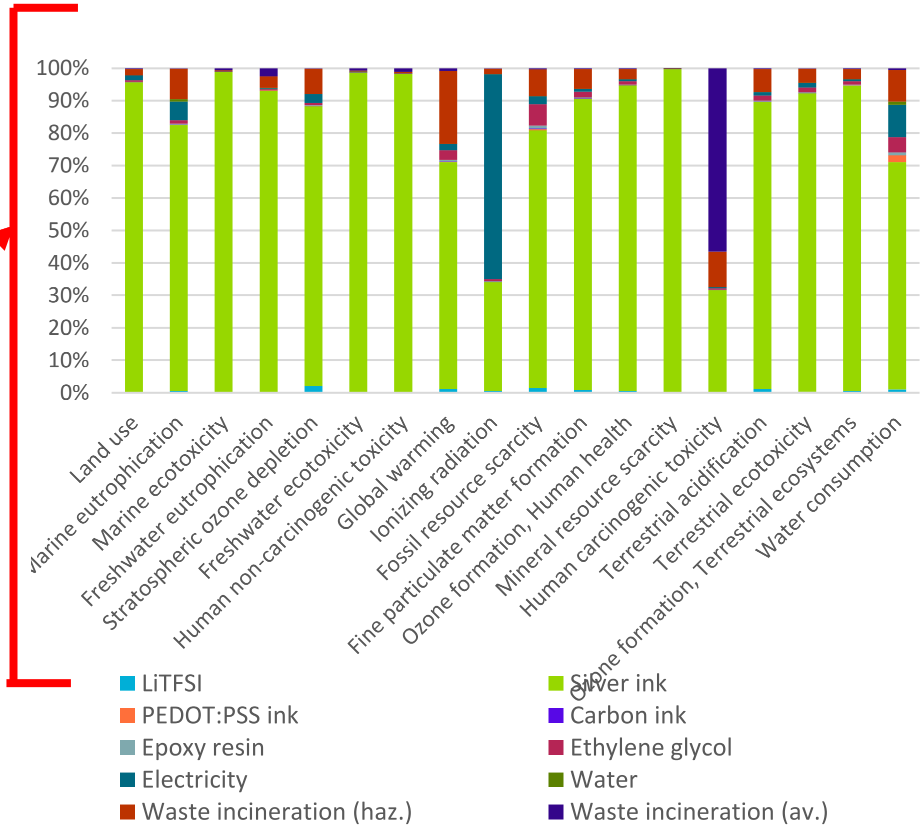
1. Hotspots analysis for anticounterfait label

I. Contribution of main device processes and/or components



II. Contribution of main processes for screenprinting of electrochromic display



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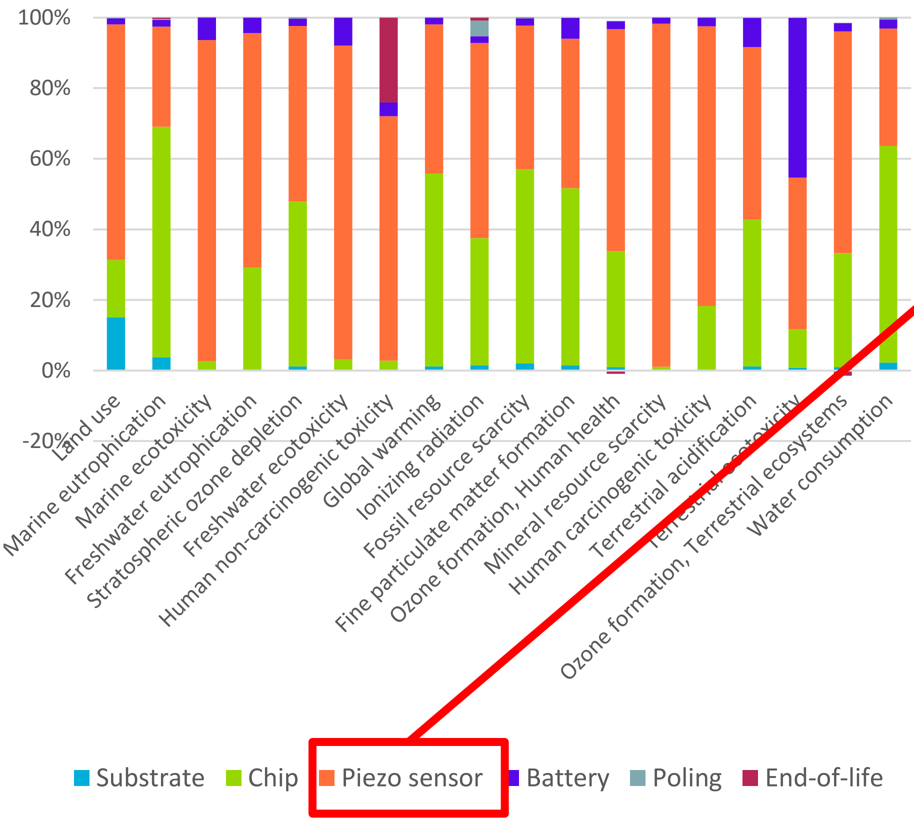
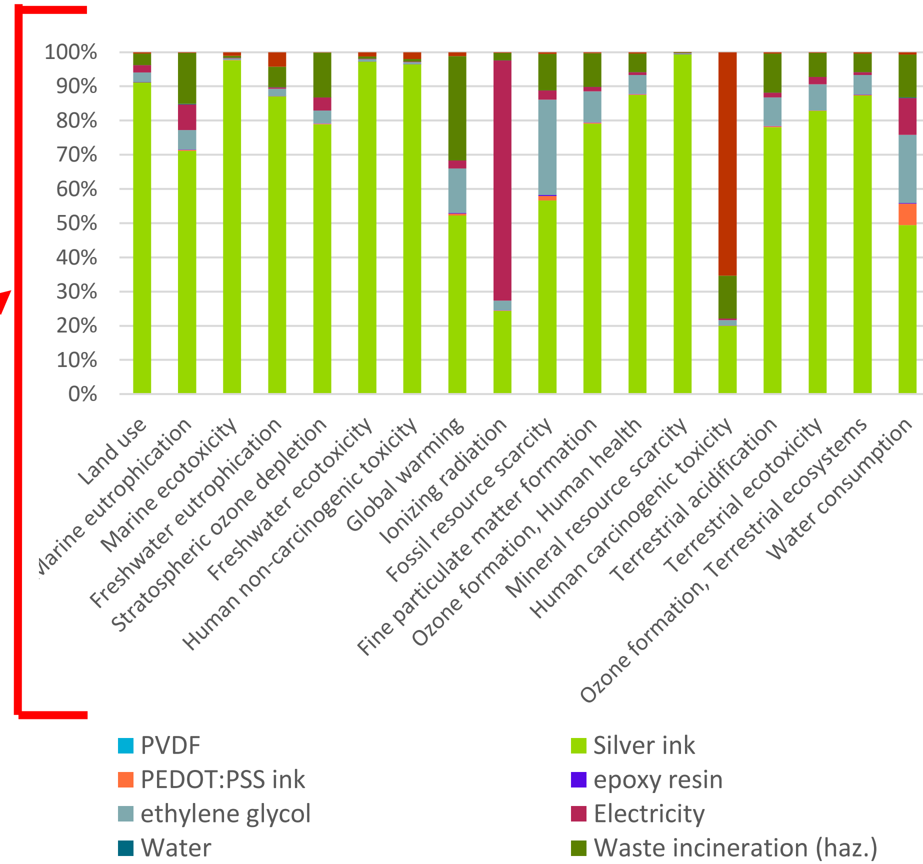
1. Hotspots analysis for shock detection tag

I. Contribution of main device processes and/or components



II. Contribution of main processes for screenprinting of piezo sensor



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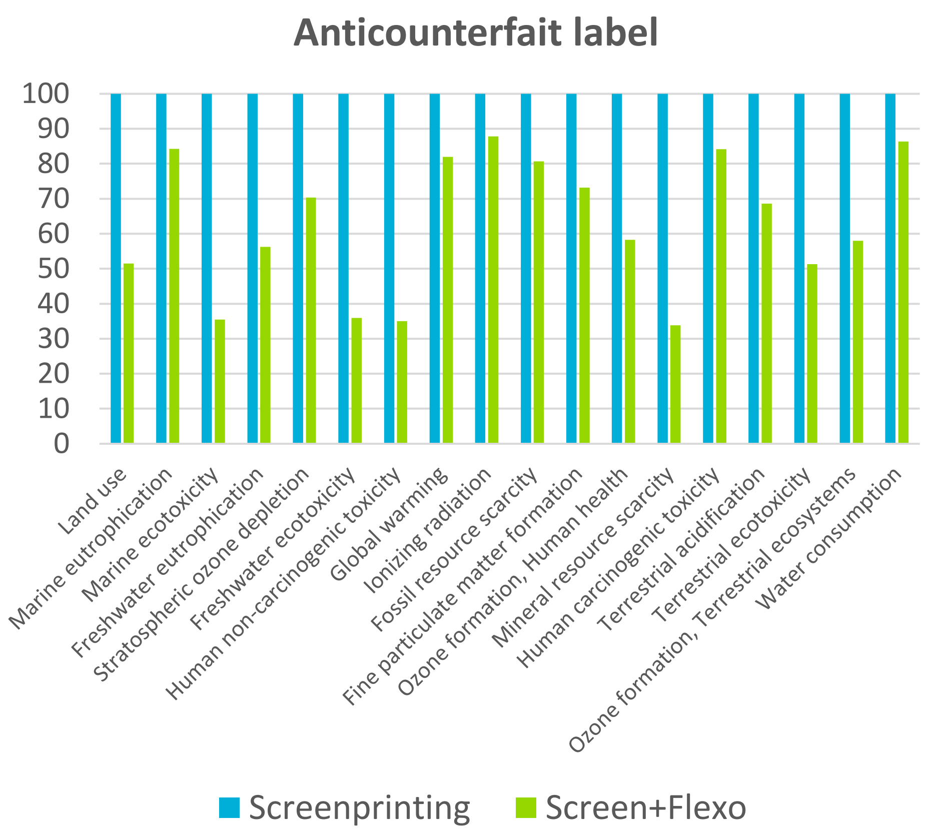
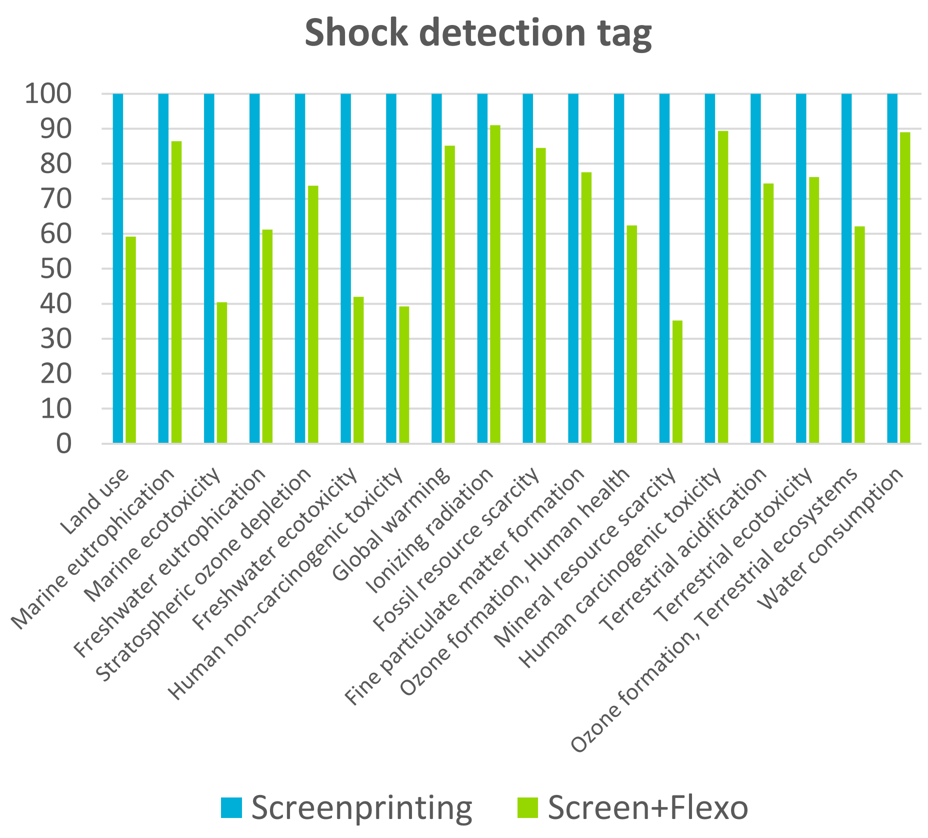
2. Comparison between screenprinting and flexo-printing*





*silver antenna is printed by flexography and the rest of the device by screenprinting

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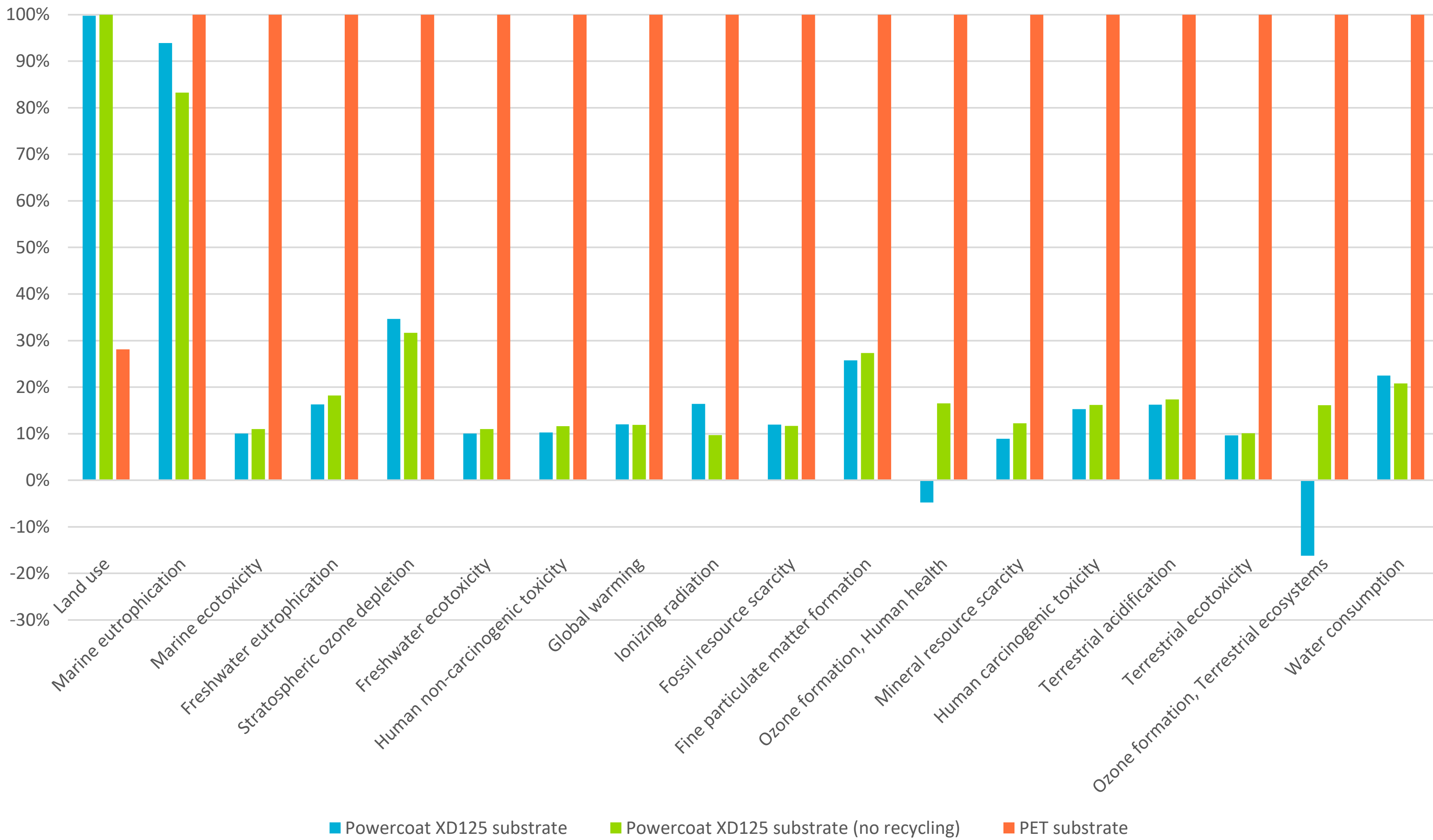
3. Comparison between cradle-to-grave Paper based ACL and PET based ACL



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Conclusions of LCA

- For hybrid electronics (printing + chips bonding), **the chip and the silver** printing are the 2 most impacting factors on environment
- Reducing the silver amount is a very good first move. Flexo printing is a good process to reduce silver amount
- More research are needed to replace silver (copper, graphene,…)
- Paper is definitely much better than plastic
- Next steps is to compare with standard electronics (PCB)

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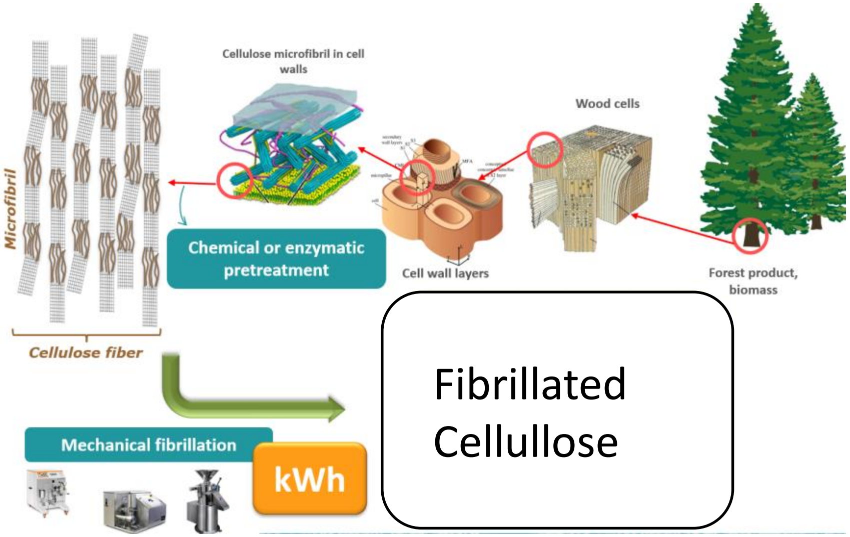
Translucent papers

- A translucent paper is existing in our range, named Sylvicta, made with Fibrillated cellulose (FC). It has a transparency of 79 % and a very good barrier to Oxygen, grease and flavor. For more, it is recyclable (according to ISO 13430)

- We started a new EU project named MADRAS (Advanced Materials and Processing in Organic Electronics) with one of the aim to increase the transparency up to 90 % and to use it for printed electronics as an environmental replacement of PET when transparency is needed.



This project has received funding from the EU Horizon 2020 programme under grant agreement No. 862492

New pre-treatments

- 3 new pre-treatments were developed at lab scale :
  - Carboxymethylcellulose (CMC) continuous adsorption
  - Mercerization, followed by enzymatic treatment
  - Phosphorylation

- Planarization of the FC paper by aqueous coating
  - Up to 40 % of the transparency is lost at the surface of the paper due to roughness
  - Aqueous coating on both sides with PVDC was tested to reduce smoothness, increase transparency and add some dimensional stability to humidity variation

- We used Quality Index to characterize the FC quality (1) and transparency and transmittance. Sylvicta has a QI of 54, a transparency of 79 and a transmittance of 7

(1) Desmaisons, J., Boutonnet, E., Rueff, M., Dufresne, A., Bras, J., 2017. A new quality index for benchmarking of different cellulose nanofibrils. Carbohydr. Polym. 174, 318–329.

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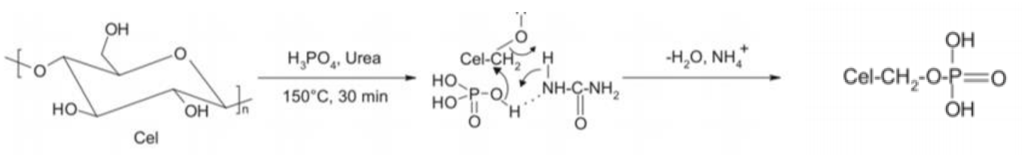
MADRAS

Phosphorylation

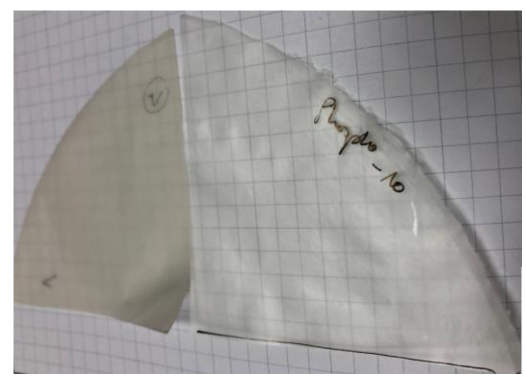
In the literature, $(NH4)_2HPO_4$ is often used, but it has the drawback of ammonia release during the reaction



To avoid that, we used NaH2PO4 / Urea , which doesn't release ammonia, but the grafting is a bit less effective

Impregnation paper → NaH_2PO_4 / Urea (1 min impregnation) → Curing at 150°C for 20min → Masuko Grinder

	Phospho Imprégnation-0	Phospho Imprégnation-5	Phospho Imprégnation-10
Turbidity (NTU)	392	296	113
Transmittance (%)	0.77	7.50	31.73
Tear Resistance (mN)	388	191	25
Young's Modulus (Gpa)	2.40	9.92	12.15
Porosity (%)	66.0	27.9	24.3
Simplified Quality Index	23.4	59.0	83.0



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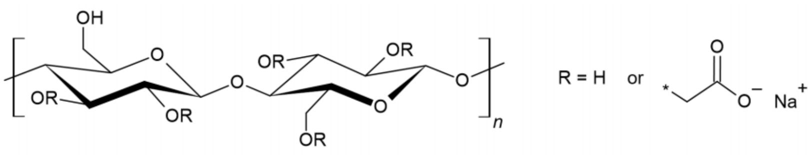
MADRAS

CMC continuous adsorption



CMC is a negatively charged polymer

Add a cation $CaCl_2$ to bind CMC on Cellulose

CMC is added in excess to have new site during mechanical shearing (Masuko)

Pulp

CMC
12 g/ 100 g of pulp

$CaCl_2$
C = 0.05 M

Adsorption reaction
- T = **80-85** °C
- 3h of reaction (1h+2h)
- pH adjusted with $NaHCO_{3(l)}$ between **7.5 and 8** after 1h

Masuko
Pulp+CMC at 2 wt%
- 10 passes at 0
- 10 passes at -5
- 10 passes at -10
- 0,1,2 passes at -20

Sample	CMC adsorbed (mg/g of cellulose)	Turbidity (NTU)	Porosity (%)	Tear resistance (mN)	Transmittance (%)	Young's modulus (GPa)	Simplified quality index	Energy consumption (MWh/t)
B-CBF127-5	21.5	256 ± 7	30.6 ± 1.4	80 ± 9	4,77 ± 0.60	9,44 ± 0.21	63.9 ± 2.8	6.893± 1.950
B-CB127-20	68.4	206 ± 2	25.7 ± 6.0	47 ± 3	11,01 ± 3.23	9,15 ± 0.58	71.4 ± 4.7	10.905 ± 1.017
B-CB1229-10	101.7	246 ± 2	31.2 ± 2.8	30 ± 4	31,34 ± 0.61	7,86 ± 0.25	72.0 ± 3.3	14.915 ± 1.575
B-CB1227-15	158.9	164 ± 2	19.3 ± 1.4	48 ± 3	9,17 ± 0.84	9,35 ± 0.10	74.0 ± 2.2	12.845 ± 1.343
B-CB12212-20	19.7	361 ± 3	22.0 ± 1.9	35 ± 3	12,91 ± 1.23	8,86 ± 0.09	71.4 ± 2.6	11.354 ± 2.136
B-CA12212-20	14.3	323 ± 2	21.1 ± 1.4	42 ± 10	10,49 ± 0.67	8,08 ± 0.13	69.8 ± 3.4	11.387 ± 0.672
B-BF-10	0.0	323 ± 6	19.7 ± 1.0	60 ± 4	2,23 ± 0.67	8,68 ± 0.12	65.9 ± 2.6	12.127 ± 1.366
B-BFF-10	0.0	499 ± 10	29.4 ± 1.4	70 ± 5	14,04 ± 1.00	6,78 ± 0.14	58.4 ± 2.5	18.433 ± 1.090

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MADRAS

Mercerisation + enzymes

cellulose

NaOH (5, 10, 15%)

washing

Enzymes

Masuko Grinder

	Turbidity (NTU)	Transmittance (%)	Tear resistance (mN)	Young's modulus (GPa)	Porosity (%)	Quality index
Enz. hydr.	240 ± 48	7.1 ± 0.06	31 ± 9	11.21 ± 0.41	29.7 ± 2.5	75.0 ± 5.1
NaOH 10 wt%	761 ± 37	15.4 ± 1.17	27 ± 4	4.84 ± 0.20	38.5 ± 1.8	54.0 ± 2.8
NaOH 10 wt% + enz. hydr.	314 ± 13	42.2 ± 0.86	9 ± 3	8.94 ± 0.24	27.2 ± 9.5	82.7 ± 5.4

Grades	1 (Sylcita)	CMC	Phos.	NaOH
Transmittance [550 nm]	7	32	31	42
Transparency [%]	79	84	84	84

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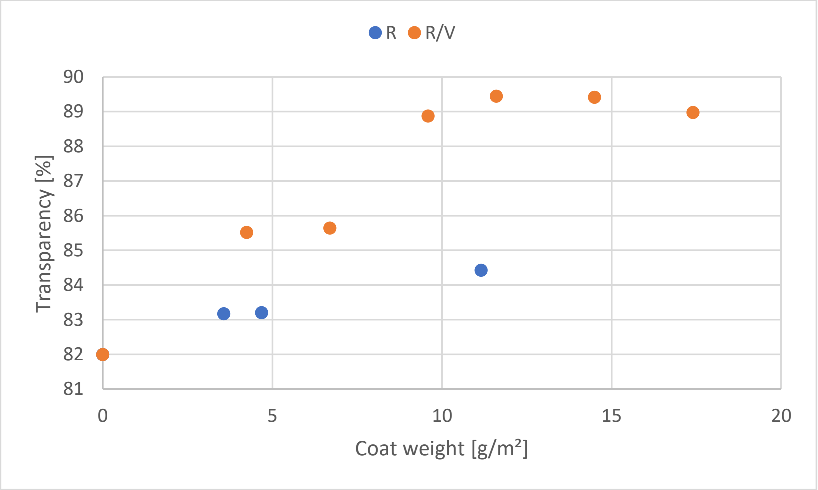
MADRAS

Planarization

- Planarization was tested on grade 1 FC substrate, on one side and on 2 sides
- A plateau is obtained at 10 g/m² coating / side with +7 in transparency

- PVDC is used because of its high surface energy and barrier properties
- The idea is to combine Planarization with high QI FC paper



With planarization

Without planarization

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MADRAS

Conclusion of Madras (after 1 year)

- Sylvicta a translucent paper made with FC of medium Quality
- After 1 year, 2 routes to increase transparency and dimensional stability
- New pre-treatments, with a result a + 5 points in transparency
- Planarization with aqueous coating of PVDC (up to +7 points in transparency)
- The idea is to combine Planarization with high QI FC paper to reach 90 % of transparency, with good barrier, to be able to replace PET

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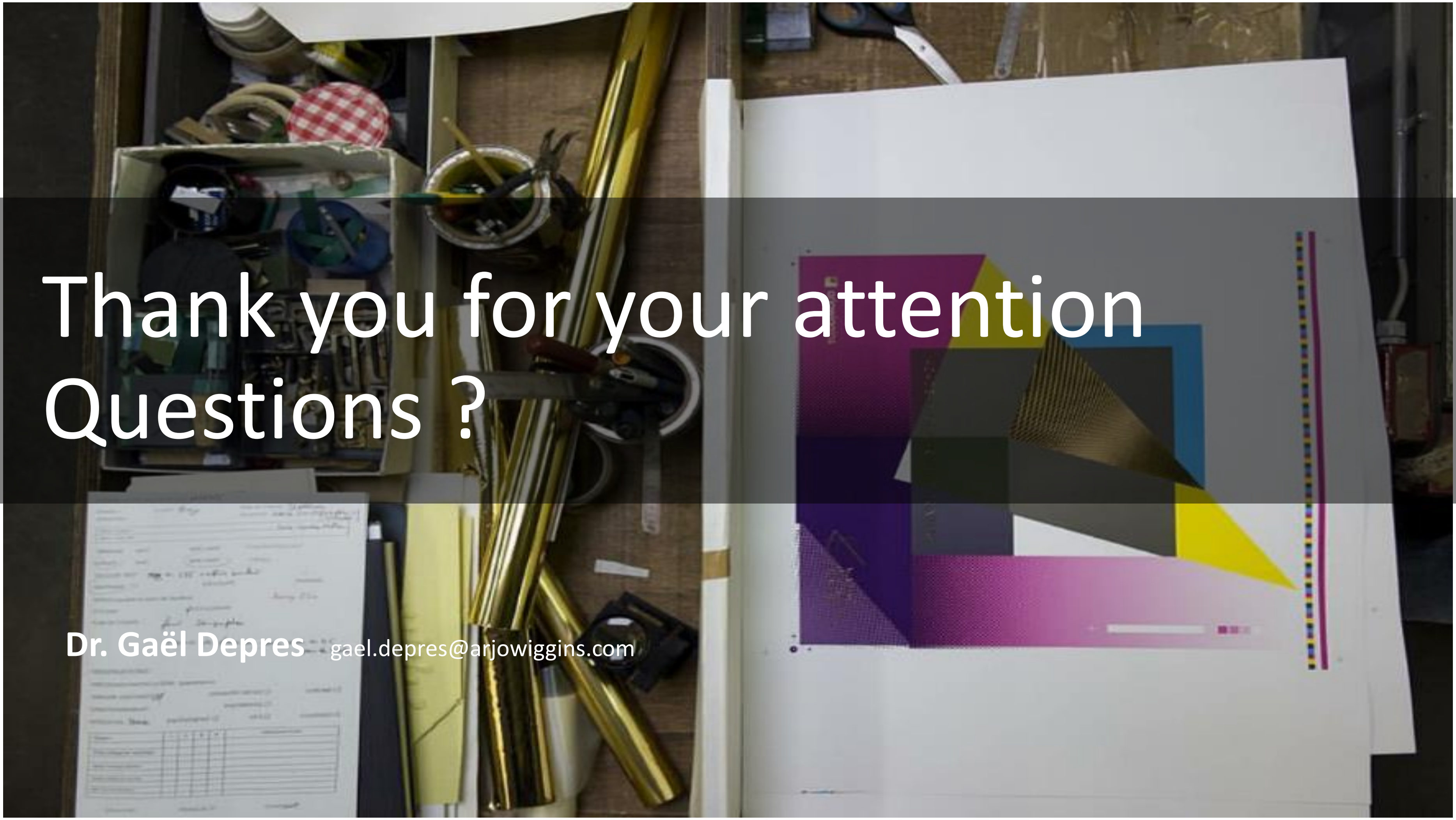
MADRAS

CONCLUSIONS

- Printing Electronics on paper can be done at industrial scale, for NFC, UHF and sensors product
- Recyclability of paper electronics has been proven and the recycle chain for paper packaging is existing with high recyclability values
- LCA of 2 existing devices showed that the main impacts are coming from the silicon chip and the silver ink. A changed of process has been done to reduce the quantity of silver (flexo). Paper has showed better environmental impact than plastic
- In a new EU project, named Madras, we increased the transparency of our Sylvicta paper, with the aim to reach 90 % and to replace PET
- Thus, printing Electronics on paper is a way to reduce the e-waste and the plastic issues for incoming products in intelligent packaging and labels.



Thank you for your attention
Questions ?

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