
RI.
SE
Printed, bio- and
organic electronics at
RISE.

Concern overview of research areas

RI. SE

Test and Demonstration Facilitites

Testbeds for hardware and pilot production

ProNano & Electrum Laboratory

RISE Fiberlab

Printed Electronics Arena 4.0

Dynamic testbeds

Autonomous shared transport

The Pink

UX Lab

IT testbeds

DigiCore

ICE - Infrastructure and Cloud Environment

Cyberrange

UAV

ECOSYSTEM OF ORGANIC AND PRINTED ELECTRONICS IN NORRKÖPING/LINKÖPING, EAST SWEDEN

LOE
Laboratory of Organic Electronics

RI. SE
Research Institute

PEA Printed Electronics Arena
Printed Electronics Arena

LiU Innovation
Innovation Office

lead
Business Incubator

HOPE
Business Accelerator

Digital Cellulose Center
Research Centre

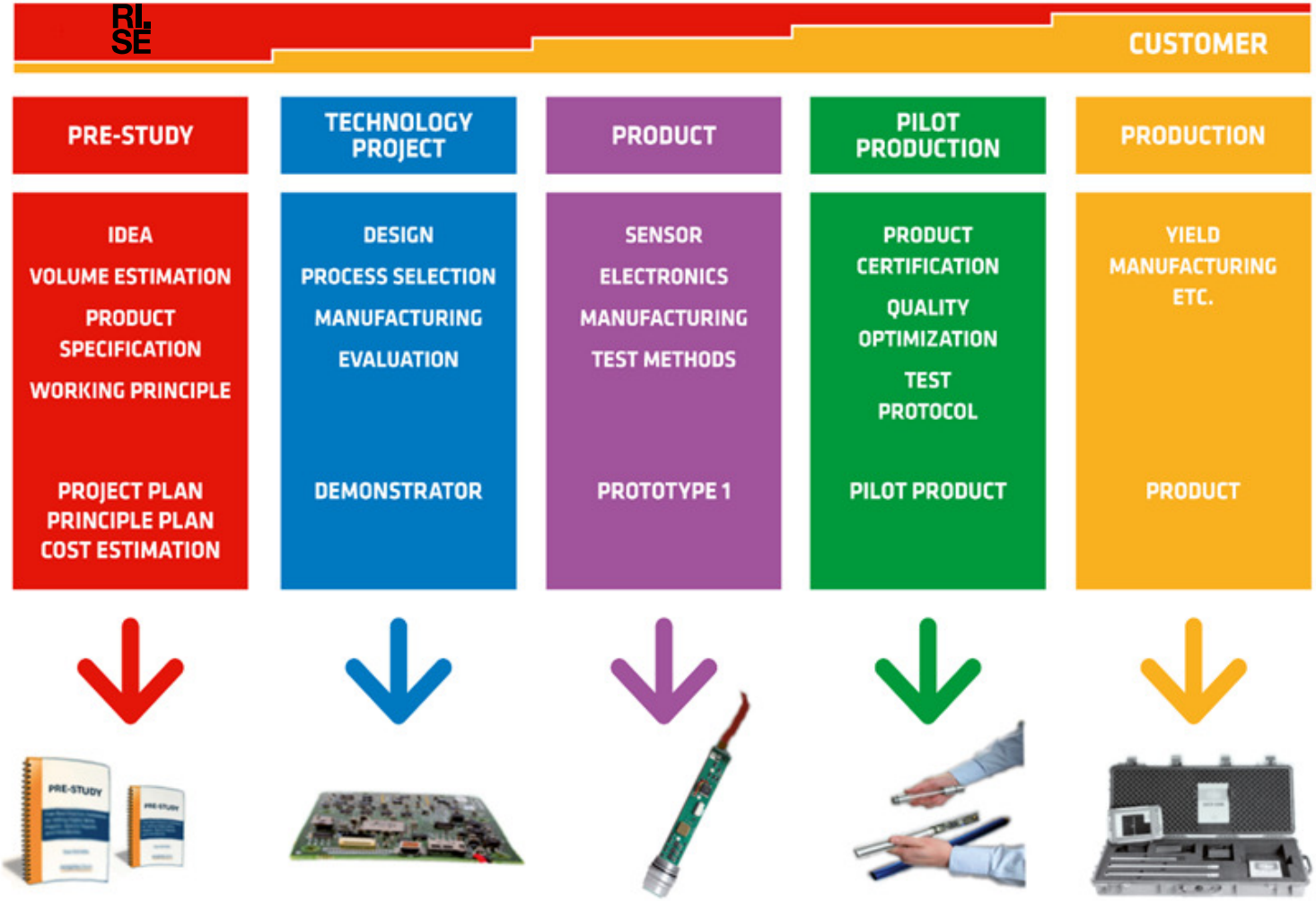
TREESEARCH
Research Collaboration

IMA Innovative Materials Arena
Innovative materials arena

Norrköping Science Park

LINKÖPING SCIENCE PARK
Linköping Science Park

Working with RISE in phases



PEA
Printed Electronics Arena

Innovation Cluster for
Printed Electronics
at an industrial level

Region Östergötland

VINNOVA

Smartare Elektroniksystem
ELECTRONIC COMPONENTS & SYSTEMS

Knut och Alice Wallenbergs Stiftelse

NORRKÖPING

RI.SE

Capabilities at PEA

Printed Electronics Arena

Competences:

- Development of printing and patterning processes
- Device design for Printed Components
- Ink formulation for screen, inkjet, gravure, flexo, slot-die coater, aerosoljet
- Electronics design – circuits and systems including wireless connectivity, firmware etc.
- System Integration
- Generic hybrid platform development (Si + printed devices)
- Demonstrator design and manufacturing
- Rapid prototyping (3D printing and electronics assembly)
- Upscaling and Tech transfer of processes to industry
- Pilot production
  - Ink manufacturing
  - Screen printing
  - Synthesis
- Component and system characterization
  - Electrical characterisation
  - Physical/chemical analysis
  - Environmental testing
  - Semi-automated testing

Printing and drying/curing processes:

- Screen (semiautomated and automated sheet-based flatbed)
- Inkjet (flat bed and R2R, industrial printheads)
- Gravure (sheet based experimental)
- Slot-die coating (sheet based experimental)
- Flexo printing (sheet based experimental + proofing)
- Aerosol jet
- Thermal drying
- IR/NIR drying/curing
- UV-curing
- Xenon-flash photonic sintering (Novacentrix)
- 3D-printing

Ink formulation capability

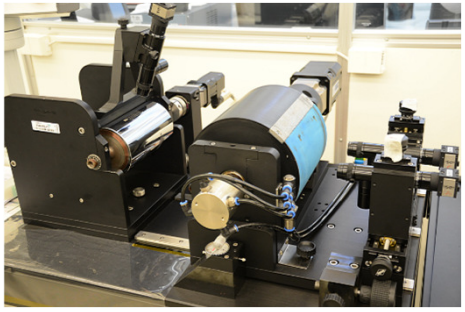
- Ink pilot production (up to 10 kg/batch)
- High shear mixing
- Speed mixing
- Probe sonicator
- Powder milling
- Rheology measurements

RI. SE PEA Printed Electronics Arena

Screen printing

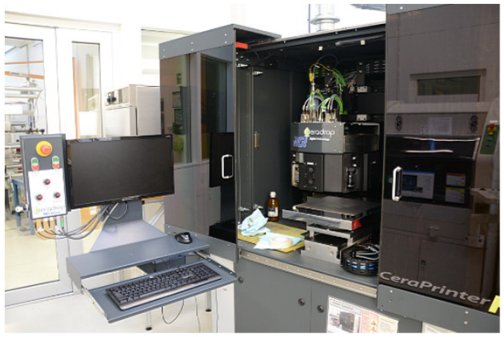
- Sheet based planar screen printing
- 2 DEK systems Horizon 03iX
  - semi automated
- ATMA MF66/F
  – fully automated incl. dryer
- EKRA E2 screen and stencil printed
- Natgraph Air Force Combi dryer (UV/IR/hot air)

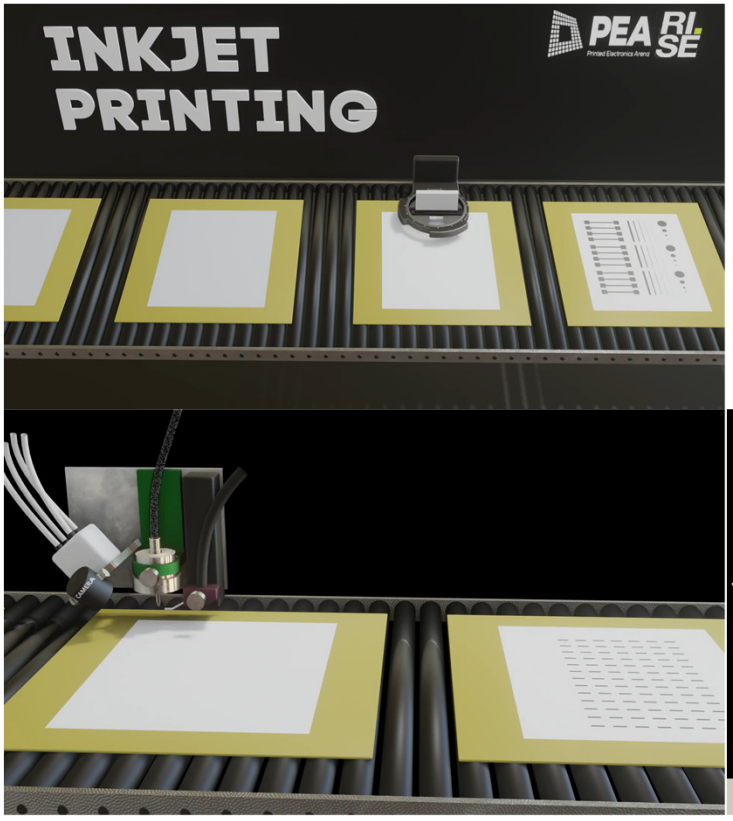
Testacolor Gravure & Flexo



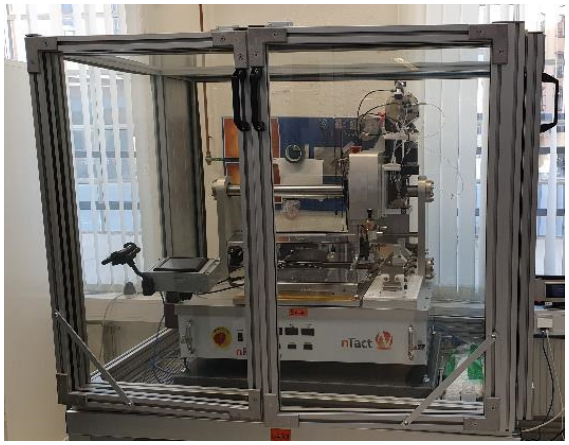
Inkjet/Aeros Jet printing

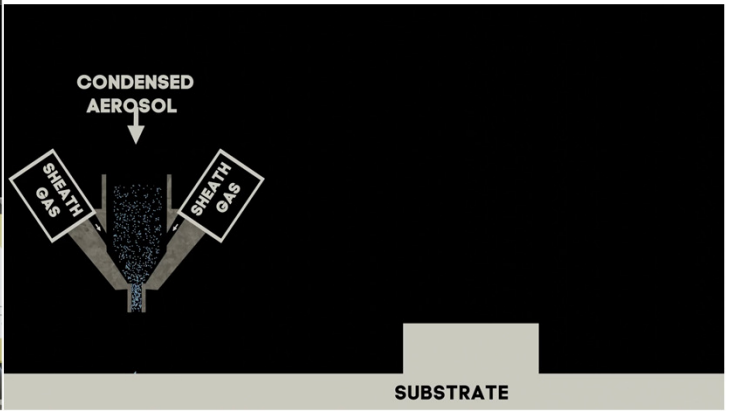
- Ceradrop F Series MF150006-Nindustrial inkjet
- Optomec Aerosol jet
- Novacentrix PulseForge 1300 photonic sintering
- Dimatix DMP280 cartridge type printer
- R2R industrial inkjet large format printer





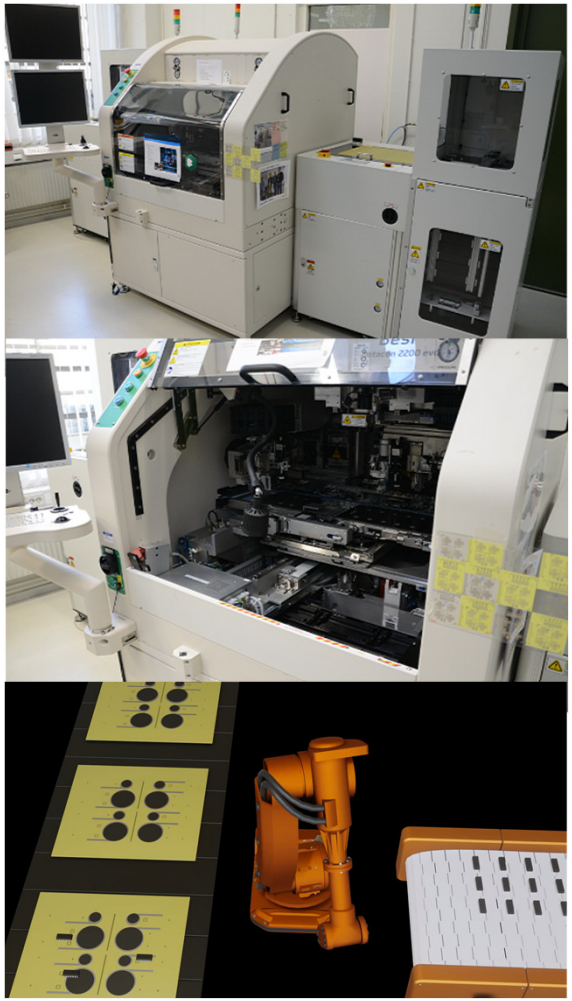
Slot-die coater nTact





Pick and place assembly

Besi 2200 Evo Pick Datacon for SMD, batteries, printed components etc.

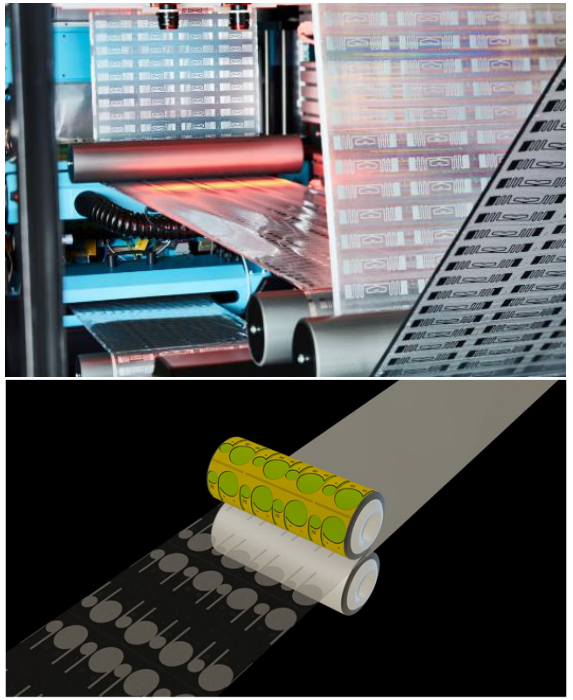


LASER cutting & engraving

TROTEC LASER cutter and engraving system

FC2250 Cutting plotter

Novel patterning method Dry Phase Patterning



3D printing

Formlab 3 Stereolithography

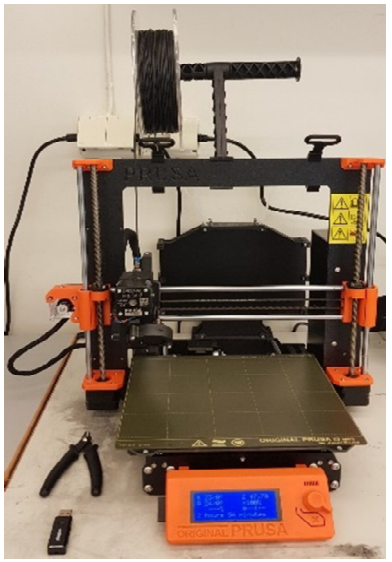
- Fast prototyping
- Same day iterations
- Filament creations

<u>Examples:</u>

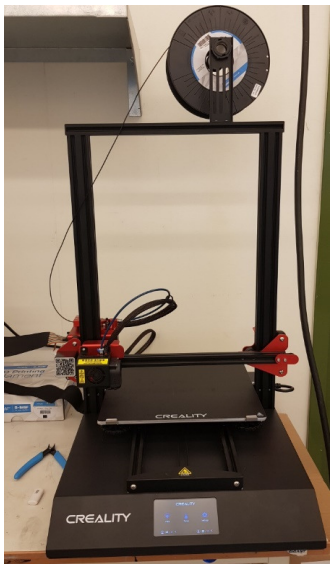
- Electronics casing
- Mock up demonstrators

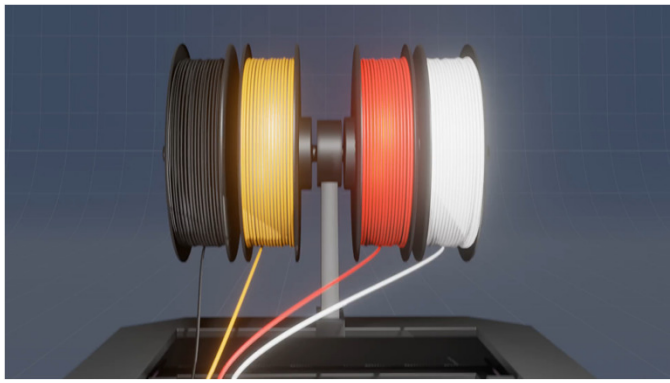
Filament based FDM printers

Prusa i3 MK3S



Creality 10S Pro V2



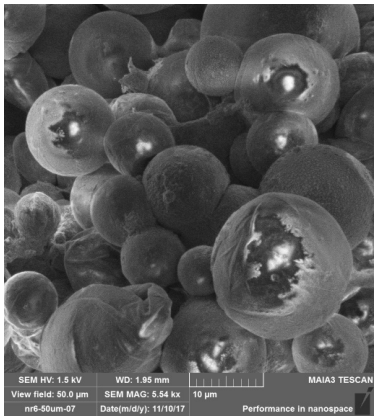


Ink and adhesives development

- Ink formulation capability
- Ink pilot production (up to 10 kg/batch)
- High shear mixing
- Speed mixing
- Probe sonicator
- Powder milling
- Rheology measurements

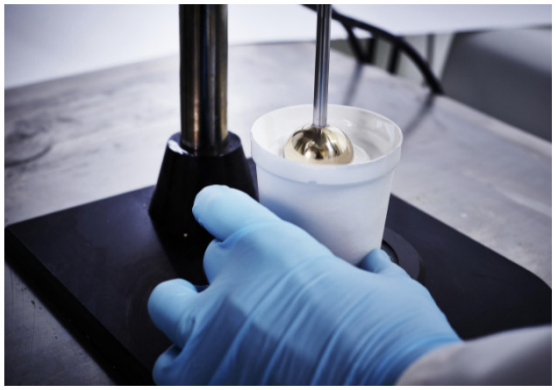
Materials examples:

- Graphene and graphene coatings
- Metal and metal-oxide nanoparticles
- Functional printing materials
- Nanoparticle inkjet inks



Graphene coated polymer spheres for non-metal ACA

Rheometer



Developement of inks, electrolytes and organic materials for printed electronics components

Powder milling system

At the Printed Electronics Arena in Norrkoping, Sweden, we move with ease from molecule synthesis in cleanrooms to small series production of printed electronics components and prototyping of hybrid circuits.

Chemical synthesis and characterisation

Characterisation

Fully integrated parameter analyzer Keithley 4200A-SCS

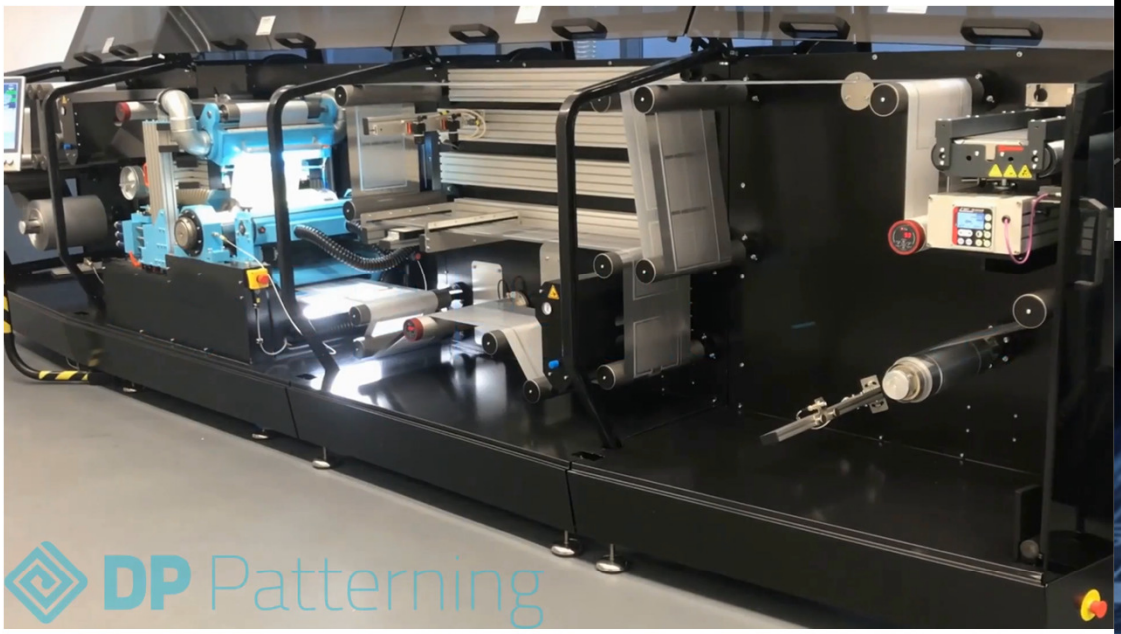
SMU	I-V Source Measure Unit
PA	Remote Preamplifier Module
CVU	C-V Multi-frequency Capacitance Unit
PMU	Pulsed I-V Ultra-fast Pulse Measure Unit
PGU	High Voltage Pulse Generator Unit
RPM	Remote Preamplifier/Switch Module
CVIV	I-V/C-V Multi-Switch Module

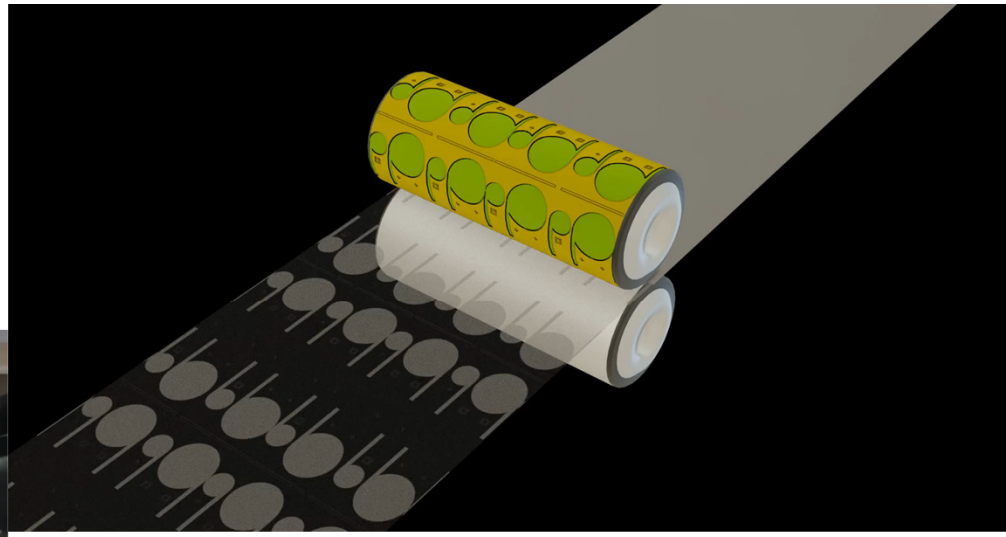
8 channels electrochemical workstation

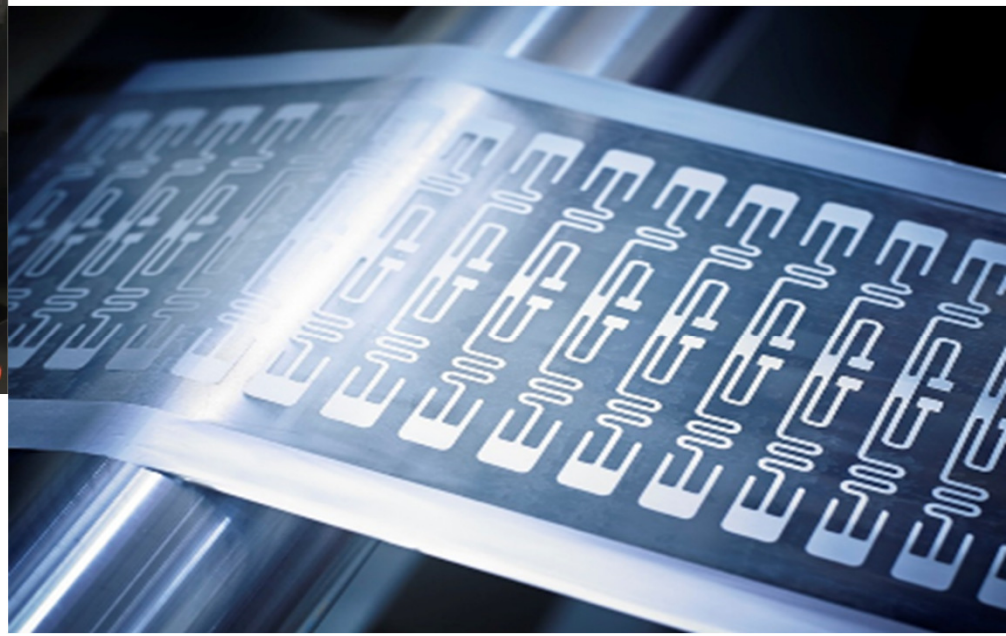
Testing of batteries
Electrochemical impedance spectroscopy
Electroanalysis

DP Patterning

Revolutionizing electronic circuitry manufacturing







Virtual tour of our facilities

Virtual tour PEA1 (printing characterization)

virtual tour PEA2 (Assembling and electronic lab)

PEA
Printed Electronics Arena

www.printedelectronicsarena.com

Stories from RISE

New solutions for a sustainable future

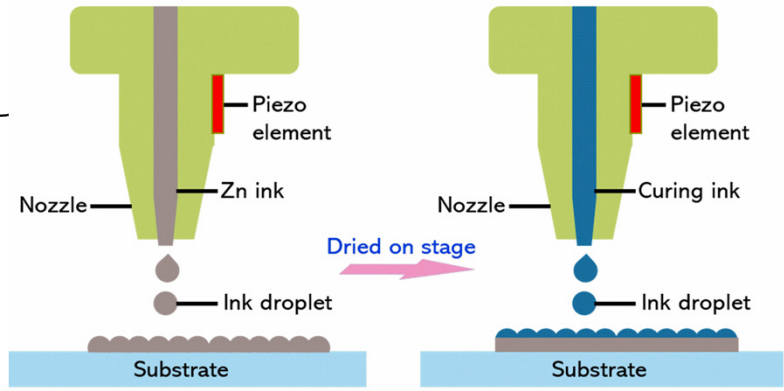
RI.
SE

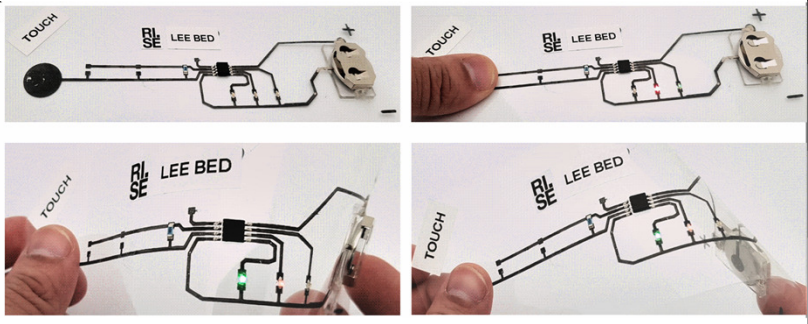
LEE·BED

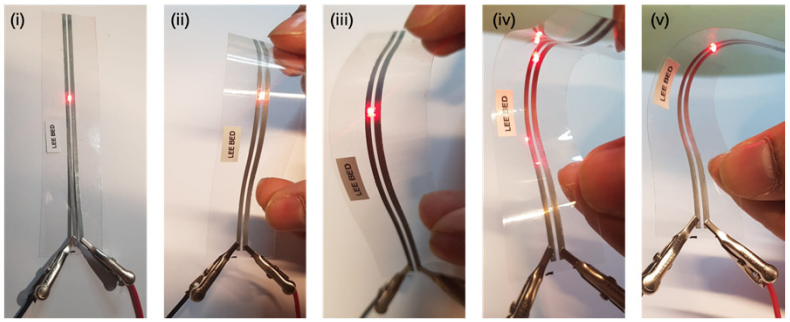
Zinc ink development

Zn ink formulation:

- RISE has worked on a general formulation engineering method to produce a highly concentrated inkjet printable metallic Zinc nanoparticle ink.
- Low temperature in-situ chemical sintering process has been developed to cure the printed features.
- The printed features after chemical curing show an electrical conductivity > 10^5 S/m.
- RISE demonstrated printed electrodes and touch sensors based on Zn nanoparticle ink.







Dissemination*:*

1. Majee, Subimal, et al. " Low temperature chemical sintering of inkjet-printed Zn nanoparticles for highly conductive flexible electronic components." npj Flexible Electronics volume 5, Article number: 14 (2021).

2. Majee, Subimal, et al. "Inkjet printing and low temperature chemical sintering of Zn nanoparticle ink." LOPEC 2021 (oral presentation).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814485

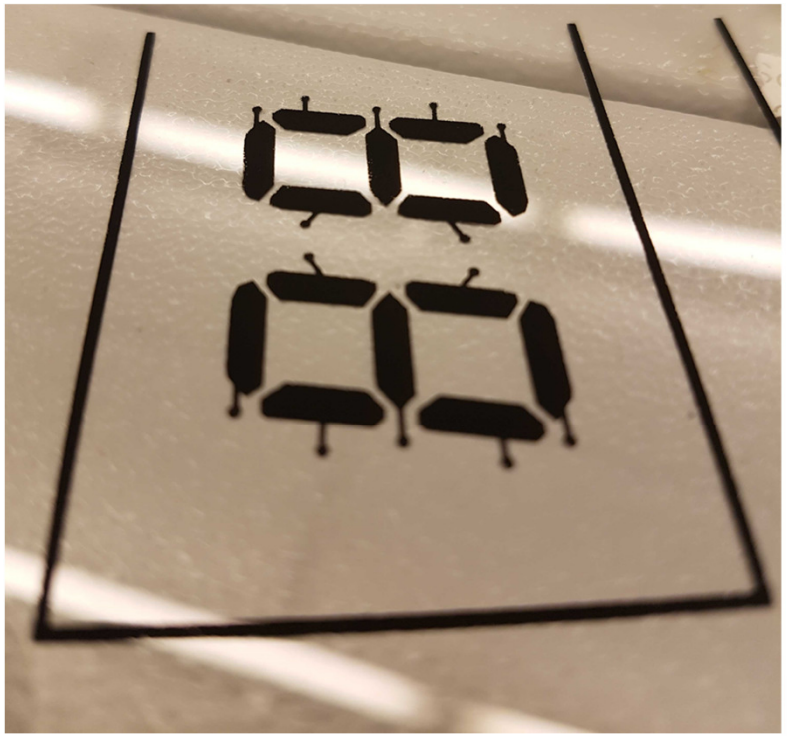
Screen printable Carbon Ink using commercial MC suspensions

Different grades of the MC have been mixed with carbon black, food grade solvents/additives and other cellulose derivatives to orbain screen printable carbon inks.

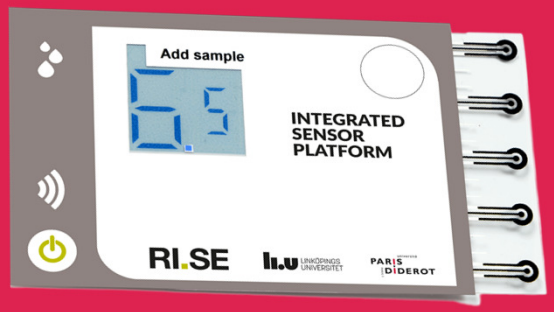
Results:

Good printability on different substrates.

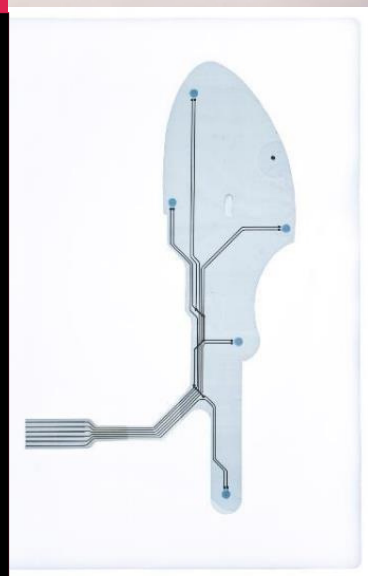
Sheet resistance 10 folds higher (ca. 1.5 kOhms) than
commercial ink has been achieved.

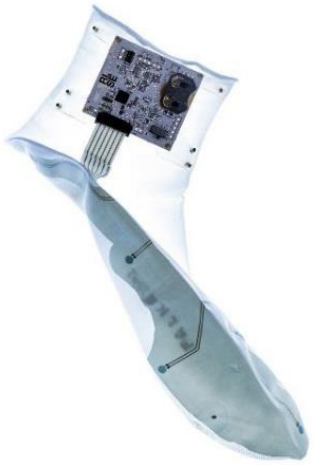


Digital Cellulose Center

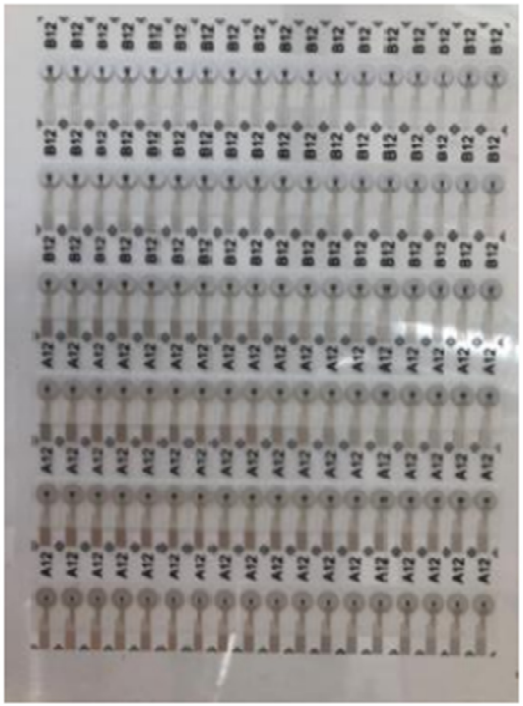


Sensors and sensor systems

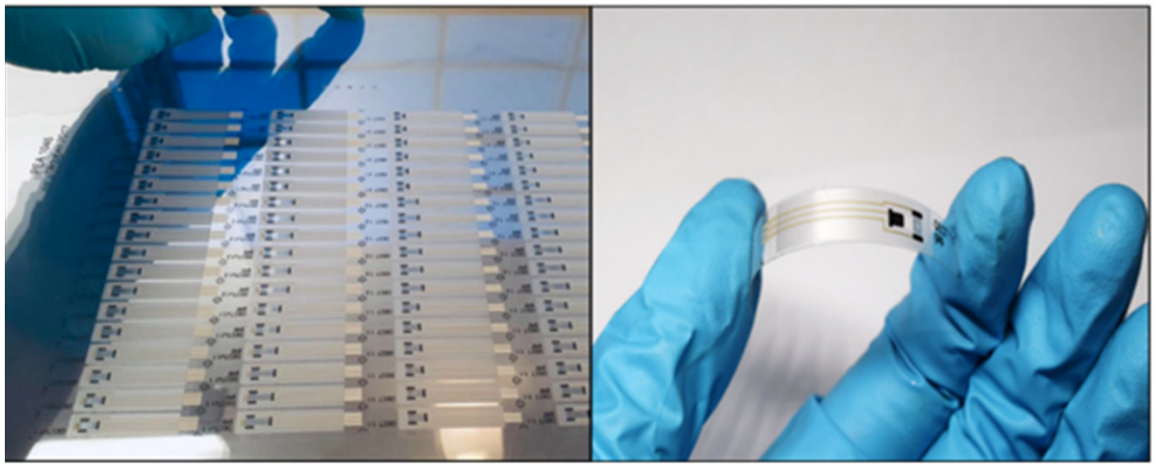




Printed for sensors

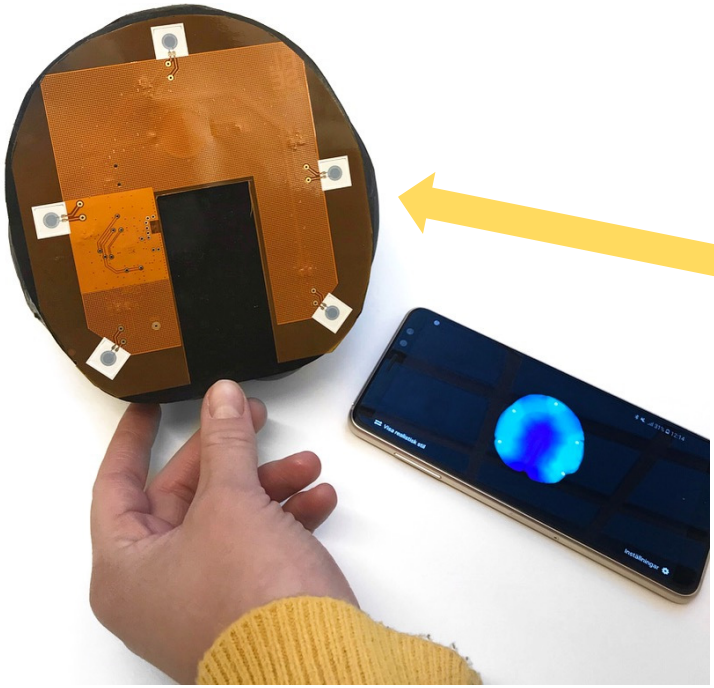


Sheet of printed 2 electrodes electrochemical sensors



Sheet of printed lateral organic electrochemical transistors (OECT

Printed piezosensitive materials as sensors



RISE – Absorbest AB

Drymax Sensor - wound care product

Challenge
Is it possible to produce an intelligent bandage that indicates when it needs to be changed?

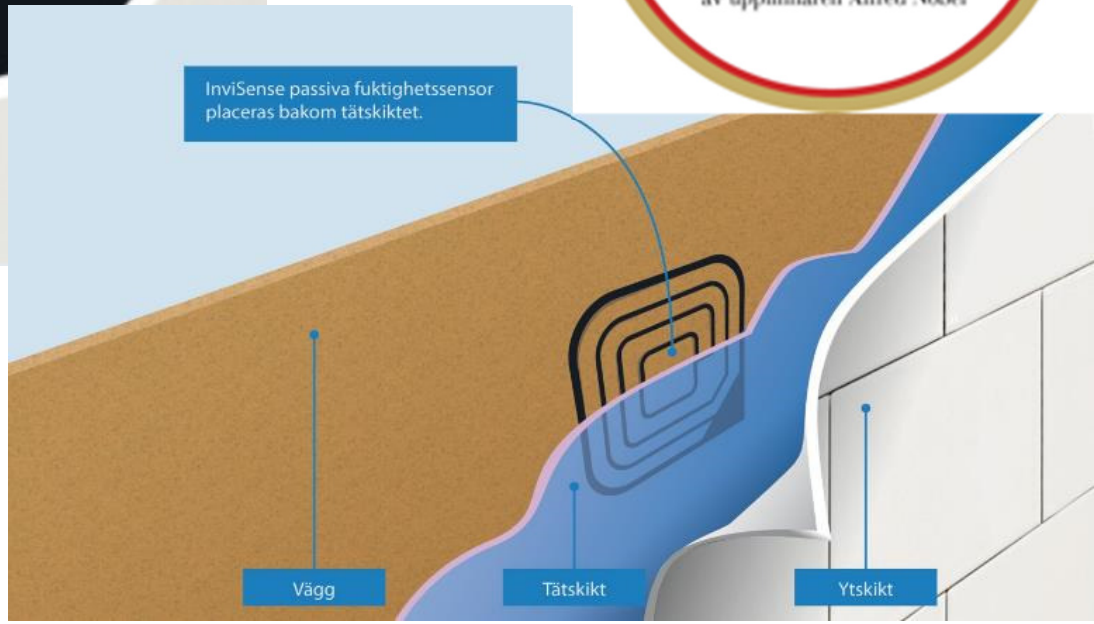
Solution
The combination of the company Absorbest's knowledge of super-absorbent wound-care products and RISE's research into printed electronics, made it possible to create an all printed intelligent bandage

The smart bandage is now on its way to the market.

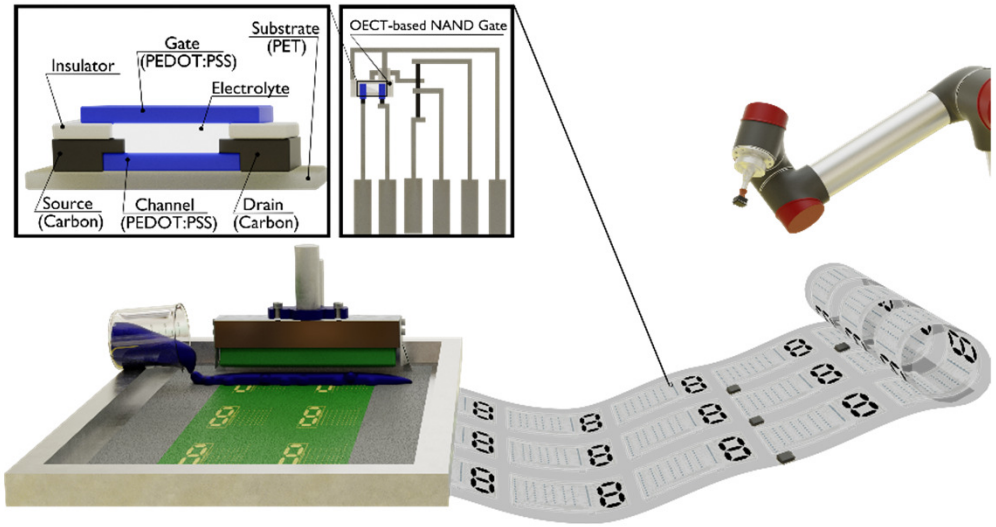
https://www.youtube.com/watch?v=Xu3I5wH_TzE&feature=youtu.be

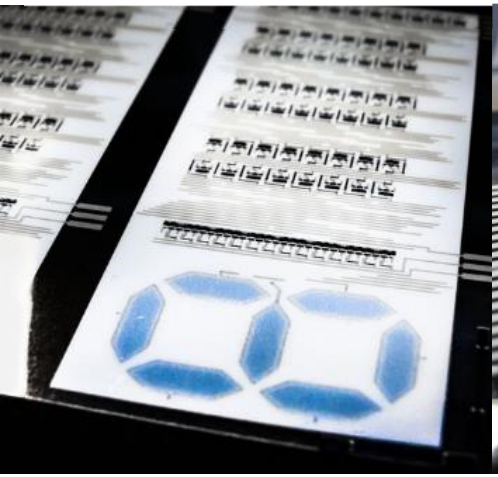
Spinout Invisense – Printed humidity sensors

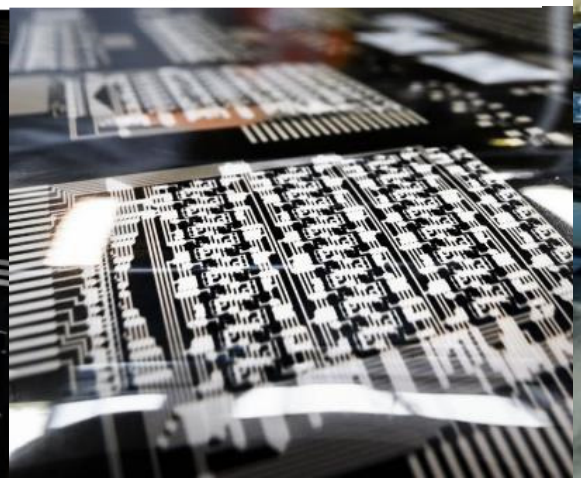
Nationell vinnare av SKAPA-priset 2017
SKAPA
Innovationspris till minne av uppfinnaren Alfred Nobel



Component Integration



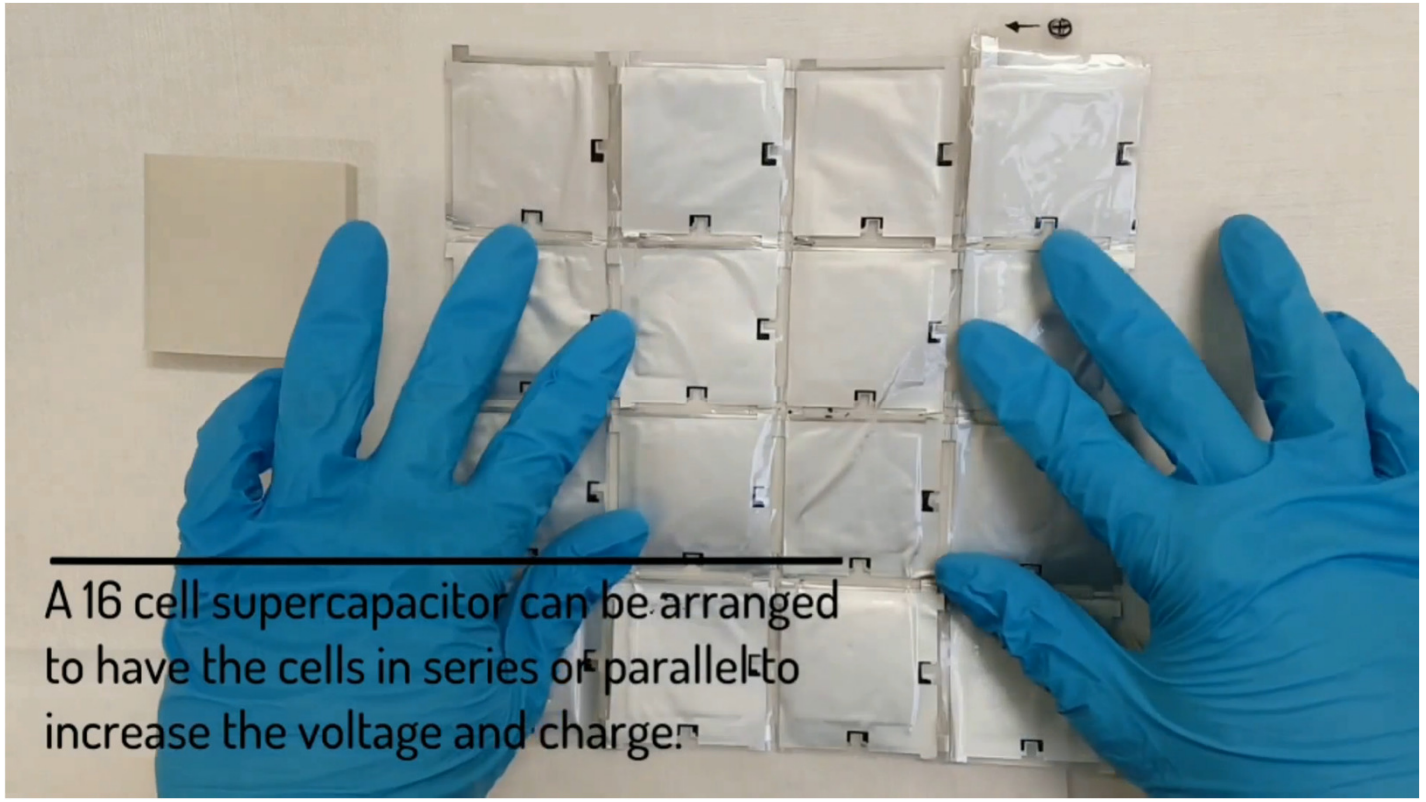




Electrochromic displays

Display Technology

Printed forest-based supercapacitors



RISE's approach to complex printed electronic: Hybrid-Printed Organic Electronic (Hy-PE)

Challenges:

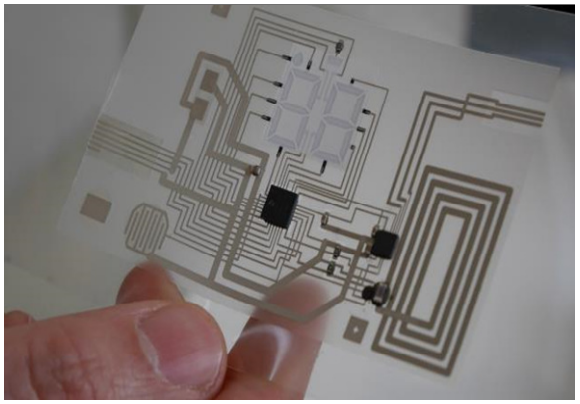
- Traditional electronics has the wrong form factor to meet the requirements of fast-growing applications as wearables and distributed IoT.
- Printed Organic Electronics cannot provide the functionality and connectivity needed

Our approach:

- Combine the high processing power and robustness of a Si chip with the low cost and flexibility of Printed Organic Electronics

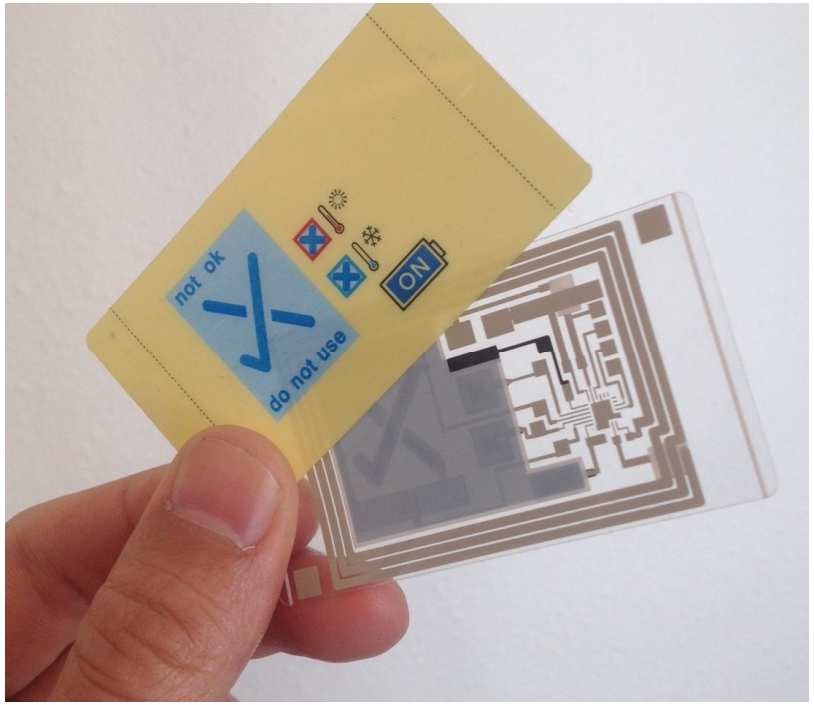
When to use Hy-PE? :

- When form factor matters
- When flexibility is a must
- Cost-sensitive devices
- Moderate requirements on complexity



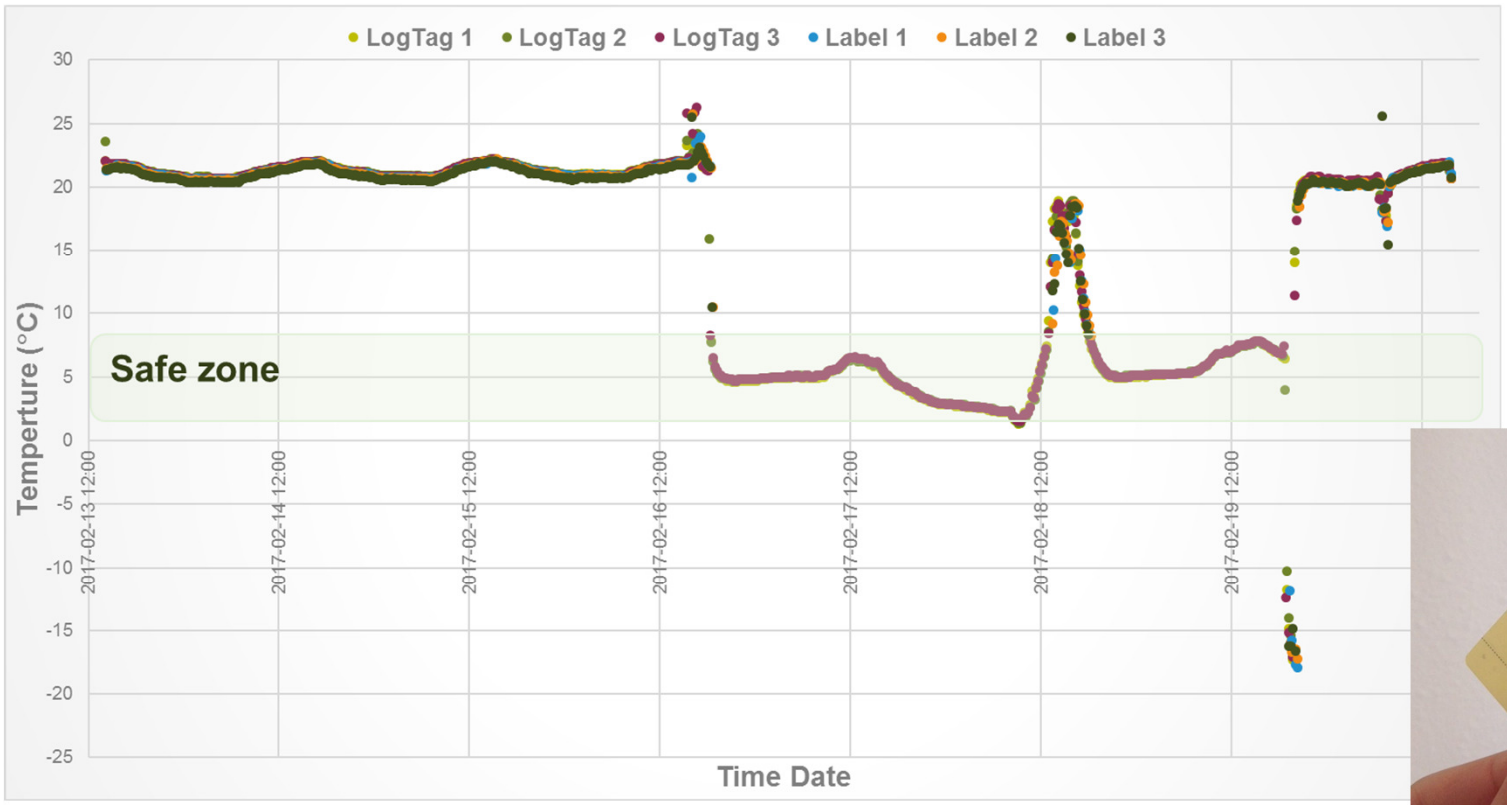
Smart Label for temperature monitoring – with on-board display for last mile handling

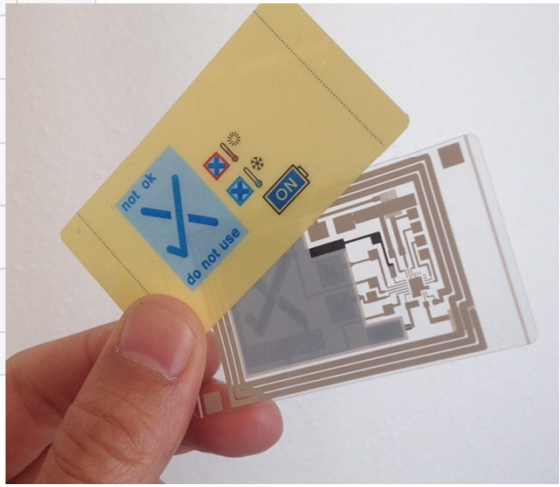
To ensure that the transportation of temperature sensitive goods is performed in acceptable temperature conditions.



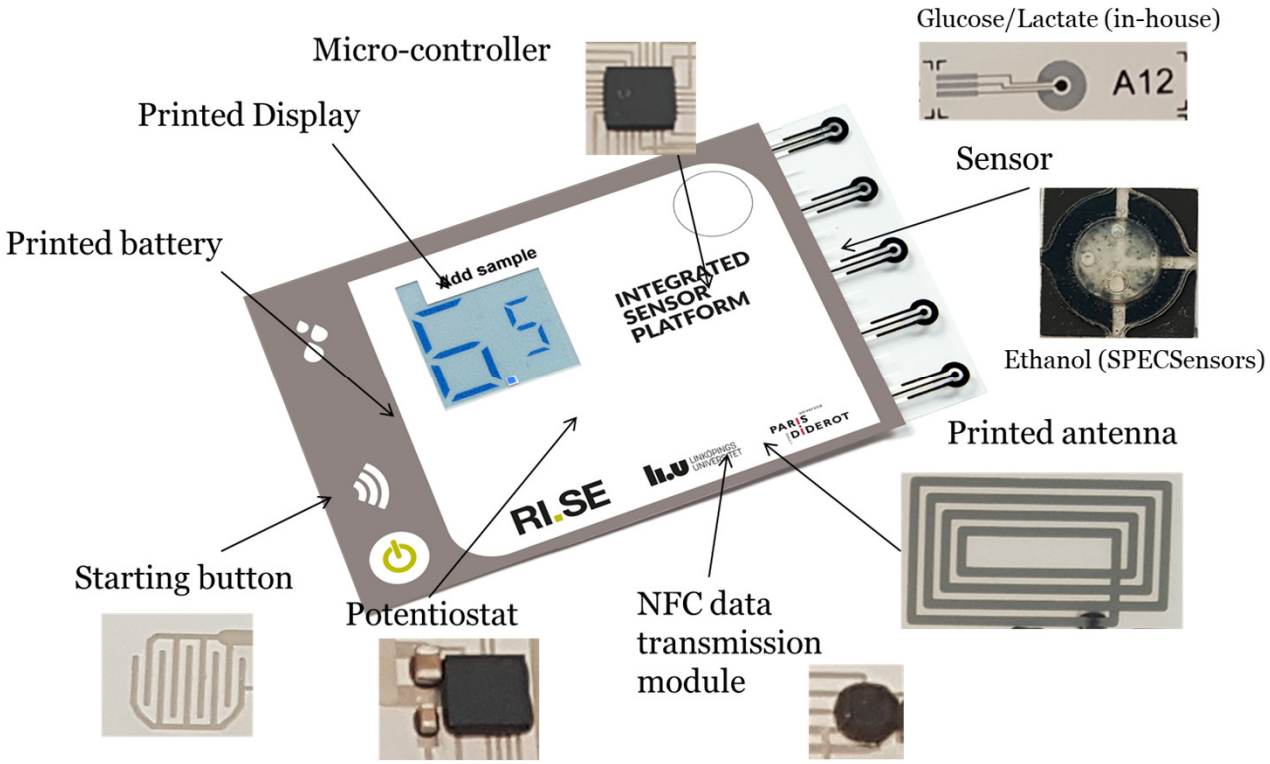
- Cold Chain Indicator for vaccines and similar
- Electrochromic Display
- NFC readout
- Flexible formfactor
- Printed Battery
- Printed circuitry
- Hybrid construction

Comparison with LogTag (existing solution)





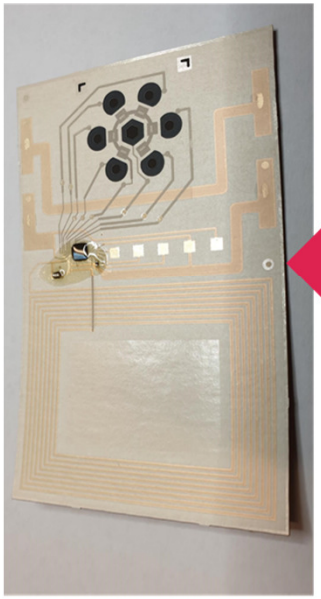
Integrated Bio-Sensor Platform (2013)

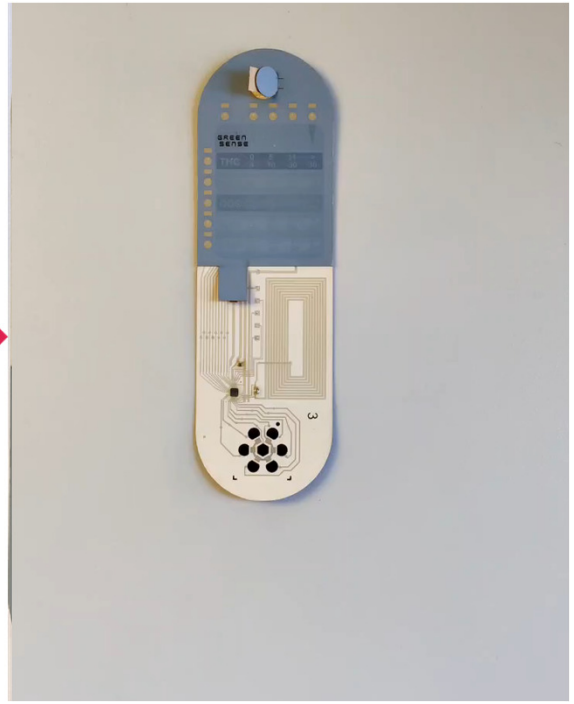


Beni V. et al 2015 ECS J. Solid State Sci. Technol. 4 S3001

Next step on integrated Bio sensor platform: GREENSENSE (2021)

In the project GREENSENSE we merge **healthcare diagnostics** and **printed electronics** in the form of a fully-integrated **biosensing platform** using **nanocellulose and paper substrates**.





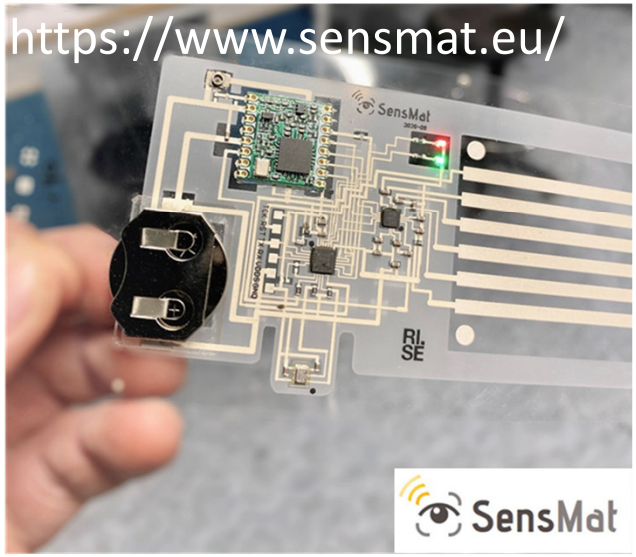
https://www.greensense-project.eu/

This project has received funding from the European UnionsHorizon 2020 research and innovation programme under grant agreement No 761000.
This publication reflects only the authors views and European Union is not liable for any use that may be made of the information contained therein.

Not only paper and flexible polymers

Energy harvesting, sensing and visual displaying on glass

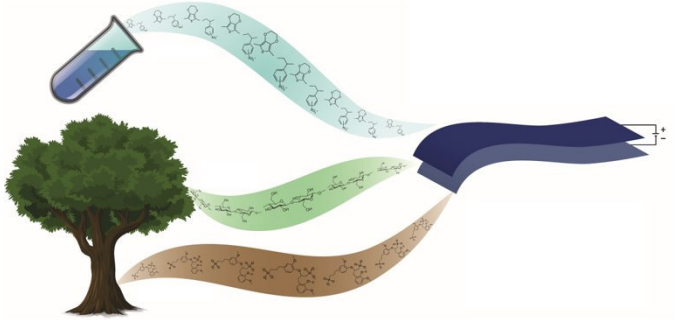
Stretching the limits



Having fun with light

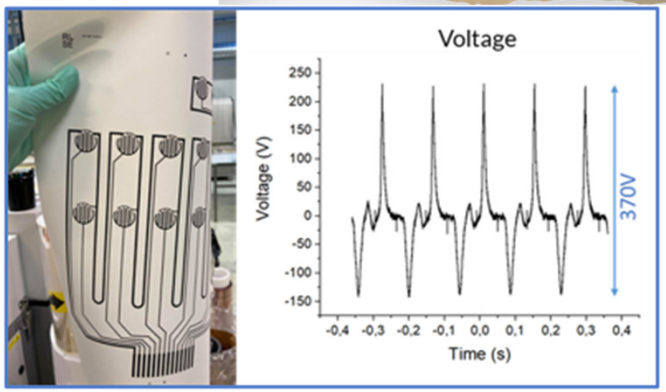
This project has received funding from the European UnionsHorizon 2020 research and innovation programme under grant agreement No 814596. This publication reflects only the authors views and European Union is not liable for any use that may be made of the information contained therein.

Some further interesting Iniciatives



Digital Cellulose Center: Towards more sustainable electronics

- Using bio-derived and recycled materials
- Using bio-degradable materials
- Moving away from conflict and critical materials
- Reducing energy use
- Improving performance
- Developing recycling routes
- Developing processes for pilot scale production

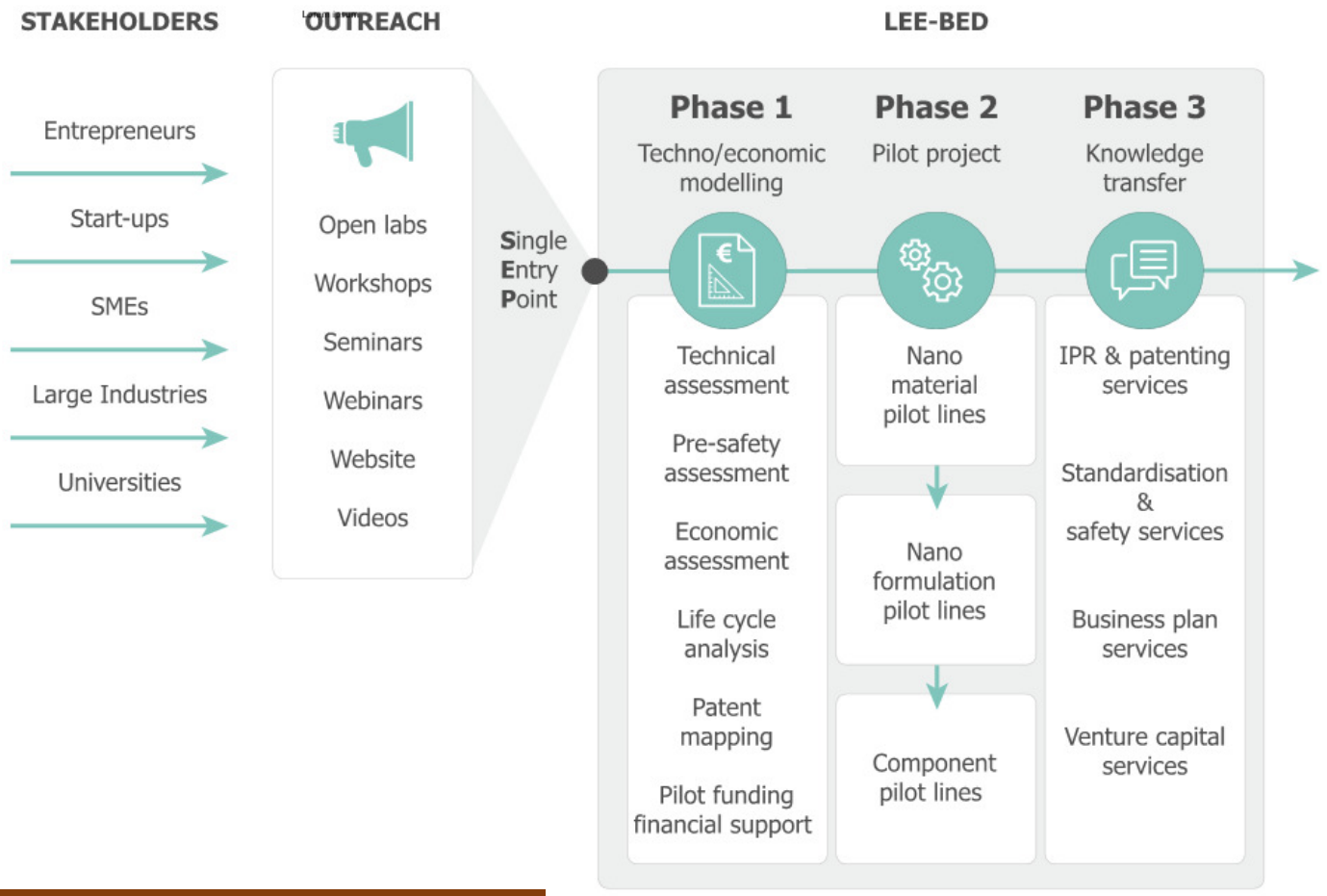


Digital Cellulose Center

LEE·BED

Innovation Test Bed for development and production of nanomaterials for lightweight embedded electronics

www.lee-bed.eu



The single entry point (SEP) is the main contact point for customers wanted access to LEE-BED services and pilot lines

EMERGE

Emerging Printed Electronics Research Infrastructure

PROJECT OVERVIEW

A Pioneer Research Infrastructure

- Functional materials
- Flexible electronics
- Printing electronics
- 3D printing
- Green electronics
- Biosensors
- Smart diagnostic platforms
- Flexible energy sources
- Nanogenerators

Emerging Printed Electronics Research Infrastructure (**EMERGE**) is a pioneer research infrastructure that supports comprehensive user projects for leading-edge multi-and-trans-disciplinary research on sustainable flexible large-area printed electronics and photonics (FLAPEP), from which the industry will benefit.

EMERGE tackles the challenges concerning all the FLAPEP value chain, offering a true open-access facility that connects scientific expertise and technological competencies to a vast network in the ecosystem intended to boost value creation.

This approach aims to promote synergies in a win-win model, where researchers will have wider, simplified, and more efficient access to the best research infrastructures they require to conduct their projects while triggering and facilitating the formation of European symbiotic clusters.

This synergism among partners and stakeholders envisions a long-lasting, sustainable community in-line with the Green Deal initiative for environmentally friendly approaches towards a circular economy.

MAIN OBJECTIVES

Research Infrastructure Platform Worldwide

SYNERGIES
Create synergies between academia, small medium enterprises and industry.

SAVE TIME
Shorten technology transfer time towards the market.

MINIMIZE RISK
Minimize the risk of introducing FLAPEP technologies in new products.

SUSTAINABILITY
Sustain the outputs generated by the project.

More information

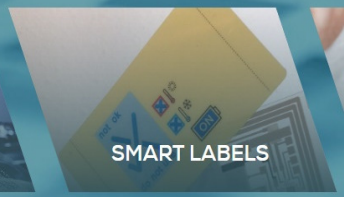
https://www.printedelectronicsarena.com

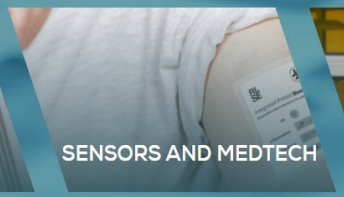
Synkar inte

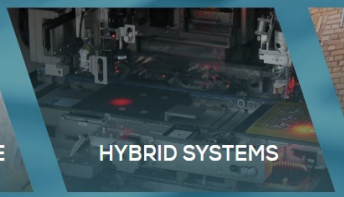
PEA
Printed Electronics Arena

PRINTED ELECTRONICS ABOUT US CONTACT SVENSKA

Printing excellence, prototyping, sensors and applied research in conducting polymers

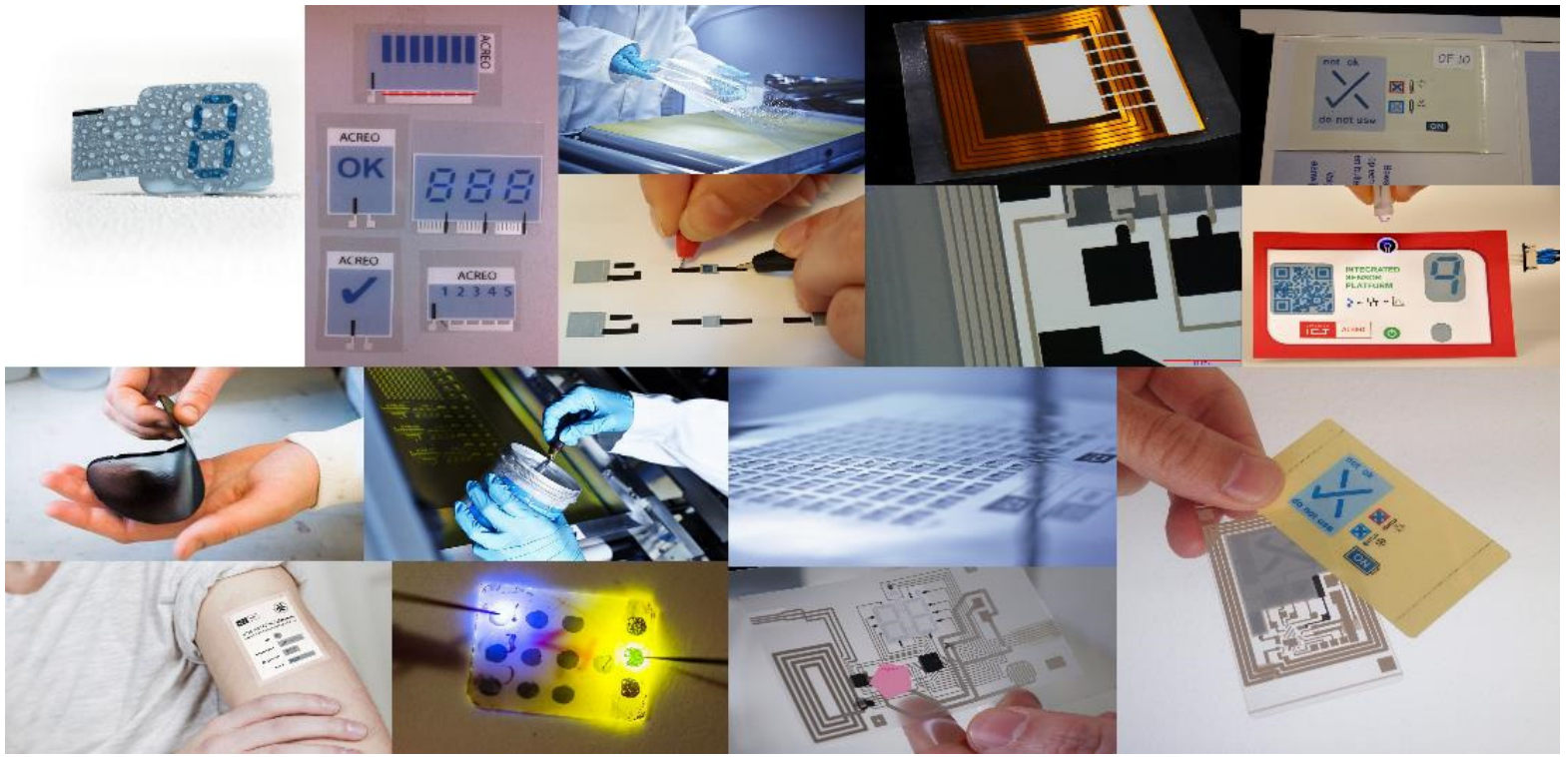






OUR FOCUS AREAS

Thank you!



Welcome to PEA!

www.printedelectronicsarena.com www.ri.se

ursula.hass@ri.se, duncan.platt@ri.se

PEA Printed Electronics Arena

RI. SE