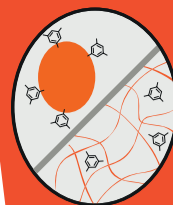
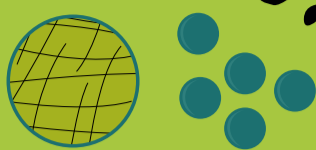


An ink based on silver nanowires for future printed paper electronics



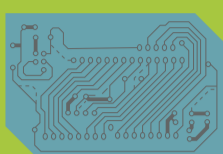
NWs AND NPs USED IN INKS



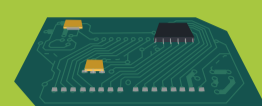
Nanowires (NWs) and nanoparticles (NPs) are increasingly used in inks to **produce printed circuits** on a large variety of supports, including **paper**.

A PROMISING FUTURE

Printed Paper Electronics



Printed Circuit Board



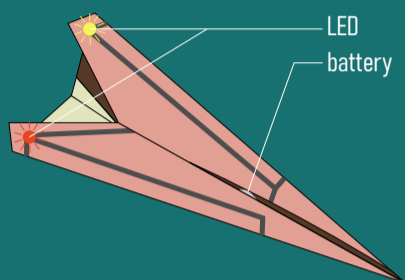
Contrary to printed circuit board, **printed paper electronics** has **some advantages**:

- ✓ much thinner
- ✓ bendable

A LARGE ARRAY OF INNOVATIVE APPLICATIONS

Printed paper electronics **can be used**:

□ to form **3D self-standing structures**



□ in **flexible smartphone**



□ in next-generation food labels developed to **monitor and report food quality**.



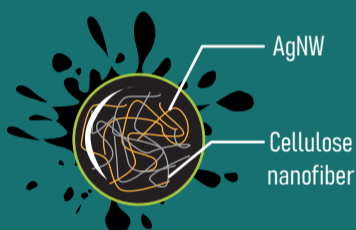
OBJECTIVES

Developing an **innovative alternative to printed circuit board**, using paper:

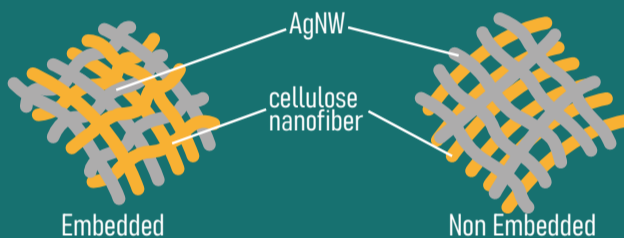
- **verifying the conductivity of ink** on paper,
- **immobilizing nanowires** (NWs) to avoid the release during use, **analyzing interactions** between NWs and its matrix.

PRINTED PAPER ELECTRONICS MANUFACTURING

The ink for this application also **contains**:



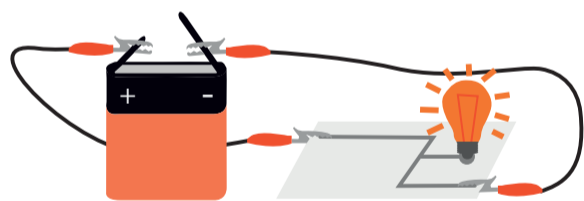
Depending on **paper formulation process**, AgNWs can be



SOME RESULTS OF THE PROJECT

Conductivity of AgNWs on paper

AgNW network conductivity is known on printed circuit but it **has to be confirmed on paper**. Indeed, the fact that Ag NWs are interlaced in cellulose can prevent the conductivity.

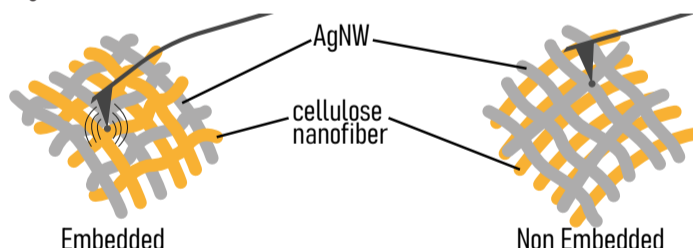


AgNWs are still conductors even on paper. Then the stability of AgNWs has to be confirmed.

Analyze the interactions between NWs and their matrix

Interactions between paper and AgNWs have been analyzed thanks to a specific technique. A tip is put on paper printed electronics to analyze the **adhesion forces**.

These experiments have been done for **embedded and non embedded AgNWs**.



Strong interactions occur between AgNWs and nanocellulose.

Interactions are weaker when AgNWs are above nanocellulose fibers.

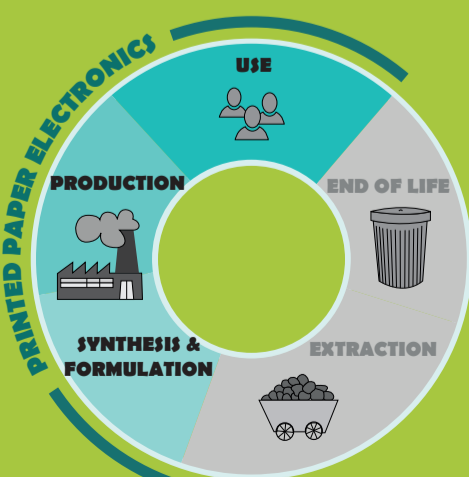
AgNWs are electric conductors on paper, thus printed **paper electronics can be a more flexible alternative** to classic printed circuit board.

Depending on the manufacturing process, **AgNWs could be embedded or non embedded**.

Embedded AgNWs have stronger interactions with paper, this limits the release of AgNWs, thus **they are more stable and safer** for human use and the environment than non embedded AgNWs. Further experiments are conducted to better understand the end of life of printed paper electronics.



LIFE CYCLE STAGES STUDIED



✉ labex-serenade@osupytheas.fr

The LabEx (Laboratory of Excellence) Serenade is a research project funded by the Programme d'Investissements d'Avenir (PIA) 2012 within the framework of the Initiative of Excellence of the University of Aix-Marseille (AMIDEX).



<https://bit.ly/3glLlL5>