Drug detection enabled by printed electronics

Genes'Ink from France is developing conductive inks for a nanocellulose-based Drug of Abuse biosensing platform in the framework of the GREENSENSE project

Since January 2018, Genes'Ink has been part of the GREENSENSE project funded by the European Union's Horizon 2020 research and innovation programme. The aim of GREENSENSE is to develop nanocellulose (NC)-based printed electronics for their final integration into a multi-parameter, hybrid-printed biosensing platform to detect drugs of abuse (DoA). NC-based materials (e.g. substrates and inks) offer better printability and performances compared to paper in the printed electronics domain. Besides, NC is known for their technical and environmental advantages compared to polymers (i.e. high degree of functionalisation and recyclability). This project is a promising source of innovation in the biomedical industry. It is planned for 4 years with a total budget of €8M.

The project was launched on 1 January 2018. 13 partners have joined their efforts to achieve the project goal of developing a sustainable NC-based biosensing platform.

Project goal

Printed electronics (PE) is one of the fastest growing technologies in the world. PE is interesting for various application fields such as consumer goods, Internet of Things (IoT), healthcare, aerospace, electronics, media and transport. Paper and plastic are considered as key substrates in the development of future flexible electronic devices. Unlike polymer substrates, paper/cellulose-based electronics are cost effective, recyclable and are expected to have a significant impact in the reduction of environmental impact of "electronic trash". Unfortunately, the surface properties of conventional paper (porosity and surface roughness) are not suitable for printed electronics. To overcome these issues encountered with conventional paper, NC-based films with

Partners of the GREENSENSE project

- **Leitat**, technical institute expert in industrial innovation processes. GREENSENSE is coordinated by Leitat which is also participating in the NC functionalisation and NC-based inks formulations.
- **AIT**, Austrian Institute of Technology, which participates in the development of the printed biosensors to be included in the biosensing platform.
- **Melodea**, expert in the extraction of cellulose nanocrystals, which participates in the production and functionalisation of crystalline nanocellulose (CNC) and CNC-based films at pilot scale.
- **RISE Acreo AB**, provider of innovative and value-adding ICT solutions. Acreo is involved in ink development, optimisation of printing processes, development of electrochromic displays and is responsible for the manufacturing, by combining printing and pick & place hybridisation, of the GREENSENSE biosensing platform.
- **Infineon**, a semiconductor company that participates in the development of microchip.
- **Atlas Medical**, manufacturer and supplier of quality diagnostic reagents and kits, participates with its knowledge of in vitro diagnostic devices and the final validation of the biosensing platform.
- **Genes'Ink**, manufacturer and supplier of conductive and semiconductive nanoinks. Genes'Ink is developing NC-based Ag conductive nanoinks in the framework of the GREENSENSE project.
- **IMST**, a leader in R&D of new products for mobile communication participates in the development of a printed NFC system and its communication to a smartphone.
- **PROACTIVE**, a knowledge-based company providing services inter alia in innovation management and key enabling technologies.
- **Prelonic Technologies**, developing printed electronics elements consisting of batteries, displays, logics, etc. since 2007. Prelonic will develop printed energy storage systems - Zn/MnO_2 primary batteries and supercapacitors.
- **EMPA**, a materials science and research institute, addressing sustainability assessments in the framework of GREENSENSE.
- **RISE Bioeconomy (INNVENTIA AB)**, a division within RISE Research Institute of Sweden, participates in the production and functionalisation of cellulose nanofibres (CNF) and CNF-based films at pilot scale.
- **Coatema**, an engineering expert for high quality coating, lamination and printing plants. Coatema participates in the development of NC-based substrates using R2R pilot lines.

RFID antenna printed with Ag nanoink by Genes'Ink, leader of GREENSENSE's WP3 – NC based inks formulation

Integrated printed biosensor platform by RISE Acreo , leader of GREENSENSE's WP4 – printing and curing of functional inks on NC and WP5 - printed electronic components development with NC

mechanical strength, transparency, low porosity and smooth surface roughness are considered as promising alternatives.

Thus, GREENSENSE aims to develop a sustainable, wireless and autonomous NC-based biosensing platform for quantitative DoA (Drug-of-Abuse) analysis. By using nanocellulose, it will integrate different printed electronic components (a Near Field Communication (NFC) antenna, energy storage (E. storage) devices and a display) with a newly developed printed biosensor and a microchip. Nanocellulose will then be used:

- as a substrate for printed electronics,
- for the encapsulation of the final device,
- and as an active component in the formulation of functional inks.

If necessary, the nanocellulose surface will be treated to improve printability and compatibility with the functional inks.

Outlooks

In the framework of GREENSENSE, a sustainable, nanocellulose-based biosensing platform for Drug-of-Abuse analysis will be developed. This platform integrates high-added value printed electronic components, such as an antenna, a display, a supercapacitor or a battery and biosensor with a specialised silicon microchip.

High throughput and high precision screen printing and inkjet printing techniques will be used to manufacture components at large-scale. The final flexible and recyclable biosensing platform will be mass producible with ultra-low power consumption and therefore, cost-effective, sustainable and environmentally friendly.