INN PRESSME

Open Innovation Test Bed

Bioguard

Biodegradable Antennas for Counterfeit Protection

INN-PRESSME Final event

December 2nd 2024 - in Brussels

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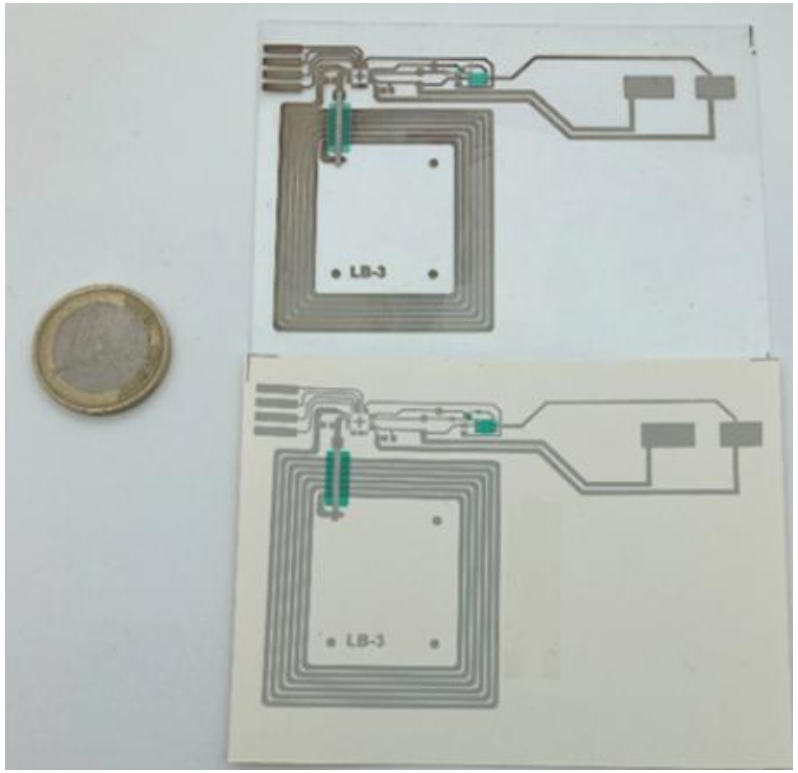
Objectives of the project

Versarien | cidetec surface engineering PL5 - INK | cea PL13 - PICTIC



BIOGUARD developed a conductive ink for the production of printed near-field communication (**NFC**, a short-range wireless technology) antennas typically used in applications such as anti-counterfeit.

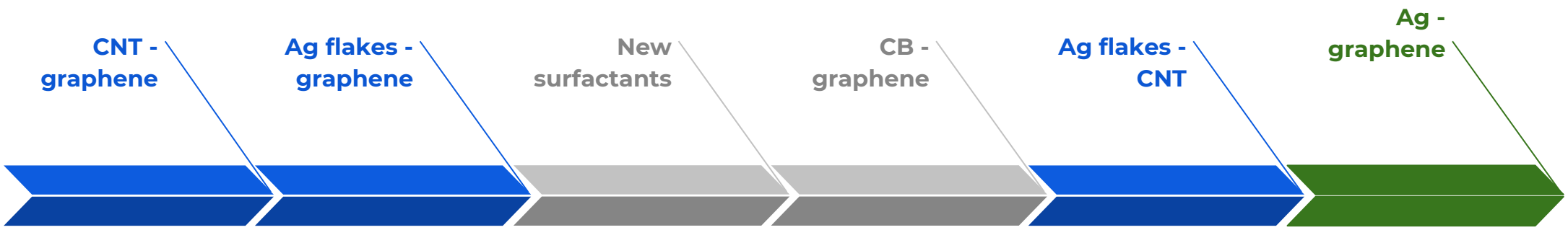
The primary objectives sought to print these inks on paper-based substrates which could be recyclable or biodegradable (currently using metallic antennas on plastic substrate).

Title	Lead	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Project Management &Exploitation	CEA									
Graphene Dispersion production	CGL									
Graphene ink formulation & characterization	CID									
Inks printability assessment	CEA									
Antenna manufacturing and testing	CEA									

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°952972

Products and materials

The project explored different graphene-based formulations, with the aim to reduce the sheet resistance* of the printable ink.



CNT - graphene	Ag flakes - graphene	New surfactants	CB - graphene	Ag flakes - CNT	Ag - graphene
~17 Ω/□ @ 35 µm (0.1% loading)	**~17 Ω/□ @ 30 µm (1:2 G:Ag ratio)**	**~15 Ω/□ @ 55 µm (new surfactant)**	**~12.7 Ω/□ @ 43 µm (20:1 G:CB ratio)**	**~100 Ω/□ (3:1 Ag:CNT ratio)**	**~1 Ω/□ @ 25 µm (<7% Ag)**
Coating difficulties	High contact resistance between graphene and silver flakes.	No improvement to report.	Slight improvement compared to previous formulations	The manufacturing process damaged the particles, this could explain the higher sheet resistance	Best combination of process parameters and formulation components

* As reference, a silver based coating has a sheet resistance ~ 0.4 Ω/□ @ 25 µm

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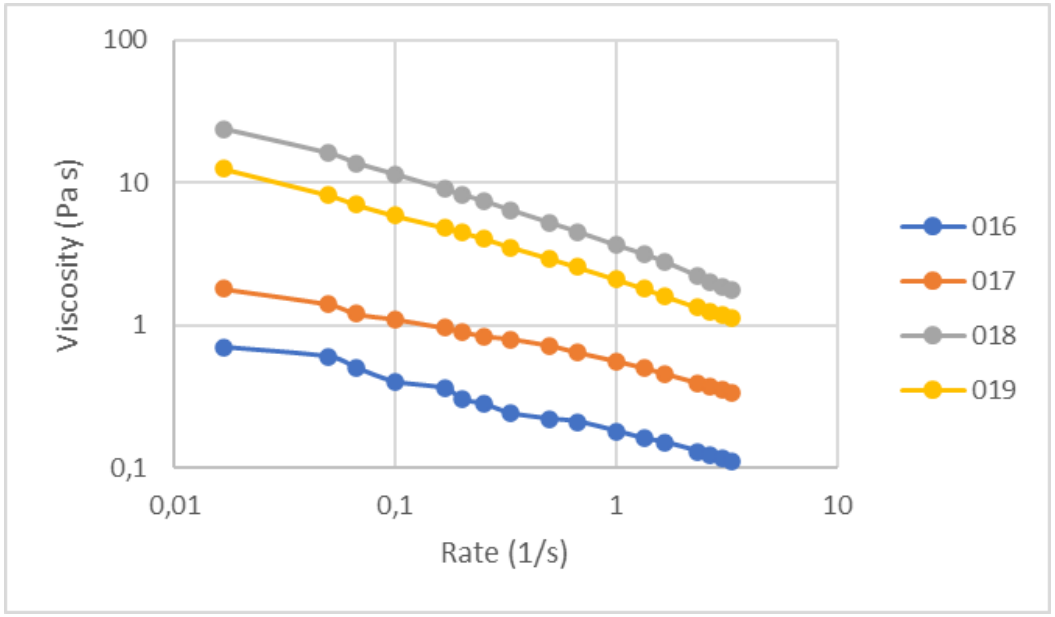
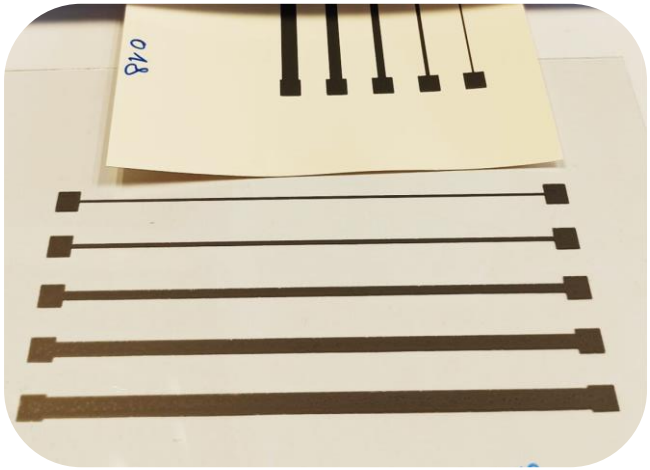
Products and materials



Two potential formulations selected

The use of waterborne hybrid cellulose/graphene-based formulations was attempted, with the aim to enhance the printability of the ink under screen-printing.



Both inks could be screen-printed on diverse substrates (PC, glass, paper). However, electrical properties remained far below target.

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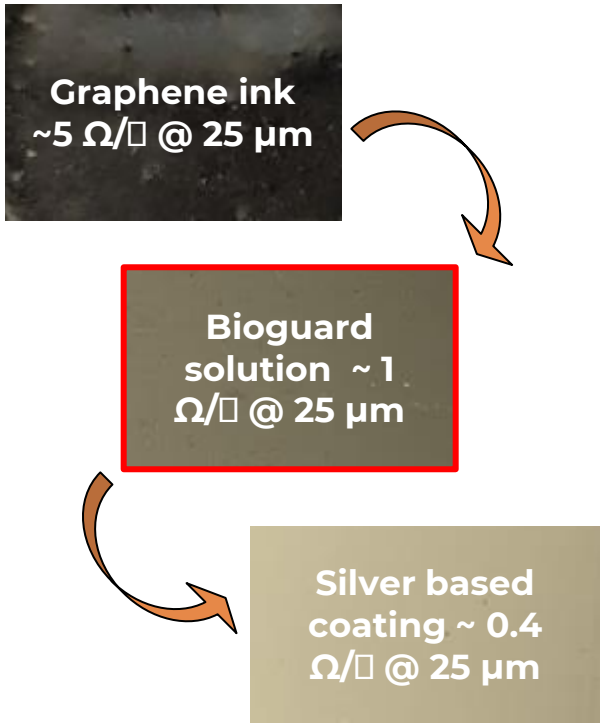
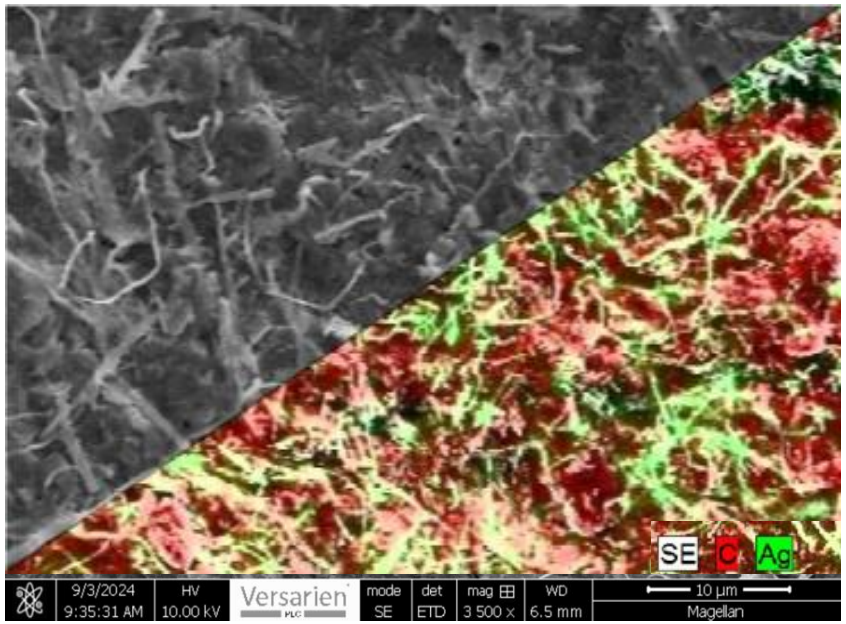
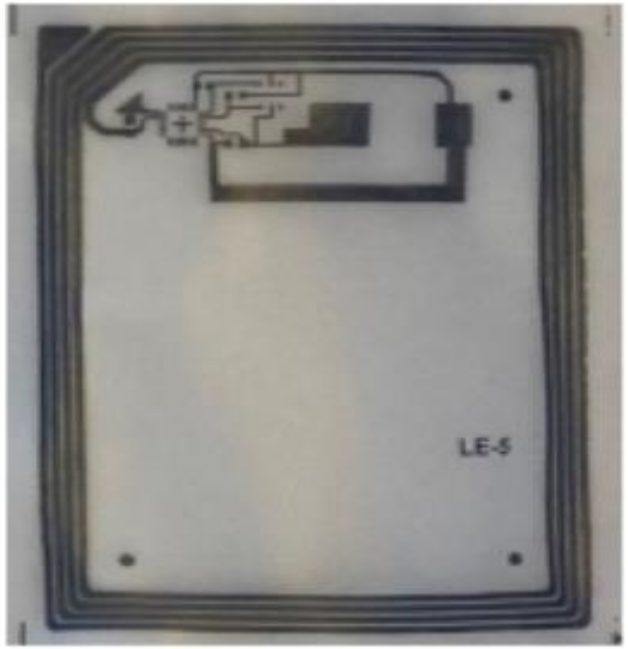
Products and materials





Uniform distribution of silver strands in graphene ink (SEM/EDS image)



The ink can be screen printed on a biodegradable substrate

Best outcome: Ag <7 wt%, graphene 10 wt%

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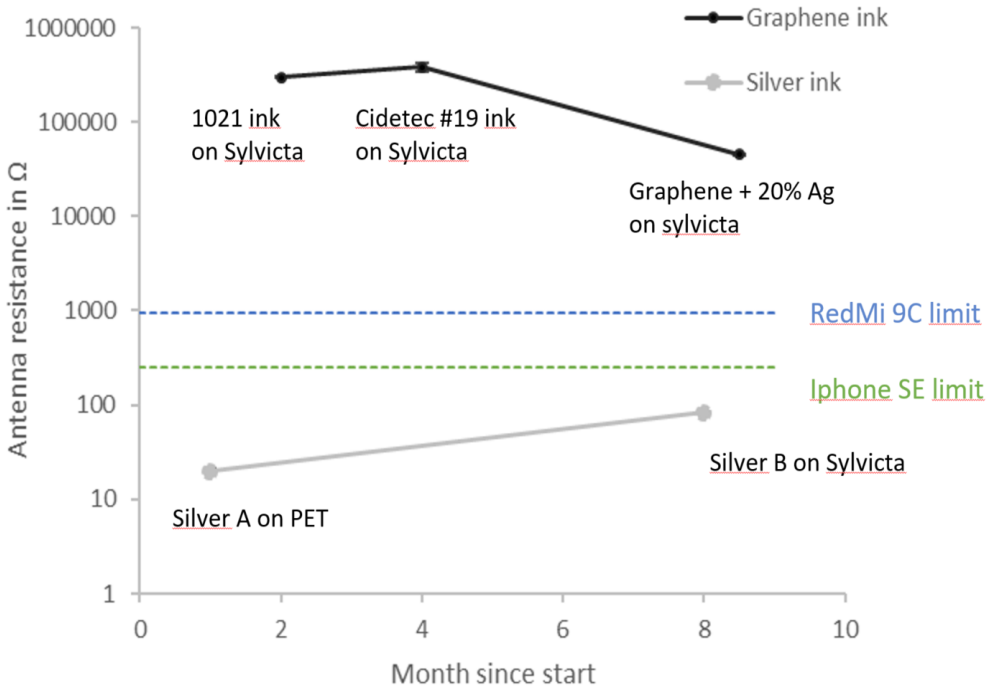
Conclusion

This work enabled to assess the relevancy of graphene for NFC antenna manufacturing, regarding two conventional and commercial phones.

A significant progress thanks to the blend graphene / silver nanostrands lowered the antenna resistance down to 45 kΩ (target <1 kΩ)

Despite this improvement, the antenna resistance is still too high to supply the chip. Yet, this work enabled to open a new path with the realization of in ink with intermediate resistivity closing the gap between metallic ink and graphene-based ink.



This new conductive ink could fill the **market gap** between graphene and metal-based inks and find its usage in producing printed passive resistance in a circuit or used as a strain gauge sensing material, or heating application.

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Thank you

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