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Development and implementation of multifunctional materials for printed electronics in harsh environments

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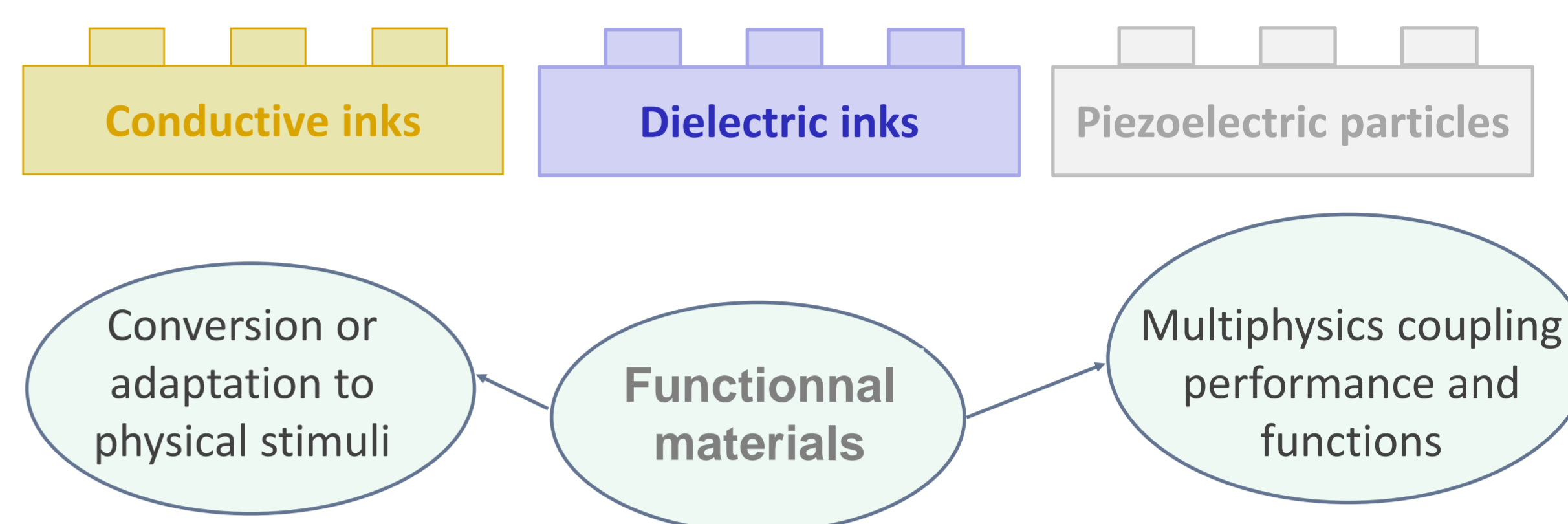
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Abstract

Despite its **potential for interesting applications**, the printed electronics market remains confined to niche applications. The current **technological bottleneck** concerns the lack of maturity of the various related technological building blocks but is also attributable to the context in which printed structures are used, which is becoming increasingly restrictive. Efforts must therefore **focus on the resistance of inks** to high or low temperatures, or to high mechanical and electrical stresses, as well as humidity. These constraints raise new questions about predicting ageing, service life and reliability in the context of **predictive maintenance**.

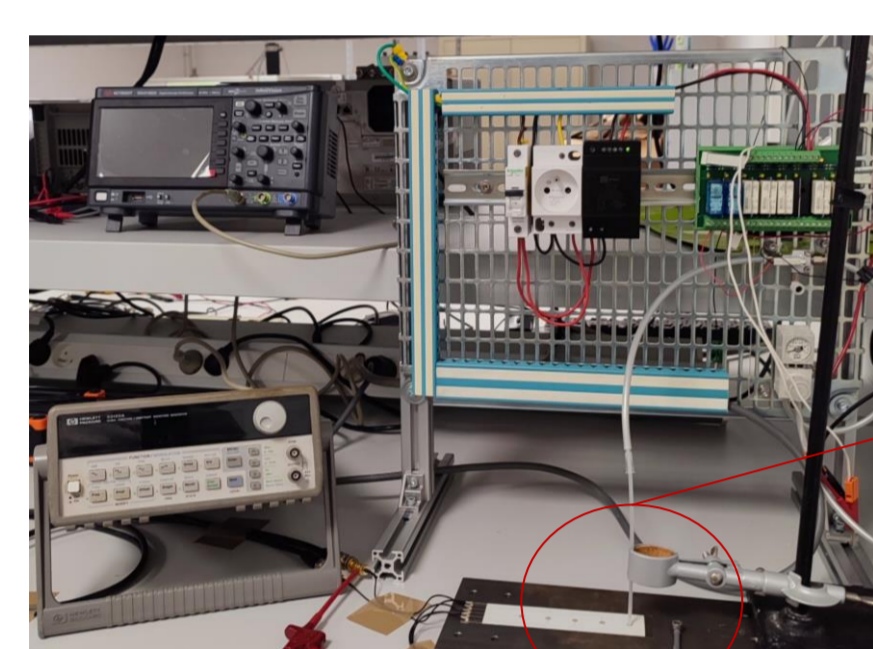
Technological building blocks

Fully integrated devices thanks to functional materials :

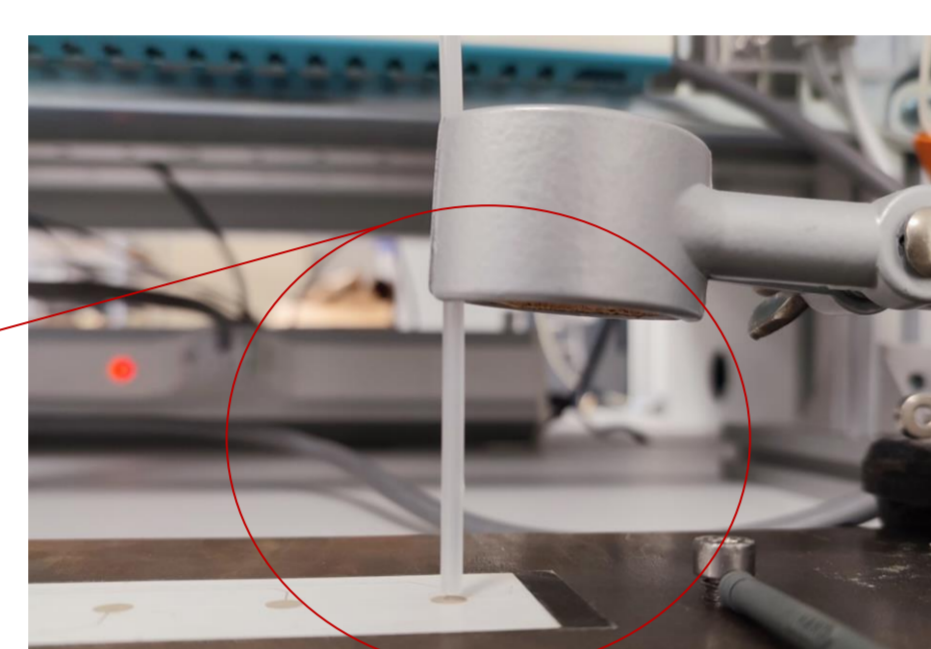


Sensors

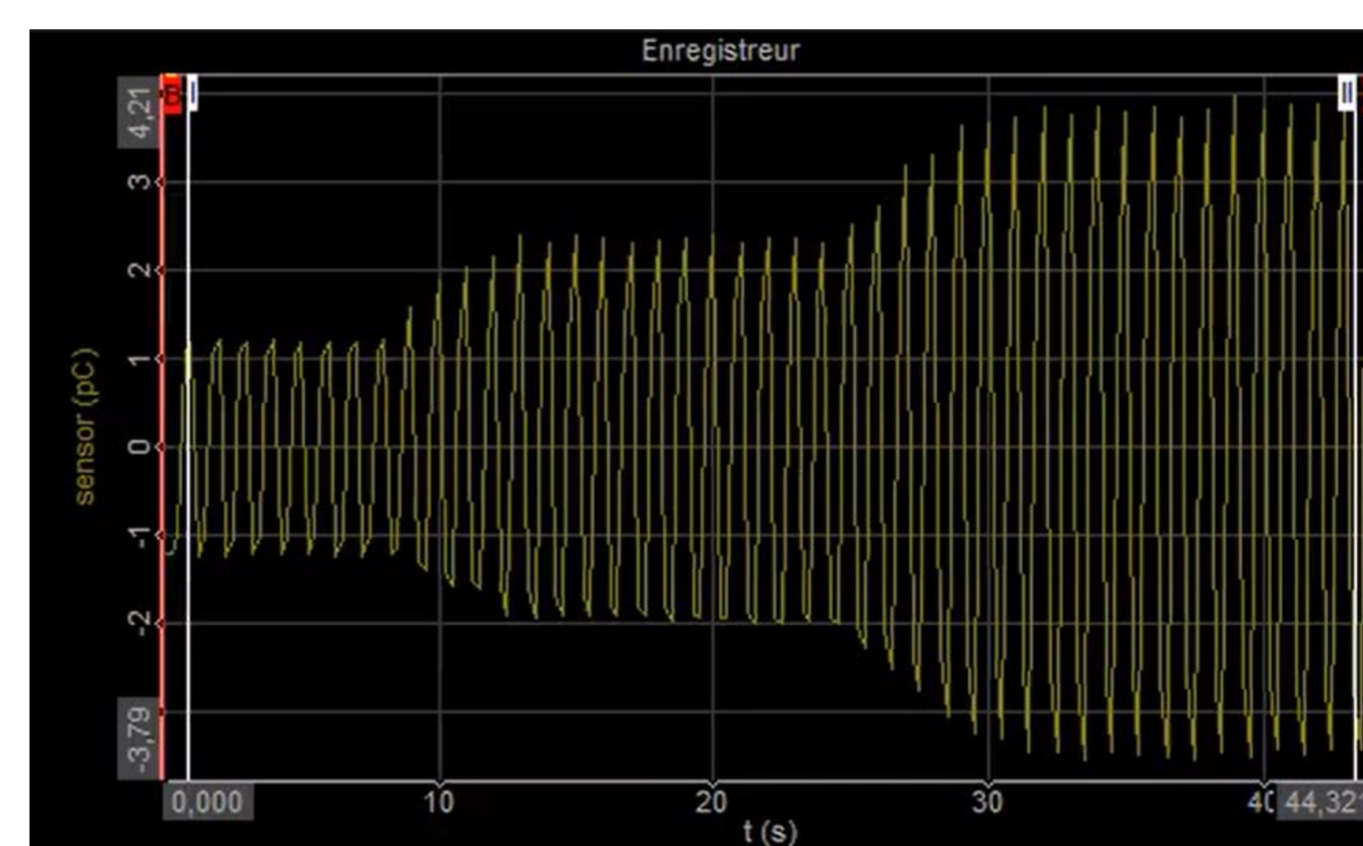
Signal detection: pulsed air



1 Test bench with air supply controlled by a solenoid valve



2 Sensor with piezoelectric particles deposited on a rigid support



❖ Signal detected at 3 different pressures using a charge amplifier and DEWESOFT software.

Sensor applications

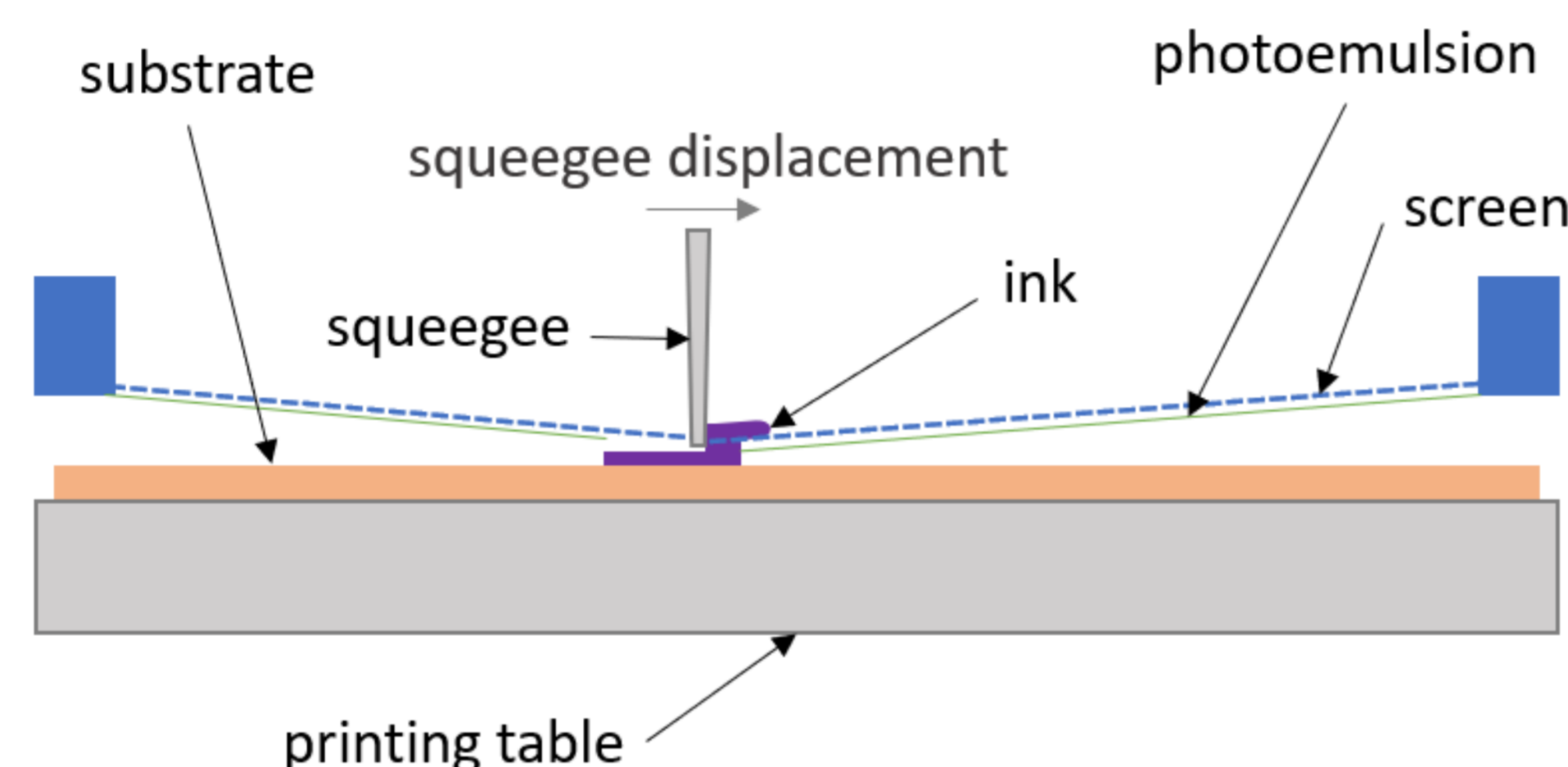
- Medical
- Aeronautics
- Transportation
- Defence
- Space

Material and methods

Printed electronics



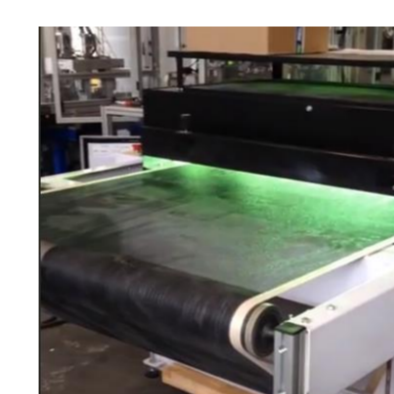
1- Inks selection



2- Screen printing process



3(a)- Thermal drying



3(b)- UV drying

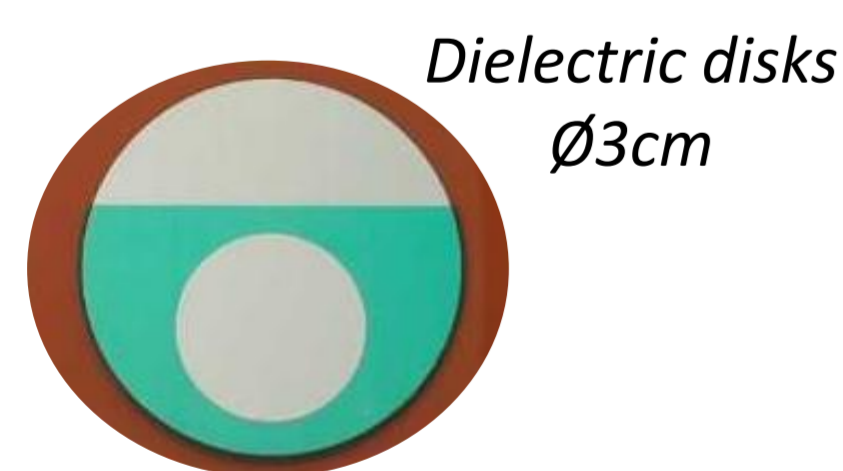


4- Example of screen-printed sensors with piezoelectric particles

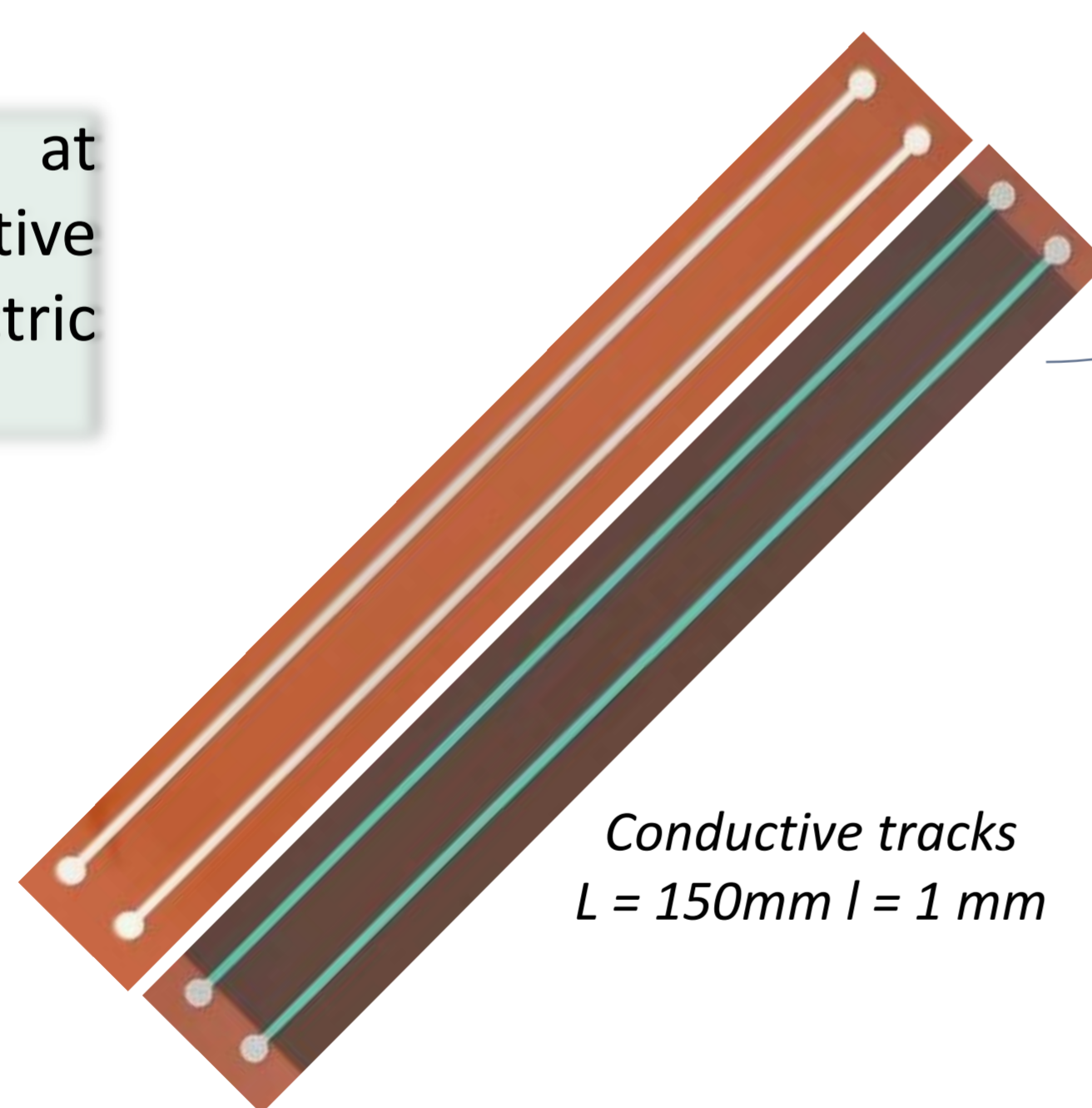
Measurements

Ageing of dielectric and silver inks

❖ Thermal ageing at 220°C of conductive tracks and dielectric disks.



Dielectric disks $\varnothing 3\text{cm}$



Conductive tracks $L = 150\text{mm}$ $l = 1\text{mm}$



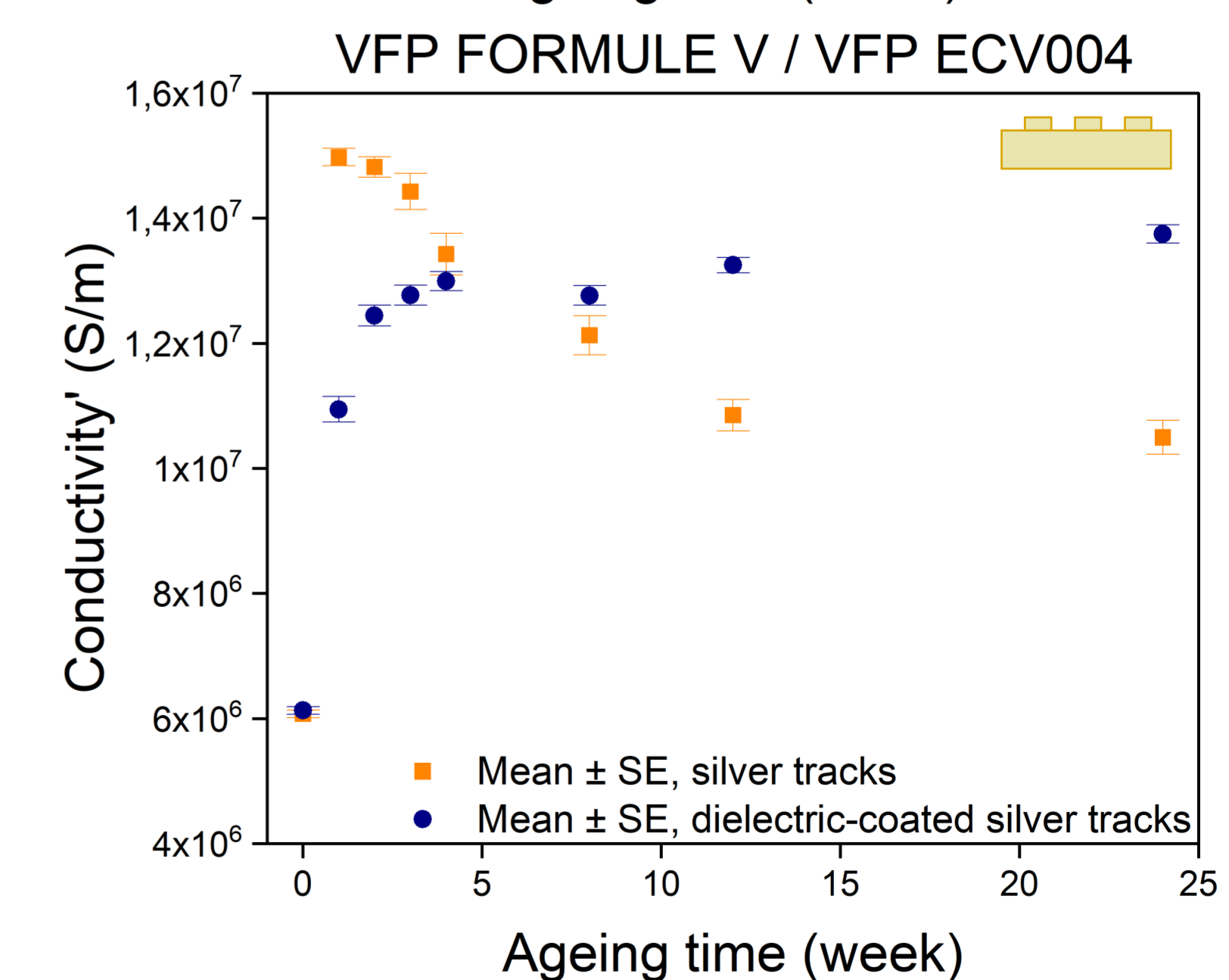
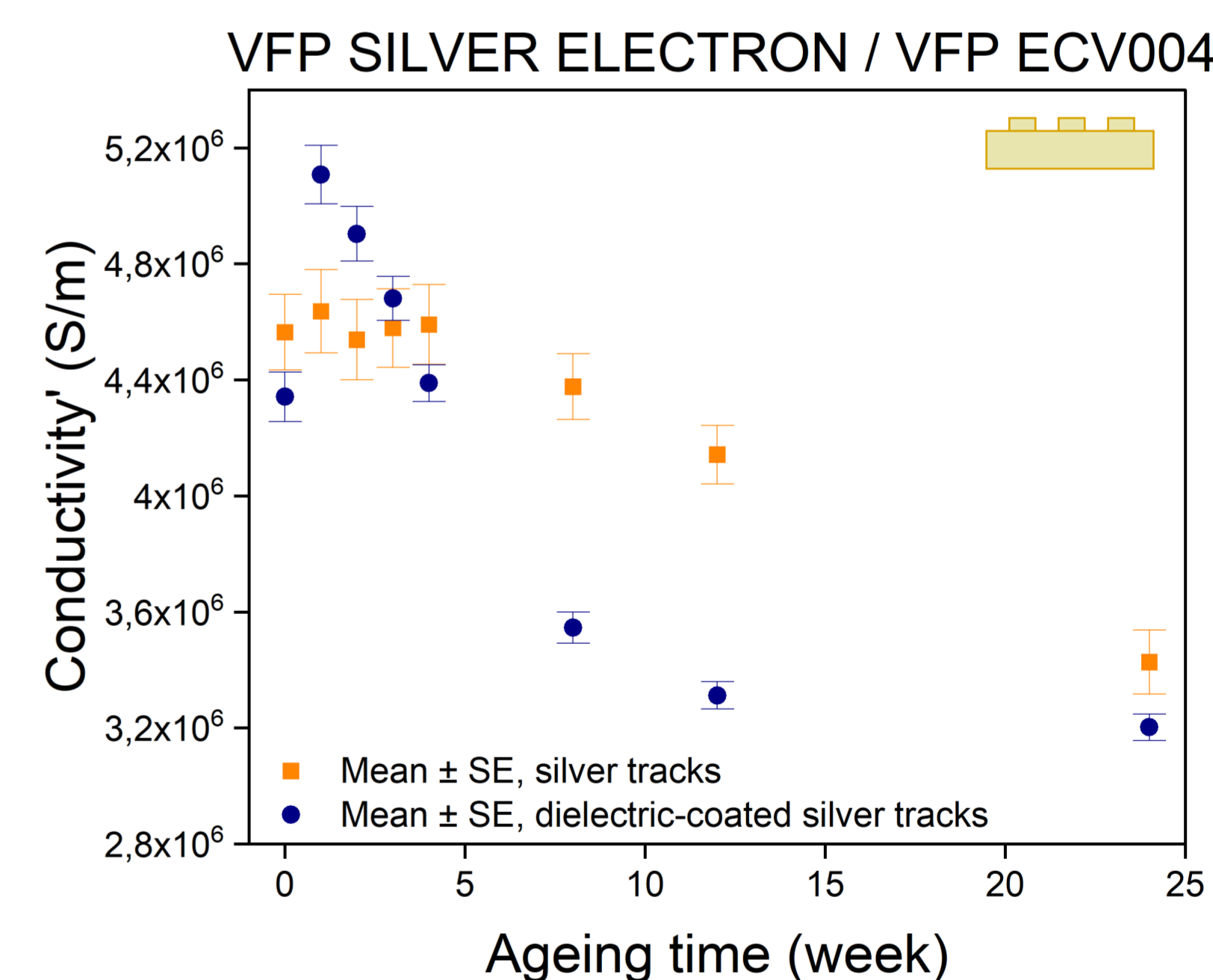
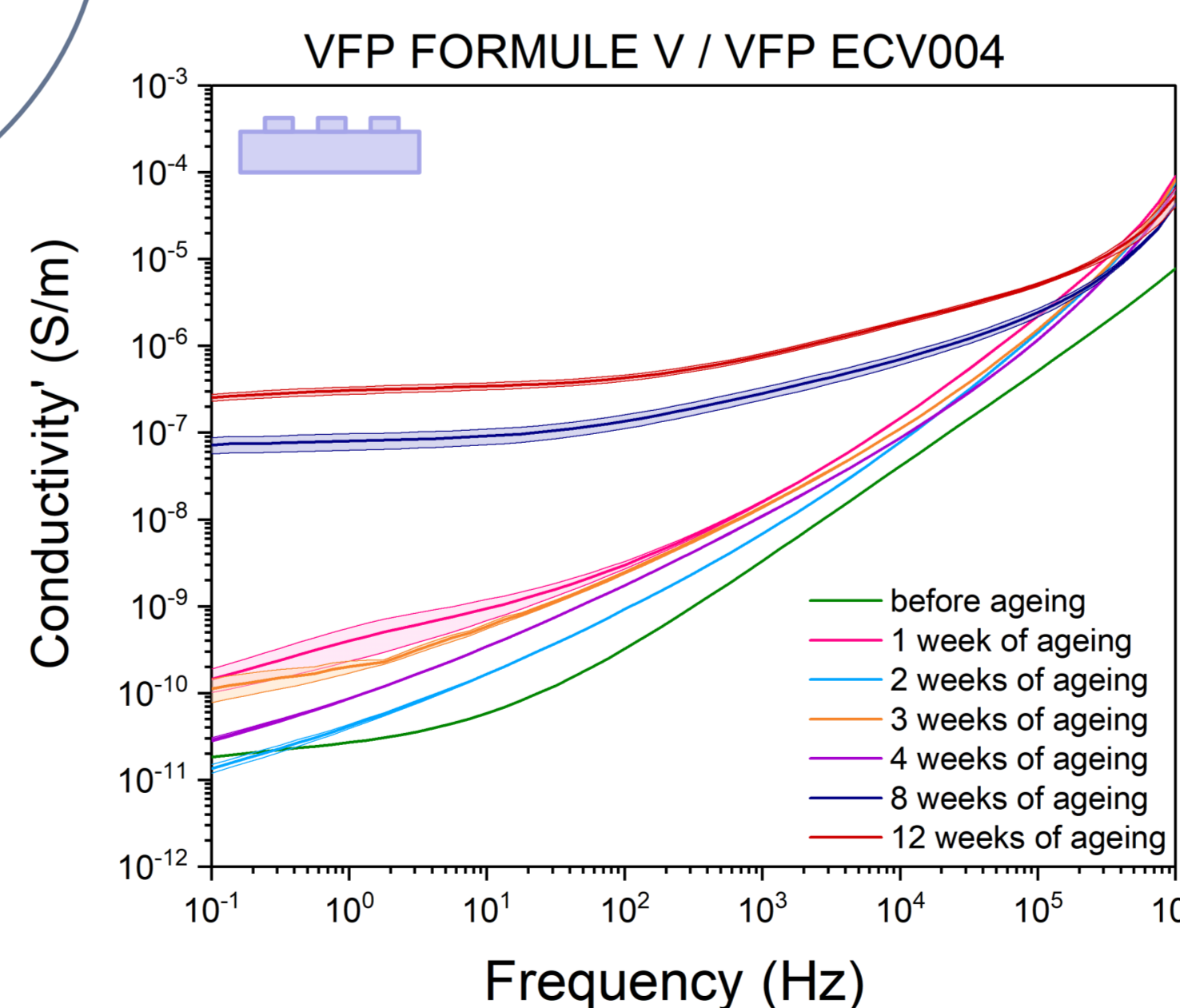
❖ Impedance measurement with milliohm meter.

❖ Investigation of dielectric ink and silver ink ageing.



❖ Dielectric measurement with NOVOCONTROL at room temperature.

❖ Frequency range : $10^6 - 10^{-1}$ Hz



Conclusion

- This ageing reproduces a **harsh environment** (static 220°C) to meet the requirements of **high-performance applications**.
- Different dielectric and electrical properties were monitored as a function of the silver ink/dielectric ink pair.
- Essential to study the **synergy** between all the sensor's elements.

Outlooks

- Additional thermal ageing will be done to better understand **low-frequency evolutions** on dielectric disks.
- Silver inks conductivity measurement under controlled **temperature and humidity**.
- **Functionalization of ink with electroactive particles** for printed sensors, and study of their ageing under environmental stresses.