Compact Low-resistance Screen-printed Flexible Antennas for NFC Applications

M. Mashayekhi[1], A. Loi[1], P. Gaucci[1], B. Feixas[1], C. Delgado Simao[1], P. Lacharmoise[1]

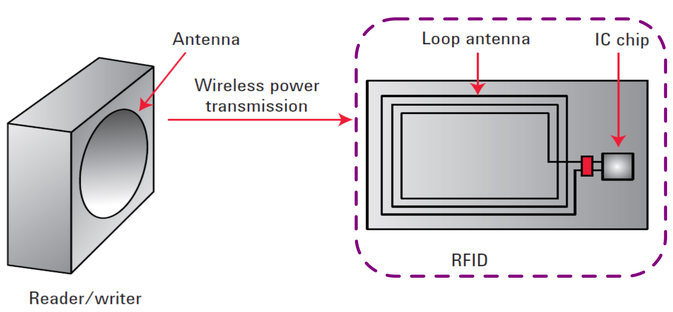
[1]*Eurecat - Technological Centre of Catalonia, Av. Ernest Lluch 36, 08302, Mataro, Spain*

e-mail address: Moha.mash@eurecat.org

Abstract

- Near Field Communication (NFC) is a wireless technology working on High Frequency that enables the exchange of data in a short range (<10cm), by establishing a peer to peer communication between the transponder and the reader
- The flexibility and miniaturization of the tag antenna plays an important role in implants, packaging, and payment applications
- There is always a trade-off between the desired miniaturization of the chip (<3cm^2) and maximum resolution of low-cost printing techniques such as screen printing. Therefore, increasing the quality factor of the printed antennas while keeping the total dimensions small enough is challenging for implant applications
- In this work, we developed flexible compact low-resistance screen-printed NFC antennas with high quality factor, as well as the footprint and interconnections, on which the SMD components of the tag circuit are hybridized.

Schematic Diagram

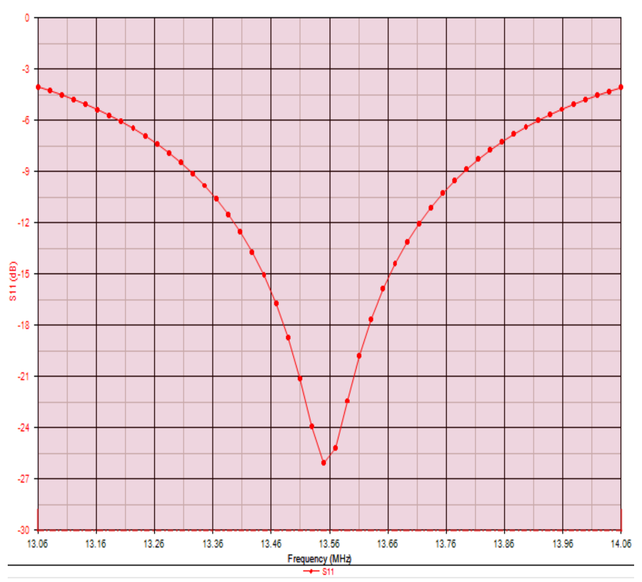


The chip is replaced by SMD components to:
1. Tunning capacitor (F= 13.56Mhz)
2. Full-wave Rectifying circuit
3. Ripple (smoothing) capacitor

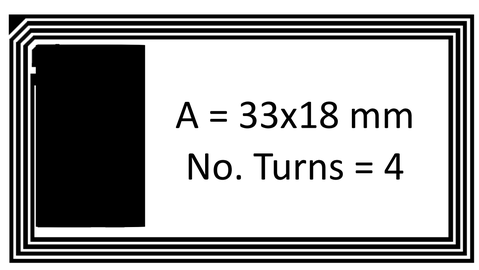
$$\omega_0 = \frac{1}{\sqrt{LC}}$$

Simulation

- KeySight Genesys RF design
- Maximize the efficiency of the tag antenna (S param) by defining the optimum:
  1. Geometrical design (considering the limitations of the total size and DRCs)
  2. Impedance matching (minimum No. components)
- Return loss = -25dB



Layout Design



The circuit layout is first designed by Altium and then adopted to screen-printing and pick&place geometrical design rules (DRC)
Line width and spacing = 250 um

Fabrication

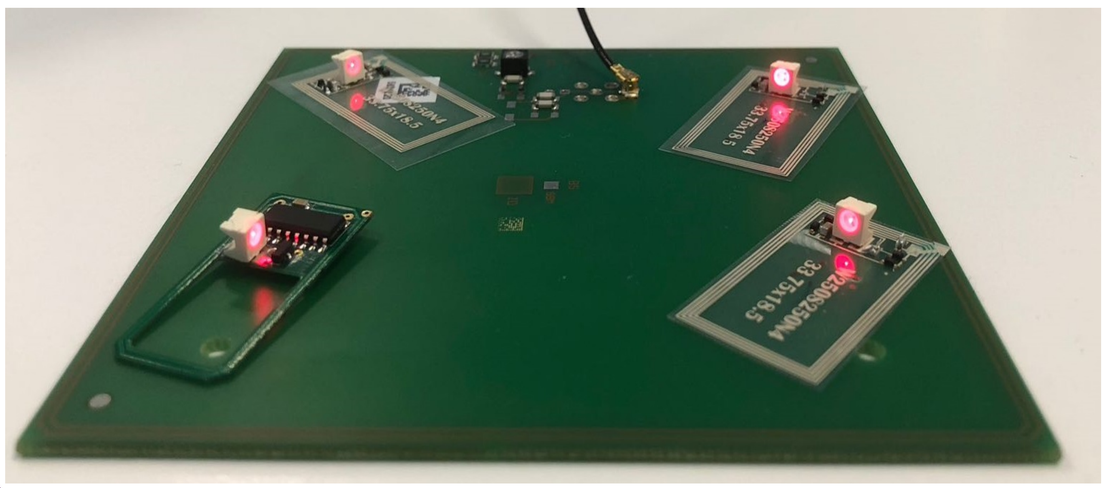
- Ink: Low resistivity silver ink 5064H
- Substrate: Polyethylene therftalate (PET) plastic foils (thickness 125 um)
- Mesh 120: the best trade off between the resolution and conductivity
- Thermal Curing: 120 degree for 15 min
- Photonic Curing: 300V, 1800us pulse
- Pick & Place:
  Delomonopox AC265 adhesive paste
  Drop volume of 0.03 cc

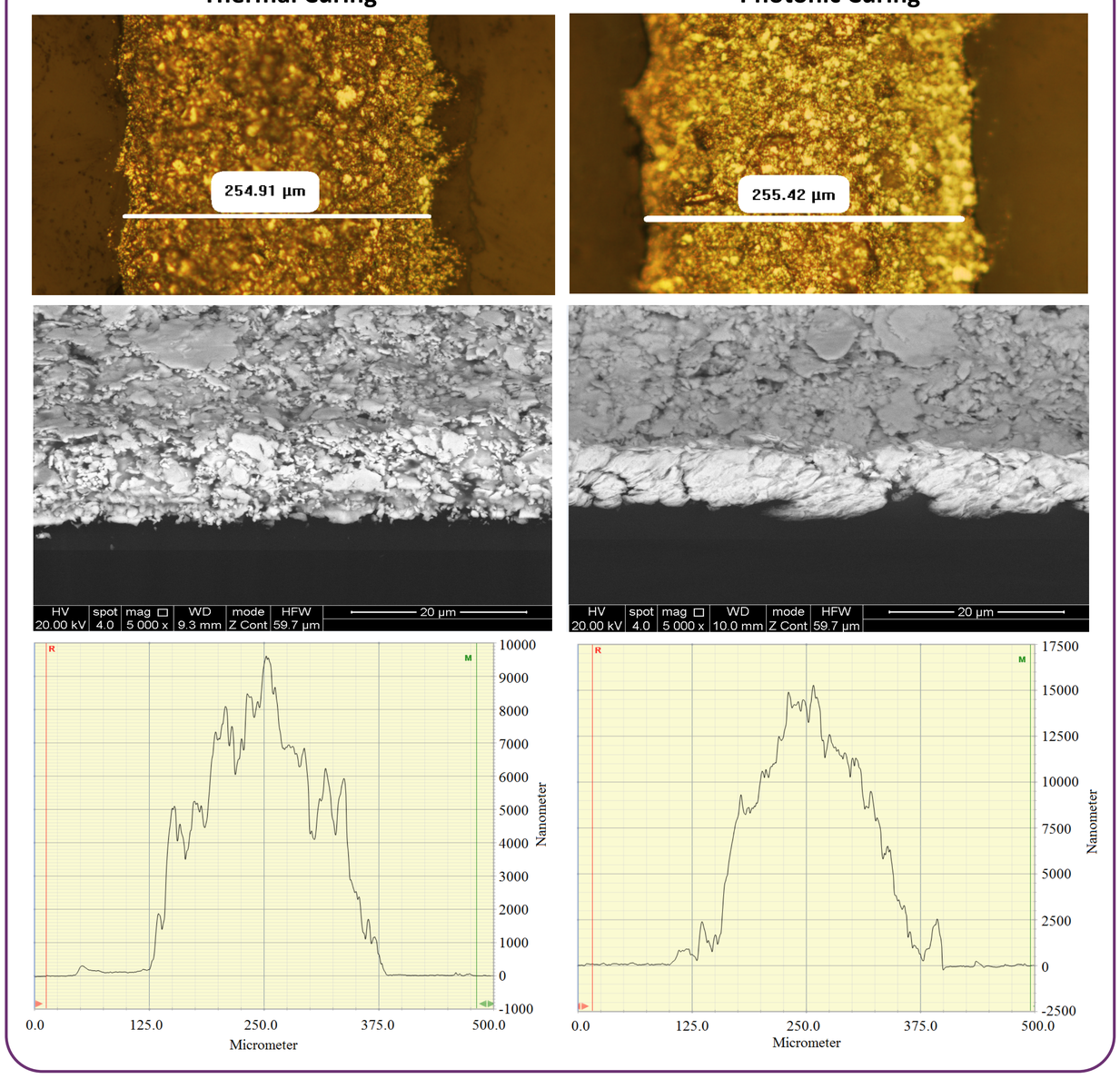
Characterization

	Thermal	Photonic
L (uH)	1,5	1,5
R (Ω)	55	41
R_S(Ω)	0.037	0.025
%RSD	6.5	11
T (um)	9.5	15
QF	2,32	3,11

Validation

An LED to check the functionality of the antenna and integrated circuit.





Conclusion

- Flexible and miniaturized NFC antennas with low-resistance and high quality factor (QF>2) were fabricated by screen printing
- A key challenge in development of printed NFC antennas with high QF is to obtain high conductivity and induction of the loop
- Photonic Curing was used as the solution for minizing the resistance of the antennas while keeping the induction high by taking the most advantages of the real state area

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 720694.