

# **PRINTED ELECTRONICS ON RECYCLED PAPER, CARBOARD AND FOILS**

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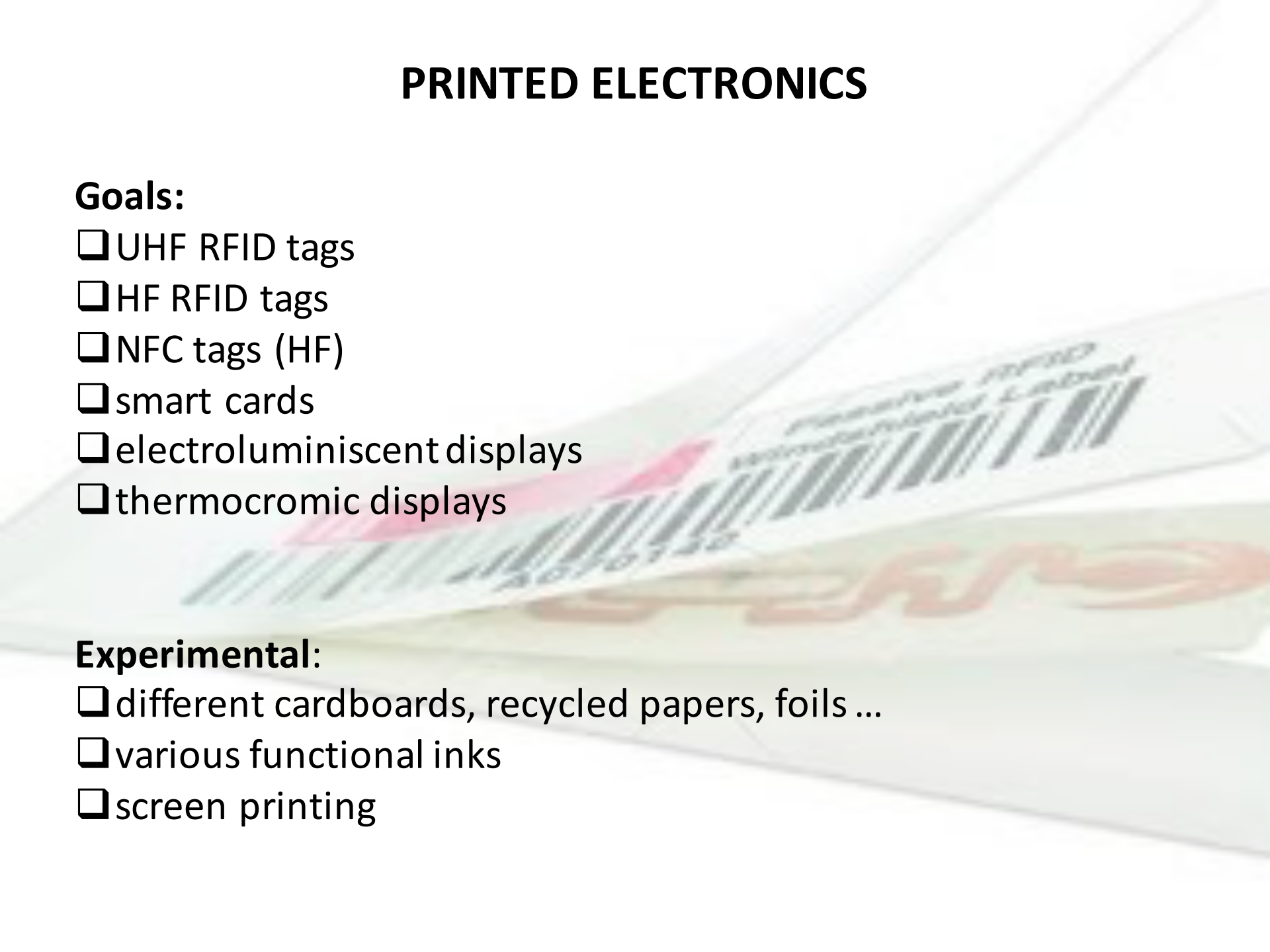
# PRINTED ELECTRONICS

## Goals:

- ☐ UHF RFID tags
- ☐ HF RFID tags
- ☐ NFC tags (HF)
- ☐ smart cards
- ☐ electroluminiscent displays
- ☐ thermocromic displays

## Experimental:

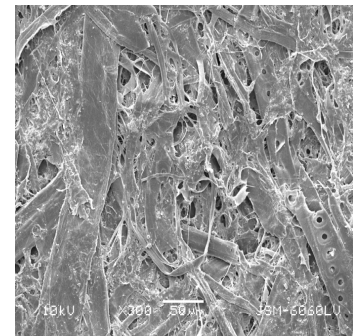
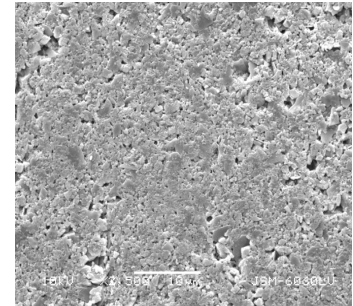
- ☐ different cardboards, recycled papers, foils ...
- ☐ various functional inks
- ☐ screen printing



# PRINTED ELECTRONICS

## Printing substrate properties:

Property / Paper	Cardboard	Coated paper	Uncoated paper
Grammage (g/m <sup>2</sup> )	295	59.7	58.9
Thickness (mm)	0.505	0.065	0.113
ISO brightness (%)	93.0	82.2	85.7
Gloss (%)	50.5	16.5	3.0
Roughness (mL/min)	12.24	69	764
Air permeance (mL/min)	46.67	16	381
Capillary rise (mm)	15.4	8.0	87.4
Print penetration (/)	8.17	10.2	23.2

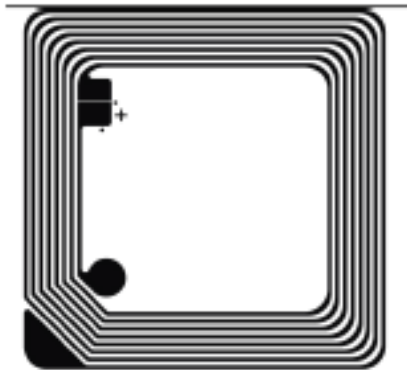


**Printing inks:** conductive silver based thermochromic and UV curable inks, dielectric inks, electroluminescent inks ...

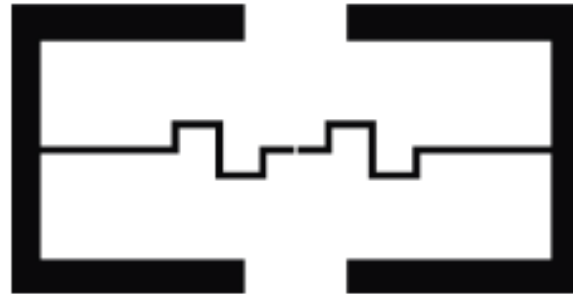
# PRINTED ELECTRONICS

## Antenna design and preparation of printing forms:

HF RFID antenna

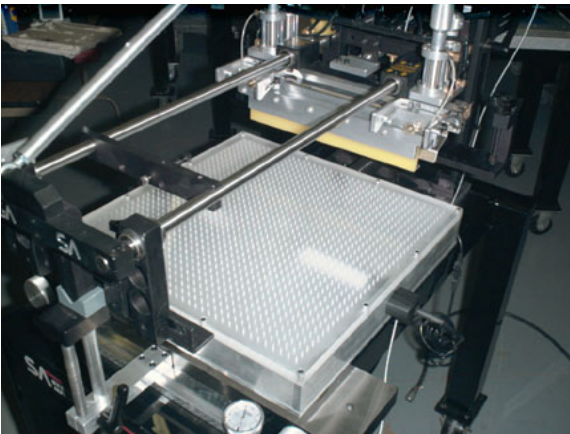
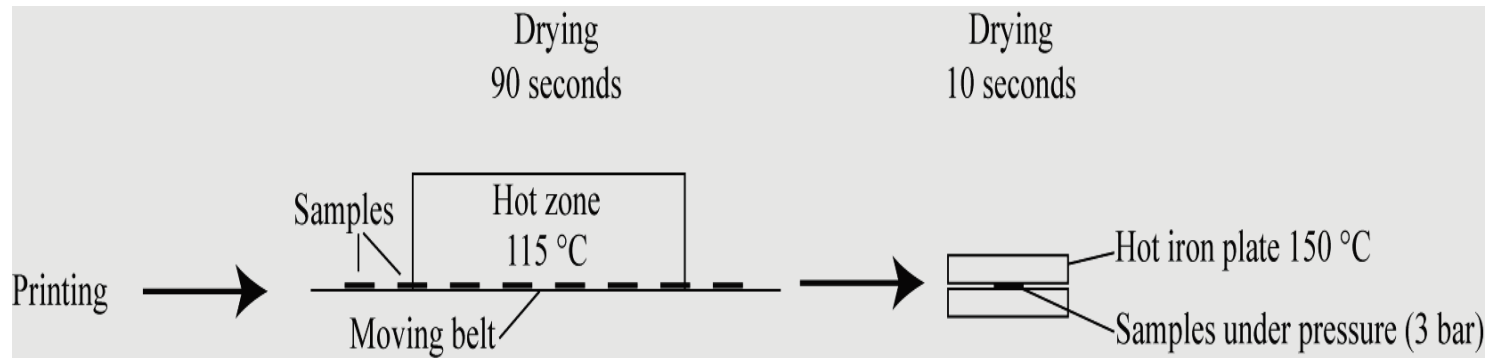


UHF RFID antenna

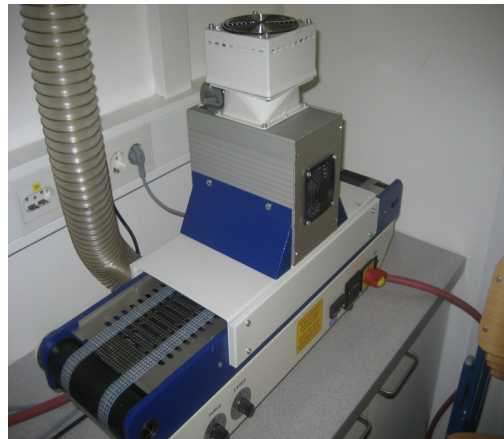


# PRINTED ELECTRONICS

## Printing and drying:



semi-automatic  
screen printer



IR tunnel



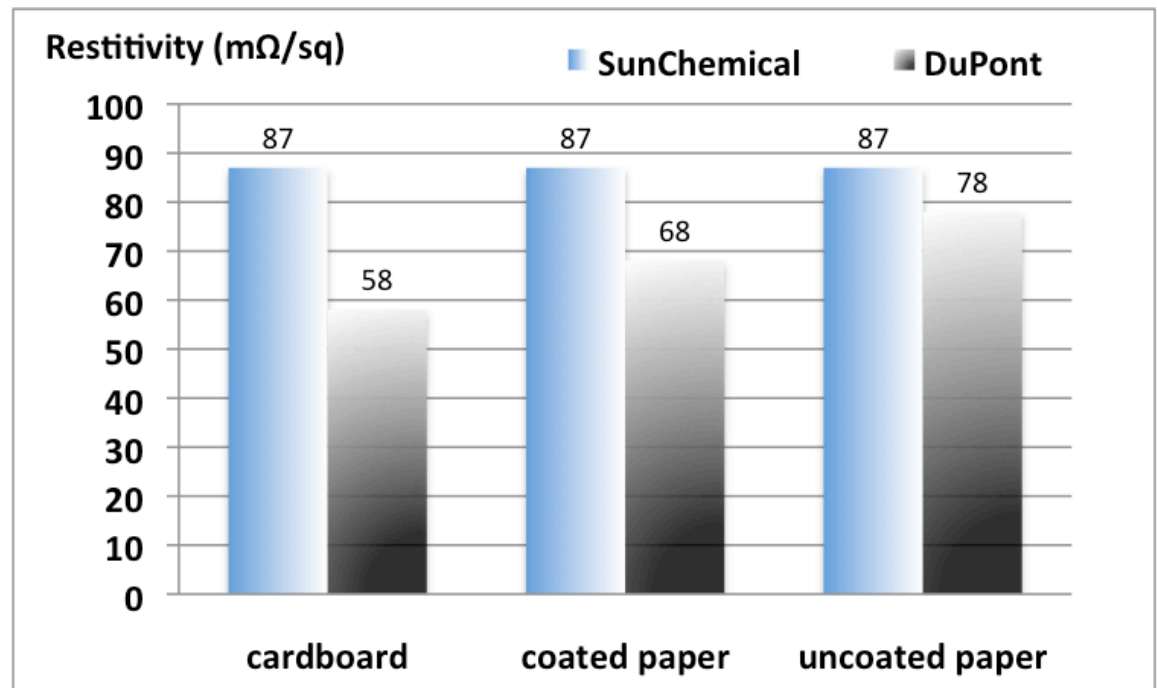
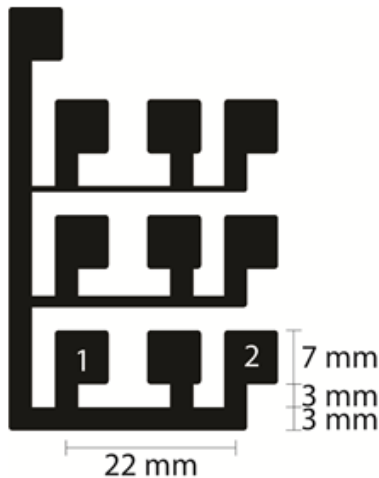
Heat-press device

# PRINTED ELECTRONICS

## Results:

Resistance measurement between points 1 and 2 and calculation of sheet resistivity.

$$N_{sq} = \frac{L}{W} = 10.3 \qquad R_{sh} = \frac{R}{N_{sq}}; \frac{\text{m}\Omega}{\text{sq}}$$



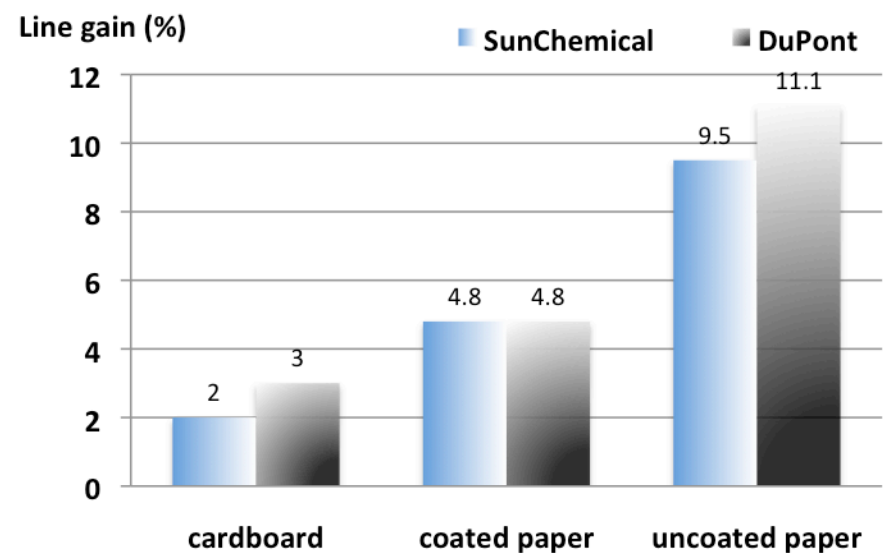
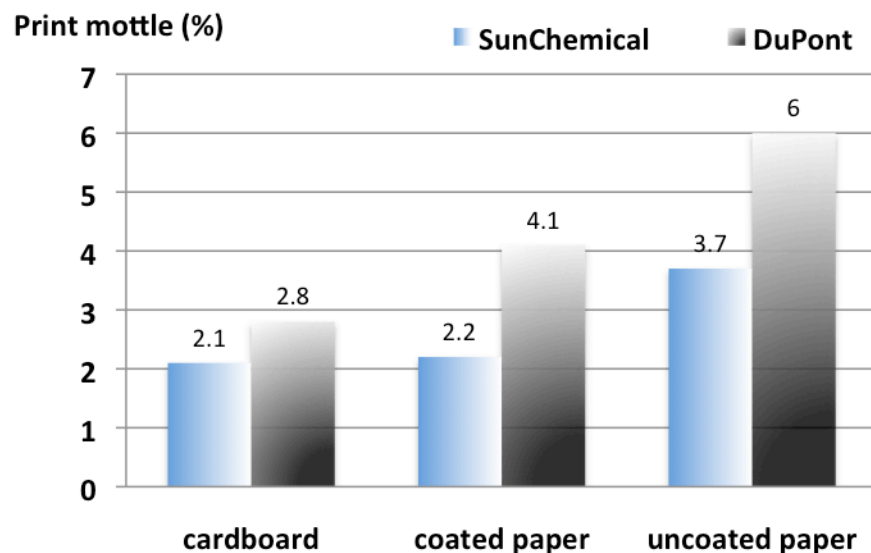
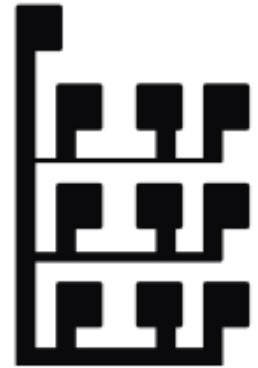


# PRINTED ELECTRONICS

## Results:

Print mottle: STFI method  $CV = \frac{\sigma}{\bar{x}}$

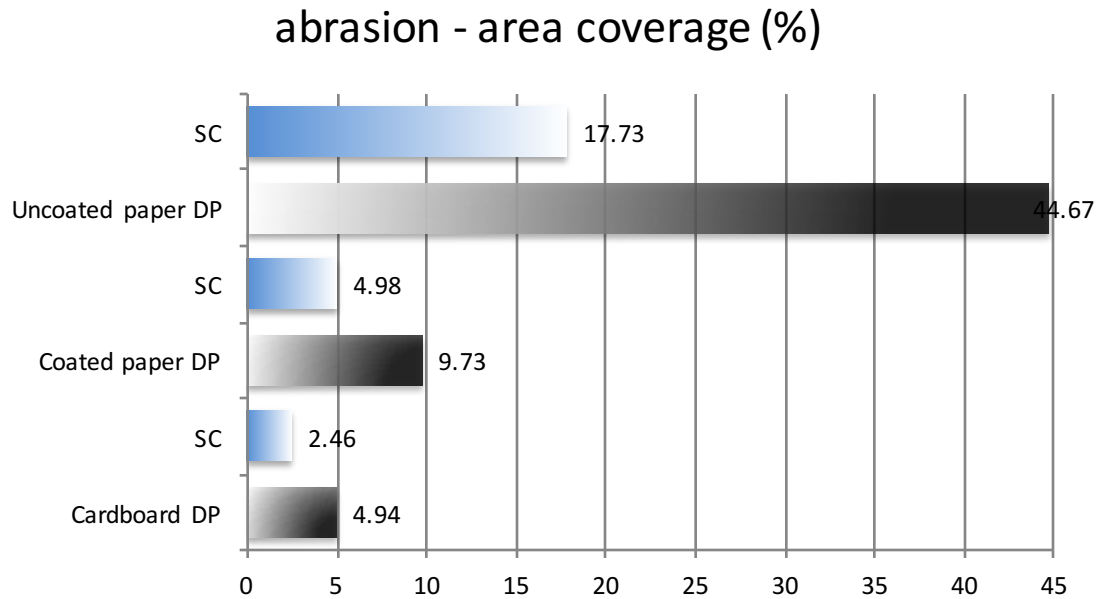
Line gain:  $\Delta L(\%) = \left( \frac{\sum_1^{10} LA_p \cdot 100}{\sum_1^{10} LA_{id}} \right) - 100$



# PRINTED ELECTRONICS

## Results:

### Abrasion resistance



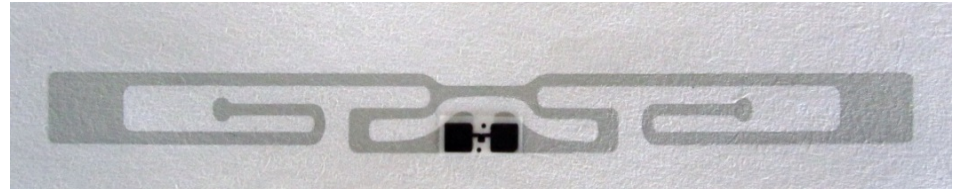


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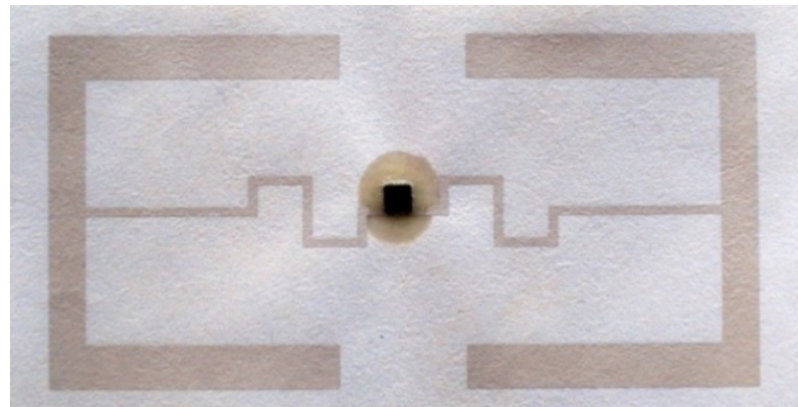
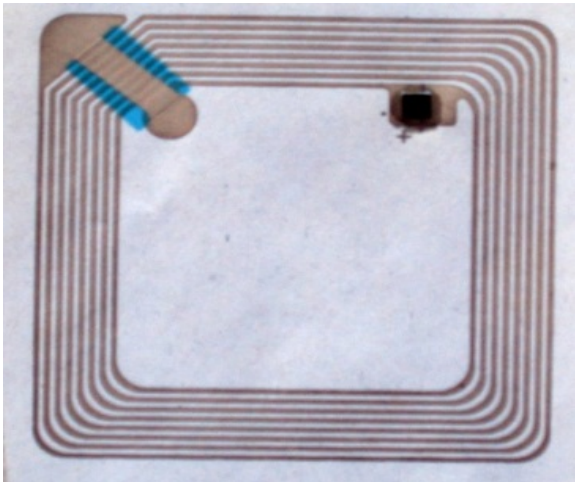
## Chip integration:

Successful implementations of HF and UHF RFID chips

Strap chip (Fraunhofer)



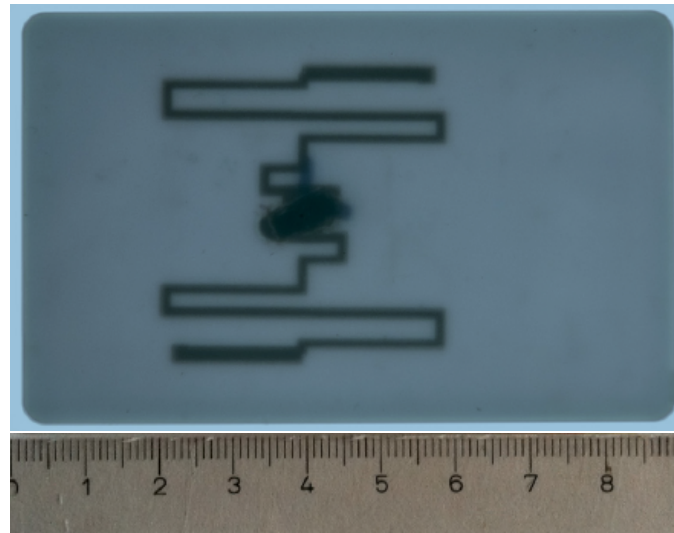
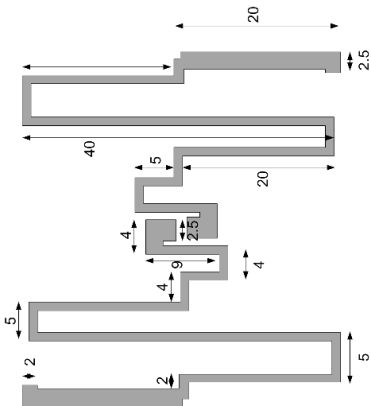
Flip chip (IDS)



# UHF RFID TAGS IN SMART CARDS

Successful implementation UHF RFID tags for smart card applications.

- HF tags can be replaced with UHF tags
- the industrial screen and flexography printing
- flexography is faster solution, but screen printing allows better repeatability



# PRINTED HF ANTENNA FOR NFC

Successful implementation of NFC tags for various applications using mobile devices.

- ❑ printed NFC (HF) antenna
- ❑ integrated chip with T sensor

Beside conventional NFC applications, T can be read with mobile phone.

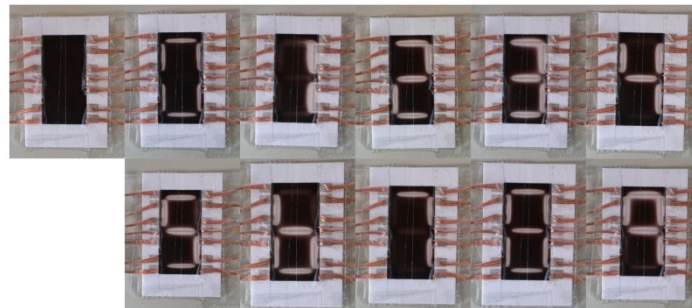


)) NFC ))



# PRINTED ELECTROLUMINESCENT AND THERMOCHROMIC DISPLAYS

Successful implementation of electroluminescent and thermochromic displays on cardboard packaging.





COST Action FP1405

Active and intelligent fibre-based packaging – innovation and market introduction  
(ActInPak)

**Thank you for your attention!**

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