CENTEXBEL

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Developments and Research Results

Coating & Finishing Technologies

ALCHEMISSTS

For products, materials, and processes that are safer, more environmentally friendly, and more sustainable.

Ine De Vilder

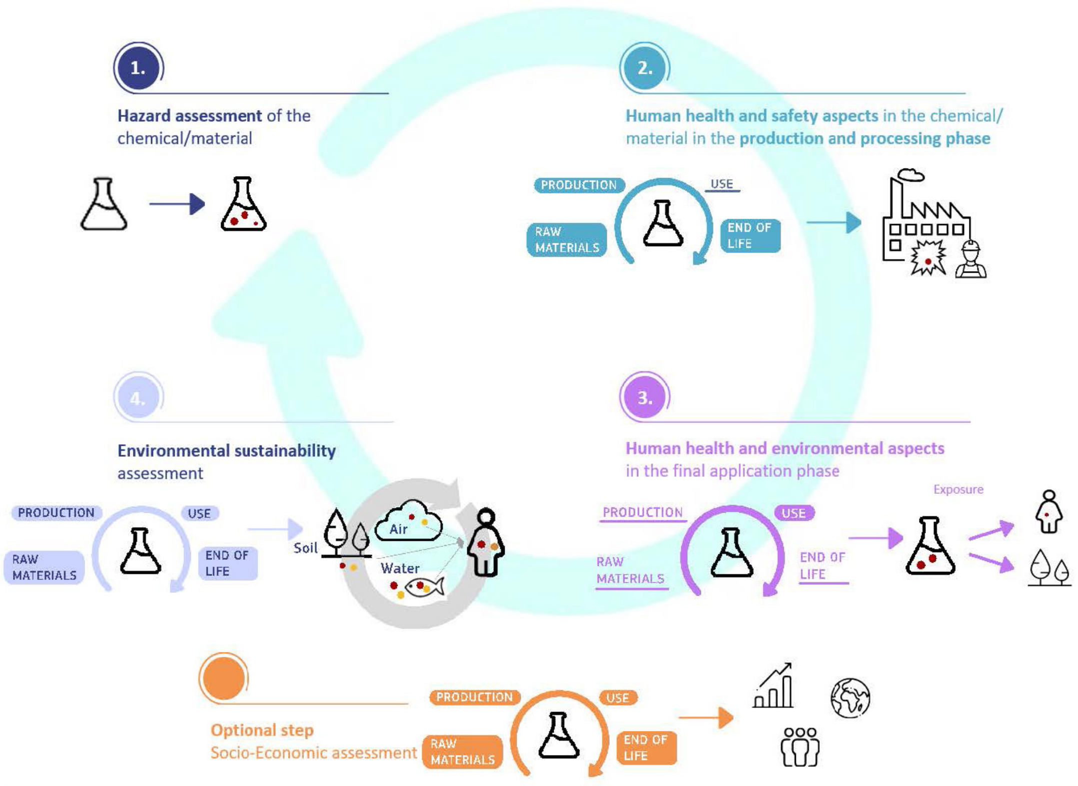
To establish a circular economy as outlined in the European Green Deal, it is essential that products are designed with ecological considerations in mind, facilitating their recycling at the end of their lifecycle. Ensuring the safe recycling of materials necessitates the avoidance of harmful substances, including those classified as substances of very high concern (SVHC), during the manufacturing process.

The European Commission has established the Safe and Sustainable by Design (SSbD) framework[1] to facilitate the replacement of Substances of Very High Concern (SVHC), and to avoid regrettable substitutions. This framework represents a strategic approach to the development of products, materials, and processes that emphasize the safety of human health and the environment while fostering sustainability throughout their entire lifecycle.

The primary components of this framework include:

1. **Safety Assessment:** Guarantees that products are free from hazards and reduce risks to both individuals and ecosystems.
2. **Sustainability Assessment**: Analyzes environmental effects, concentrating on resource efficiency, recyclability, and the reduction of carbon emissions.
3. **Lifecycle Thinking**: Addresses safety and sustainability considerations at every phase - from design, production, and usage to disposal.
4. **Integration of Goals**: Strives to harmonize safety and sustainability without sacrificing either aspect.
5. **Innovation and Circularity:** Promotes the use of renewable materials, energy efficiency, and adherence to circular economy principles.

1 https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/chemicals-and-advanced-materials/safe-and-sustainable-design_en



Steps of the SSbD framework

SOURCE *Safe and Sustainable by Design chemicals and materials - Methodological Guidance p. 9 (doi:10.2760/28450 KJ-NA-31-942-EN-N)*

The SSbD framework facilitates adherence to regulatory standards, promotes innovation, and aligns with global sustainability objectives, thereby encouraging the development of safer and more sustainable solutions for a healthier future.

To evaluate the feasibility of implementing this framework in the creation and subsequent use of new chemicals, AlChemiSSts will conduct three case studies focused on the design, development, and introduction of innovative chemicals in the following applications:

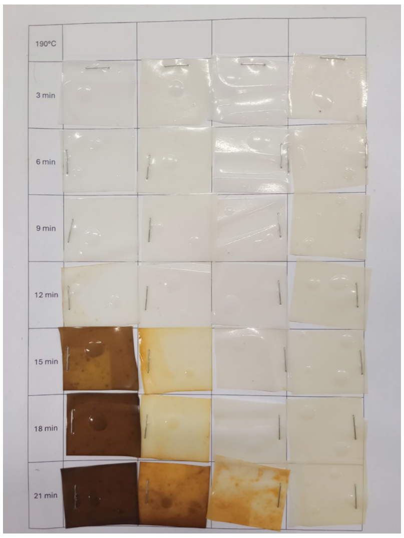
- Substituting phthalates in plasticized PVC for use in sports mats and footwear
- Replacing antimony trioxide and medium-chain chlorinated paraffins in flame-retardant battery casings, insulation foam, and safety shoe soles
- Finding alternatives to petroleum-based surfactants in paints, metalworking fluids, and industrial oils

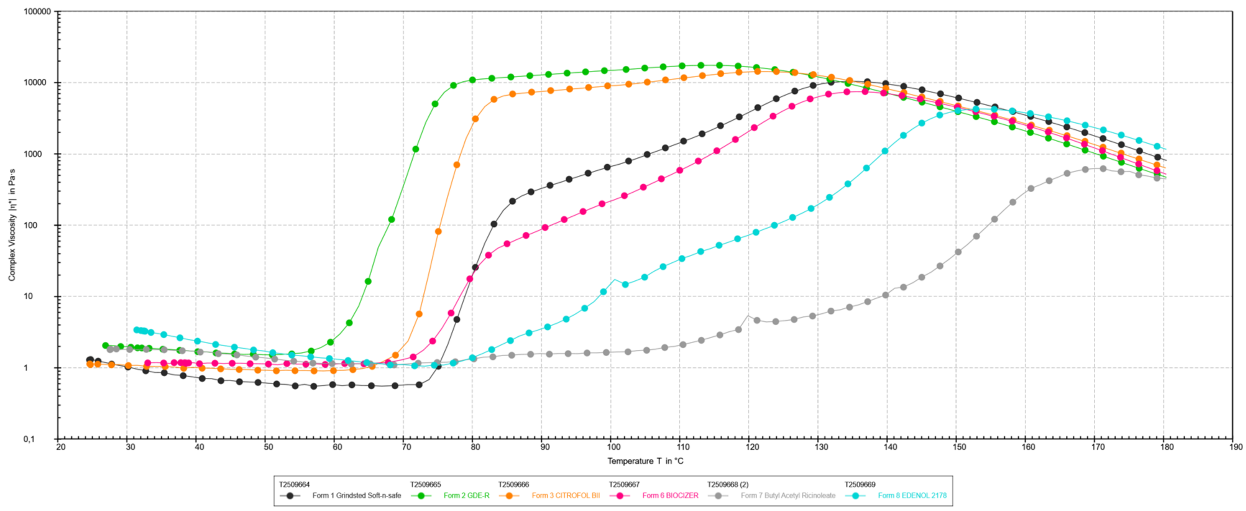
Throughout all phases of development, from laboratory scale to demonstrator, the SSbD framework will be utilized to **assess the impact of the novel chemicals** on human health and environment. Simultaniously, we will **identify potential gaps and obstacles of the SSbD framework** at every stage.

The findings of this study will be communicated to policymakers to facilitate any necessary adjustments to the framework.

In collaboration with Sioen Industries, we are focusing on incorporating the newly developed alternative plasticizers into PVC coatings used for sports mats. Alongside evaluating the technical performance, we will also assess the practical implementation of the SSbD framework.

At this stage, we are benchmarking several commercially available phthalate-free plasticizers against the newly developed alternatives. So far, approximately 30 candidates have undergone an initial screening. Their impact on coating-paste viscosity, PVC-paste gelation behaviour (via rheological measurements), and the heat stability of the PVC coating has been assessed. The most promising alternatives will move on to a second phase of more in-depth testing.





Gelation test results

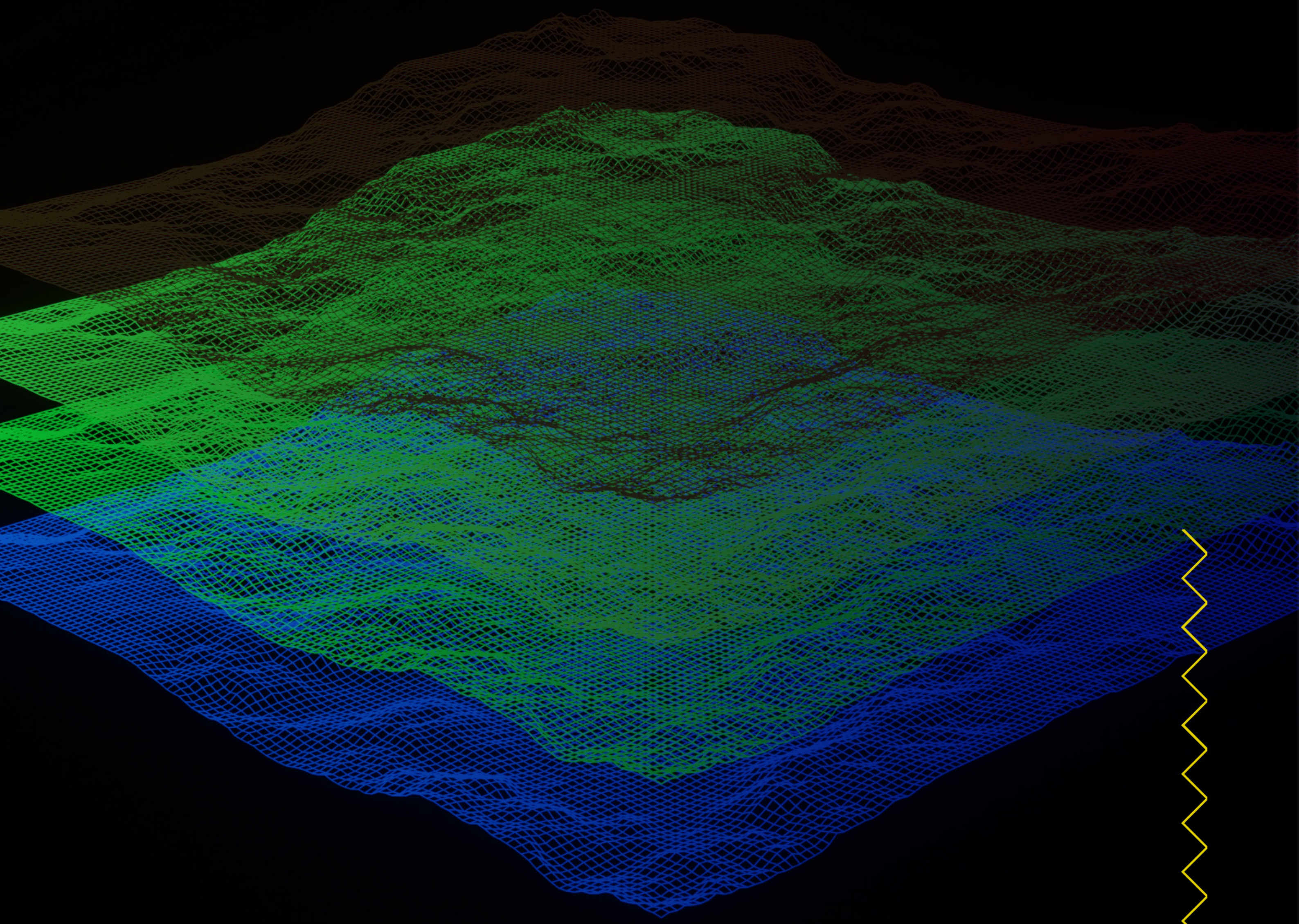
Funded by the European Union

ALCHEMISSTS receives funding from the European Union's Horizon Europe research and innovation programme under grant agreement 101178074. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union (EU) or the European Research Executive Agency (REA). Neither the EU nor REA can be held responsible for them.

Centexbel at the Front and Centre of Bio-based Solutions

The projects on the following pages demonstrate how bio-based and circular solutions are moving from concept to real-world impact. By turning renewable resources into high-value materials, rethinking local supply chains, and designing products that are smarter, safer and more durable, the initiatives collectively point to a new generation of sustainable technologies.

What makes this portfolio especially intriguing is its ambition: not just to replace fossil-based materials, but to outperform them—while strengthening collaboration between industry, researchers and future talent. Together, these projects offer a glimpse into how bio-based innovation can reshape entire sectors.



AddBIO Creates “One-Wash Removable Inks”

Brecht Demedts | Hilde Beeckman | Myriam Vanneste

Within the AddBIO project, we developed a fully bio-based and biodegradable pigment ink that introduces a novel functionality in textile coating and finishing: **temporary printing with controlled removability**. The ink is designed for commercial textile printing applications where visual communication is required only for a limited period, while the textile substrate itself should remain suitable for reuse or reprinting afterwards.

In contrast to conventional textile inks that are engineered for permanent adhesion, this ink balances sufficient durability during use with complete removability. It withstands handling and outdoor exposure, including rainy conditions, yet washes off entirely in a standard washing cycle at 40 °C. This functionality enables a circular use model for printed textiles, particularly in applications such as promotional materials for fairs, conferences, events, and short-term campaigns.

Image: The removable ink is 100% bio-based, compatible with screen printing, durable under rainy outdoor conditions, and fully washable at 40 °C.

Functional Performance by Design

The ink formulation is optimised for screen printing and ensures stable colour performance throughout its intended service life.

After use, the printed layer dissolves and degrades during washing, leaving the textile substrate clean, intact, and ready for reuse. As a result, banners, T-shirts, flags, and similar textile products can be redeployed for subsequent events instead of being discarded due to obsolete or unwanted prints.

From a formulation standpoint, the ink is designed to fully degrade in water and sewage systems and contains no heavy metals.

Restricted elements such as copper, cobalt, cadmium, and chromium are deliberately excluded. Colour performance is achieved using only environmentally compatible inorganic pigments, including iron oxides, titanium dioxide, and aluminium-based ultramarines, ensuring functionality without compromising biodegradability.

Enabling Circularity in Coatings and Finishing

This case study demonstrates how application-specific ink design can actively support circularity in textile finishing. By tailoring adhesion, durability, and removability to real-world use scenarios, coatings can enable reuse rather than locking textile products into single-use lifecycles.

Within the AddBIO project, this development contributes to a broader framework supporting biomass suppliers, bio-additive producers, and coating formulators in integrating bio-based additives into inks and coatings with predictable performance and credible environmental impact.

The project provides formulation guidelines, decision-support tools, and life-cycle assessment expertise to accelerate the transition toward bio-based and circular coating systems.

more results on https://www.centexbelpresents.be/en/addbio

VLAIO

Collective Research & Development and Collective Knowledge Transfer (COOCK), financed by Vlaio

Project HBC.2023.0479

SUINK Develops “Printed Functional Coatings for Self-Charging Automotive Components”

Brecht Demedts | Gertrude Kignelman | Begüm Akalin | Myriam Vanneste

As vehicles become increasingly sensor-rich, the automotive industry faces a growing challenge: how to power distributed sensors without adding weight, complexity, and recycling barriers through extensive wiring harnesses. The SUINK project addresses this challenge by shifting functionality from cables to **coatings and surface-integrated electronics, enabling local, self-powered sensing through printed, bio-based solutions.**

SUINK (SUstainable self-charging power systems developed by INKjet printing) is a Horizon Europe–funded project that develops sustainable, printable power systems based on functional coatings. Using inkjet printing, SUINK creates energy-harvesting, conductive, dielectric, and energy-storage layers that can be directly applied to polymer substrates and integrated into automotive components during manufacturing.

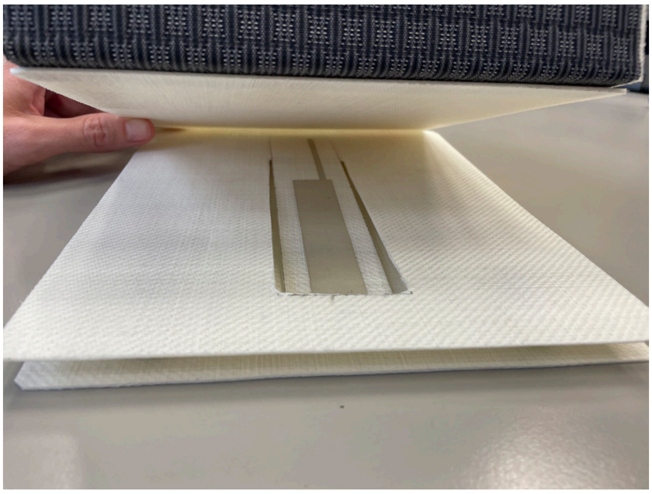


Figure : This car seat shell is made entirely from a PLA-based self-reinforced composite, featuring a PLA cantilever that generates electricity from vibrations to power onboard electronics. The conductive, PLA-compatible inks used are also PLA-based.

Functional Coatings as Energy Systems

Central to SUINK is the development of printed functional coatings that convert mechanical vibrations into electrical energy and store it locally. These include piezoelectric layers for energy harvesting, conductive coatings for electrodes and interconnections, and dielectric layers for printed supercapacitors. All coatings are formulated to be compatible with bio-based polymers, with a strong focus on polylactic acid (PLA).

Unlike conventional electronic coatings that rely on solvent-rich, fossil-based formulations, SUINK develops PLA-compatible, non-toxic inks designed for high-resolution inkjet printing. This enables precise material deposition, minimal waste, and seamless integration of electronic functionality onto flexible or three-dimensional surfaces—key advantages for advanced coating and finishing processes.

Surface-Integrated Electronics in Circular Materials

PLA plays a dual role in SUINK, acting both as a structural substrate and as an active functional material. When mechanically stretched, PLA exhibits piezoelectric behaviour and can be used as an energy-harvesting coating on vibrating components. In parallel, Centexbel develops 100% PLA self-reinforced composites that serve as recyclable structural parts and ideal substrates for printed electronic coatings. In order to optimize the efficiency of energy harvestors, we also look into poled PVDF as piezoelectric elements.

Designed for Recycling & safe and sustainable by design

A key objective of SUINK is ensuring that functional coatings do not compromise recyclability. All materials are selected according to a strict design-for-recycling philosophy. We develop three recycling routes: thermomechanical recycling, solvolysis and solvatation based recycling. One of the key findings is that for example carbon nanutubes (CNT) were extractable from compost and extracts from the compounds and therefore should not be used when the PLA is reused in biodegradable applications. The project develops recycling routes that allow both polymer substrates and metallic particles from printed coatings to be recovered at high value.

Learn More: Printed Electronics Webinar

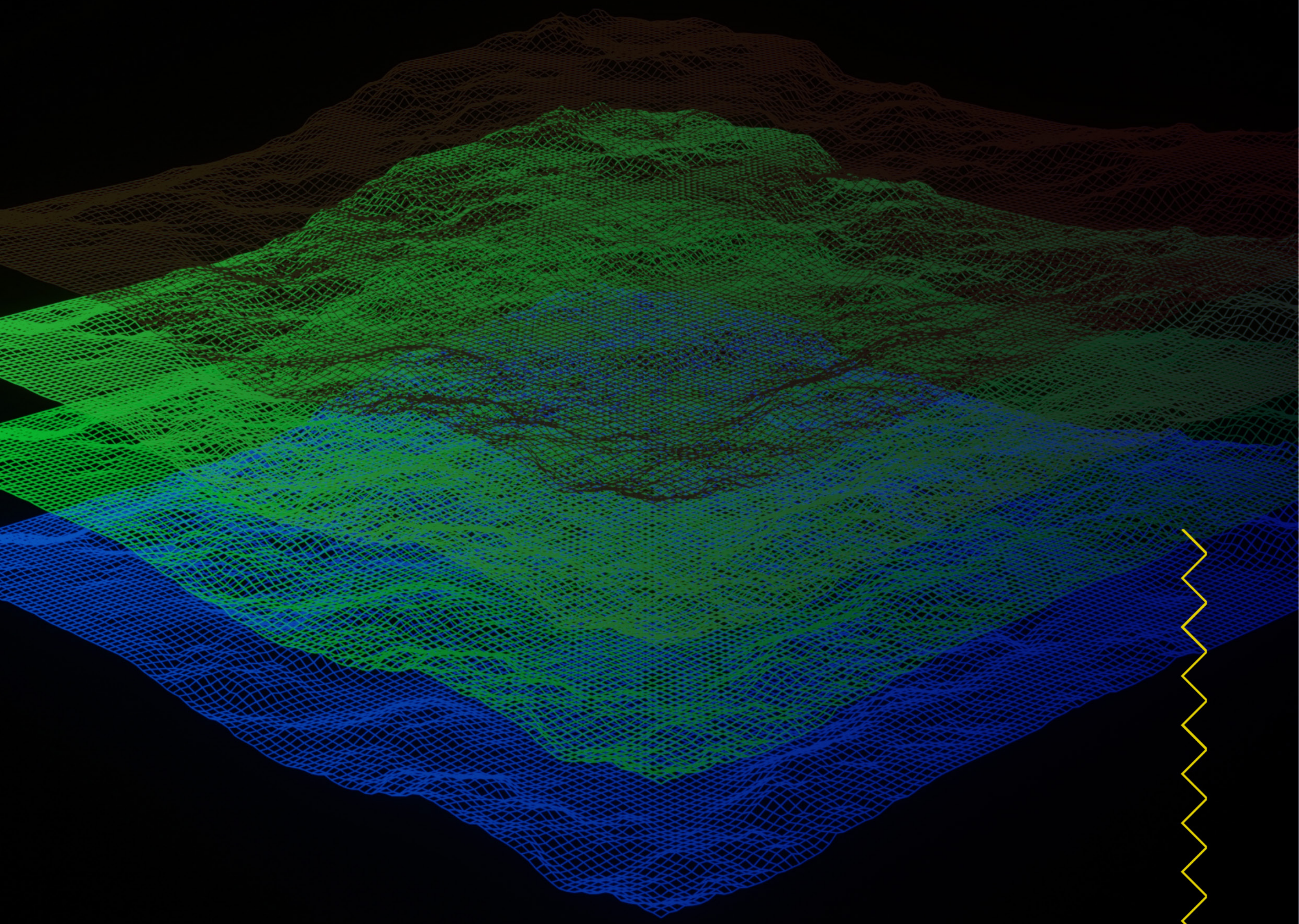
The SUINK consortium recently hosted a public webinar on conductive and dielectric inks, focusing on sustainable formulations, inkjet printability, and coating performance for printed electronics.

The recording can be viewed here: https://www.suink.eu/the-suink-project-holds-its-first-public-webinar-on-conductive-and-dielectric-inks/

Funded by the European Union

The SUINK project has received funding from the European Union’s Horizon Europe research and innovation programme under grant agreement No. 101070112.

Breakthroughs in Smart Textiles



Antirési Tackles the Urgent Issue of Antibiotic Resistance

Stijn Van Vrekhem | Pegah Zahedifar

In the AntiRési project, we tackle the urgent issue of antibiotic resistance by developing advanced technological solutions across a wide range of materials to help prevent bacterial infections and curb the rise of resistant strains. Together with our project partners, Centexbel is creating innovative antibacterial textiles tailored for medical applications, orthotic devices, shoe insoles, and sportswear.

To develop antibacterial textiles, Centexbel applies a range of deposition techniques - including foulard, knife coating, digital printing, and plasma polymerization - to incorporate various antibacterial agents, including novel compounds created within the AntiRési consortium.

The antibacterial performance of the treated fabrics is evaluated according to **ISO 20743**, using two bacterial strains: *Klebsiella pneumoniae* and *Staphylococcus aureus*.

Figure 1 presents the antimicrobial effectiveness of different agents applied to polyester fabrics using these techniques after 24 hours of incubation. The results show that foulard application and digital printing achieve the highest levels of efficiency. Among the agents tested, zinc based compounds, quaternary ammonium compounds (QACs), and reactive oxygen species (ROS) releasing products demonstrate the strongest antibacterial activity.

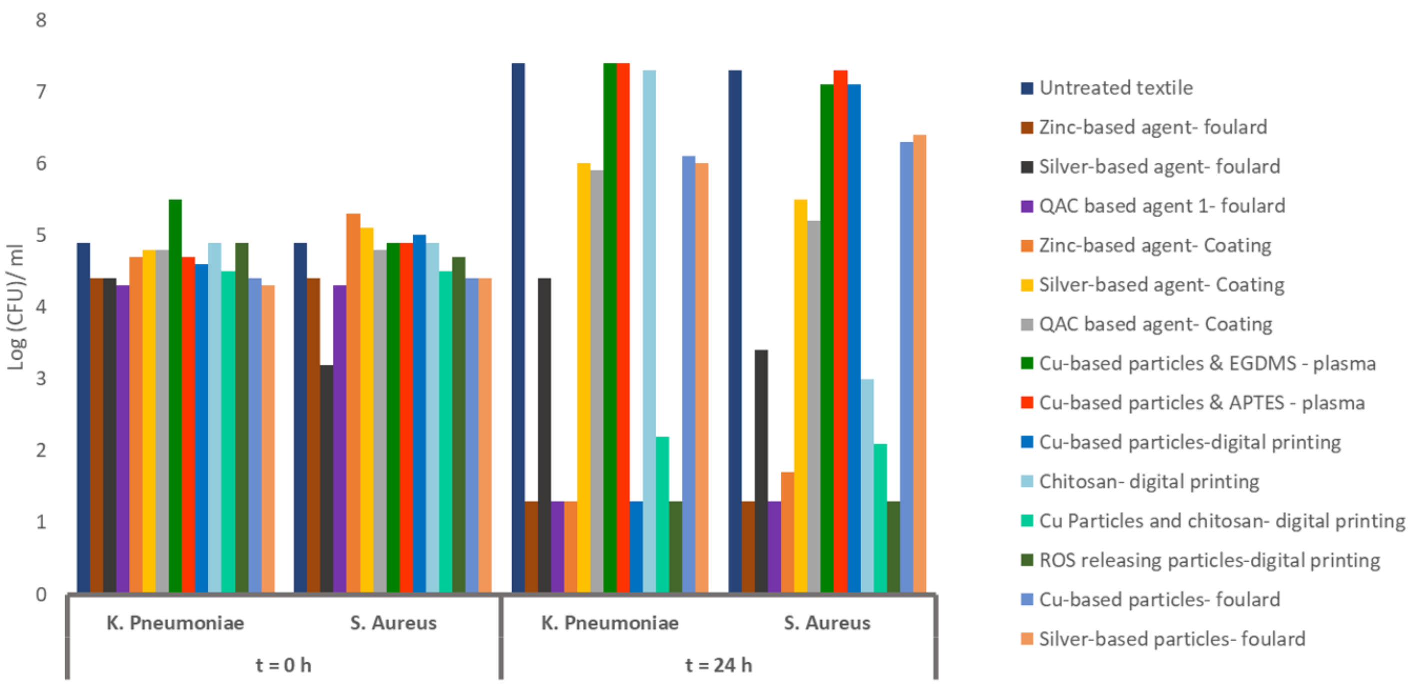


Figure 1 shows the logarithmic number of colony-forming units (CFU) per millilitre of extraction medium measured at 0 and 24 hours after bacterial inoculation. The results are presented for an untreated textile and for textiles treated with various antibacterial agents using different application techniques.

Interreg
Cofinancé par l'Union Européenne
Medegefinancierd door de Europese Unie
France – Wallonie – Vlaanderen

Antirési is an INTERREG FWV project, cofinanced by the Province of East-Flanders and VLAIO.

provincie Oost-Vlaanderen
VLAIO

Diamond Advances
“Smart Textile Solutions for Wound Care”

Elbeshary Mohammed | Willem Uyttendaele | Myriam Vanneste

Diabetic foot ulcers (DFU) are among the most problematic complications of diabetes and often lead to chronic infections, impaired wound healing, and, in the most severe cases, amputation of the lower limb. Traditional dressings provide passive protection, but they neither allow monitoring of the wound condition nor enable the delivery of targeted treatments. The Interreg DIAMOND project aims to address these limitations by developing a new generation of smart dressings in which biosensors and responsive therapeutic delivery systems are integrated.

Within this context, Centexbel has focused on the design and production of textile-integrated sensors capable of monitoring critical wound parameters such as pH and temperature. These printed sensors consist of three elements: a dielectric layer that protects the sensor from its environment, a silver-based reference electrode, and carbon-based conductive tracks that act as carriers for the sensitive components and ensure signal transmission. Together, they form essential components of a smart dressing that can detect early signs of infection and trigger localized therapeutic release. The work includes the development of conductive inks, the fabrication of multilayer sensor structures, and their transfer onto textile substrates. This document provides an overview of the sensor development process, the main technical advances, and the ongoing efforts to improve their performance and integration into the complete smart dressing.

Print screen design

To improve the manufacturability of the sensors and to resolve the clogging issues of the screen-printing frames encountered during earlier tests, new frame designs were developed (Figure 1). The new designs feature more spacious sensor geometries with wider print lines, which facilitate processing and result in uniform, defect-free prints, in contrast to the older screens.

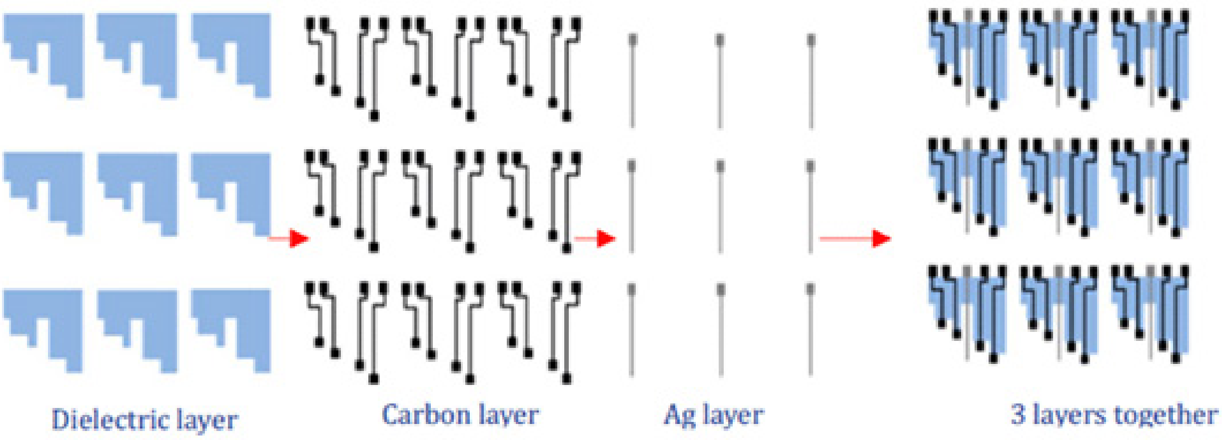


Figure 1. New screens

Dielectric Layer

A polyurethane (PU)-based formulation was developed to obtain a uniform dielectric layer suitable for screen printing on silicone paper. The system uses a PU binder as the main film-forming component, ensuring stable dielectric properties. A hardener is added to improve durability and resistance during subsequent processing steps.

To optimize print performance, a rheology modifier is used to adjust viscosity and ensure a smooth, homogeneous layer. An antifoaming agent prevents air entrapment and guarantees a defect-free coating. A small amount of dye is added solely to enable visual inspection during printing and curing and to facilitate the alignment of successive layers.

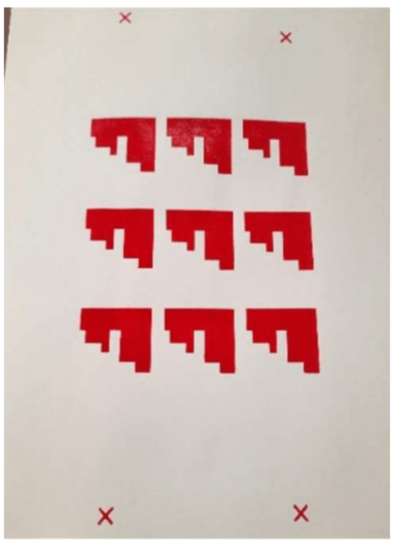


Figure 2. Dielectric layer print

CNT Ink

A water-based formulation compatible with screen printing was developed, combining a PU binder for adhesion, flexibility, and film integrity with a conductive carbon material. In this case, a dispersion of carbon nanotubes (CNTs) was selected because of their higher conductivity compared to graphite. Functional additives—a surfactant, a cellulose thickener, and a hardener—were used to optimize wetting, rheology, and durability. Water allows viscosity adjustment and ensures a homogeneous dispersion. The resulting formulation provides a stable printing process that produces flexible, durable, and conductive layers after drying and curing.

Figure 3. CNT ink

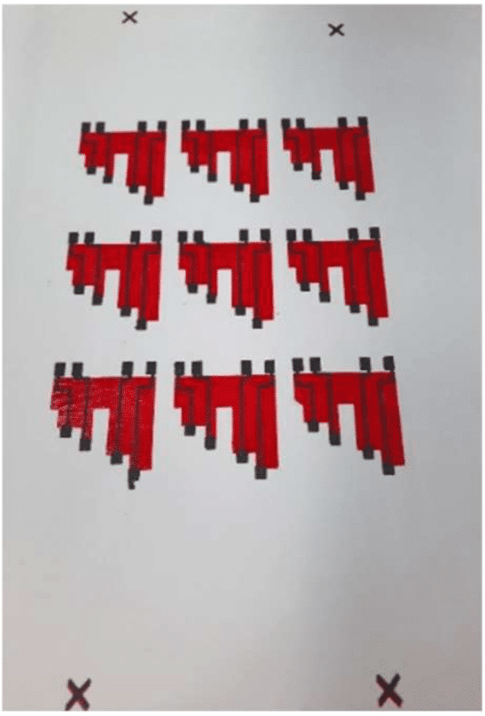


Figure 4. CNT print on a dielectric layer

Silver Electrode

A water-based ink (Figure 5) was used to create the silver-based reference electrode. This ink contains a PU binder, a hardener, and various additives, with silver particles as the conductive material. At this development stage, only metallic silver was used; the addition of silver chloride (AgCl) is planned in later formulations after further optimization. The silver ink was printed onto the dielectric layer and the CNT layer and subsequently dried to ensure curing (Figure 6).

Figure 5. Silver-based ink

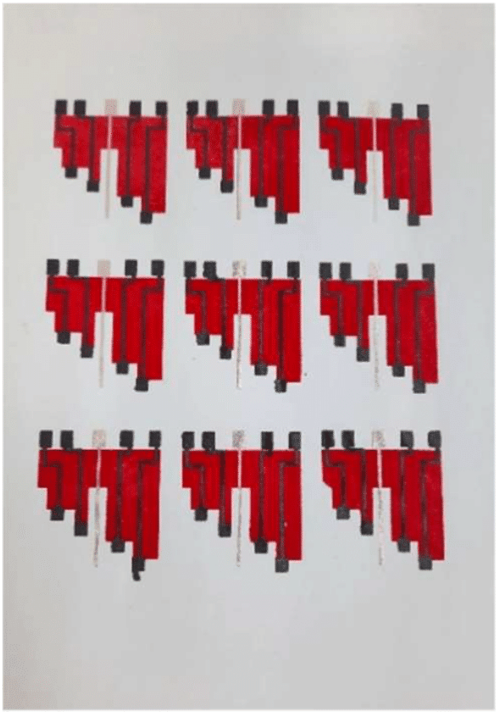


Figure 6. Silver-based prints

Transfer of the Print onto Textile

The print was transferred onto a polyester textile using a specially formulated transfer paste consisting of a water-based PU binder, a hardener, and a small amount of thickener to achieve the desired viscosity. First, a layer of this paste was applied to the carrier paper with the printed sensor and dried. Next, the textile was placed onto the transfer layer and thermally pressed. After pressing, the carrier paper was carefully removed, allowing the printed pattern to be neatly transferred and to remain firmly adhered to the textile surface (Figure 7).

The sensor samples were then cut to size and sent to UMons for testing. The results showed that the silver-based sensor functioned correctly. However, the conductivity of the CNT sensors remains low (approximately 20 kΩ), which is insufficient for electrochemical measurements.

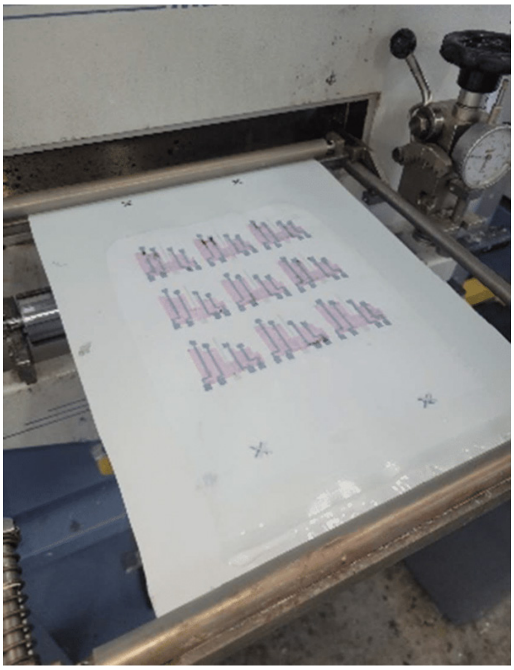


Figure 7. Application of the transfer layer

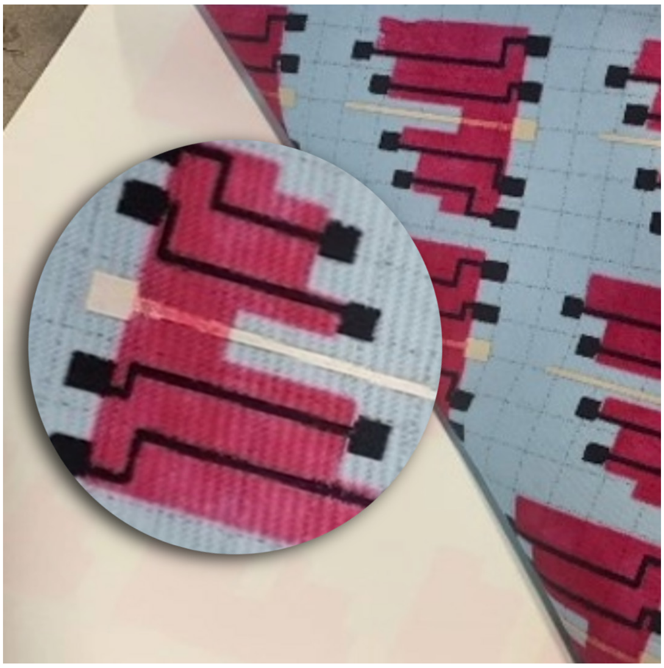


Figure 8. Textile-integrated sensors on textile

Ongoing Work

Formulation research is continuing to improve the conductivity of the CNT-based sensors. One possible approach is increasing the amount of CNT dispersion in the formulation. Another approach is incorporating a higher proportion of graphite, as graphite dispersions are generally available with a higher solids content than CNT dispersions. In addition, other types of textiles will be tested as alternatives to polyester.

DIAMOND

Interreg Cofinancé par l'Union Européenne Medegefinancierd door de Europese Unie

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The article written by Elbeshary Mohammed, Myriam Vanneste and Willem Uyttendaele was also published in the DIAMOND newsletter nr 3 : https://mailchi.mp/eurasante/newsletter-nr3-winter-25-5383502

https://www.diamond-smartbandage.nl/ontwikkeling-en-integratie-van-gedrukte-sensoren-voor-slimme-verbanden-in-het-kader-van-het-diamond-project/
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RE:HOME develops smart garments for a better rehabilitation and care of children with Cerebral Palsy

Stijn Van Vrekhem | Pegah Zahedifar | Elbeshary Mohammed

By enabling access to advanced technologies such as exoskeleton modules, orthoses, smart garments, and integrated IT platforms, RE:HOME seeks to deliver improved and standardised care for children across rehabilitation centres, healthcare facilities, and home environments.

Together with an interdisciplinary team of partners, Centexbel is advancing the development of an innovative smart garment system. Smart garments represent a specialised category of smart textiles designed for direct wear by end users, enabling continuous monitoring of physiological parameters, as schematically illustrated in Figure 1.

These garments are produced using screen-printing techniques on textile substrates, allowing functional sensors to be seamlessly integrated into the fabric.

Within the scope of the RE:HOME project, the smart garment is intended for diagnostic use, monitoring key physiological indicators. Specifically, RE:HOME aims to develop a customised home-care system for children with Cerebral Palsy (CP), focusing on heart rate, respiratory activity, and muscle function.

This innovation addresses major challenges in CP rehabilitation, where stress and discomfort can significantly limit therapeutic outcomes.

- The RE:HOME smart garment integrates sensors that measure heart rate and respiration, providing real-time insight into stress levels during rehabilitation (Figure 2a–b).
- In addition, the system interfaces with a thigh support equipped with conductive sensors to assess muscle activation and pressure distribution, supporting clinicians in optimising posture and mobility (Figure 2c).
- By delivering actionable, real-time data, the smart garment contributes to safer, more effective, and personalised rehabilitation for children with CP.

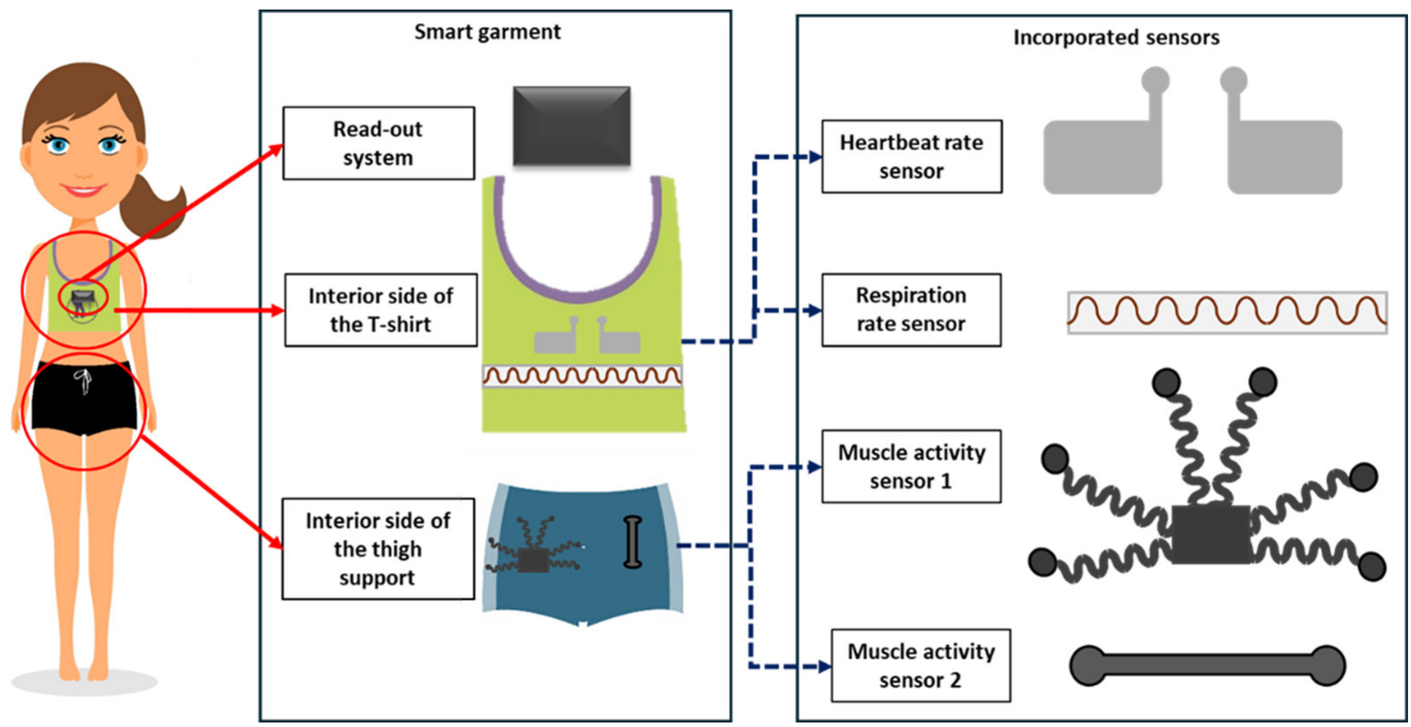


Figure 1: Schematic representation of smart garment development in the RE:HOME project

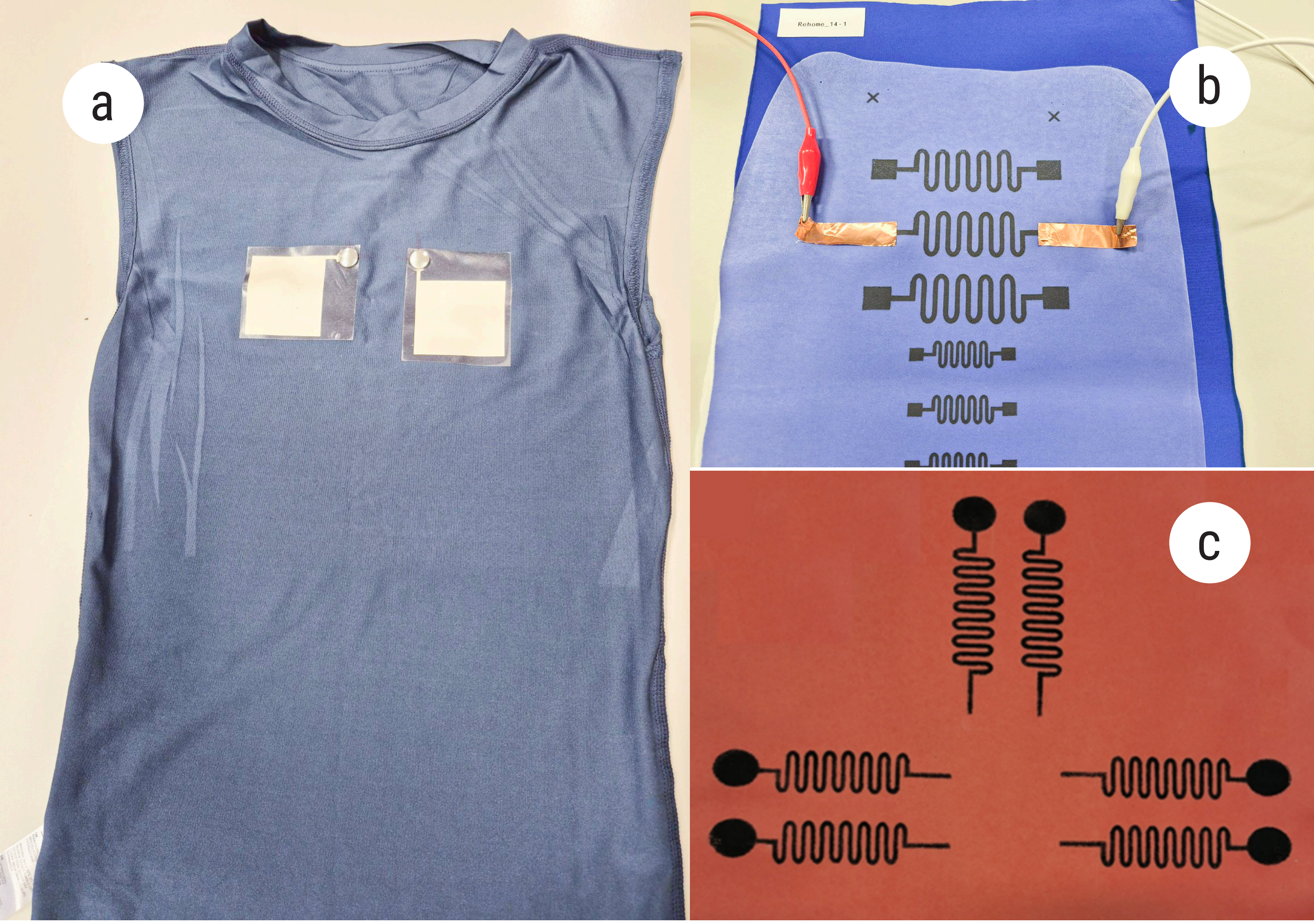


Figure 2: (a) Heart rate sensor patches integrated into a sports base layer with two snap buttons for connectivity. (b) Respiration rate sensor screen-printed on a textile base layer. (c) Muscle activity sensor screen-printed on a textile base layer.

RE:HOME is an INTERREG VI North-West Europe project, cofinanced by the Province of East-Flanders and VLAIO.

Smart Textiles for Waste Heat Harvesting

Elbeshary Mohammed, Brecht Demedts and Myriam Vanneste

ThermoHarv is an innovative research project aimed at enhancing energy efficiency in buildings by recovering waste heat and converting it into electricity using thermoelectric and pyroelectric materials. By integrating conductive and functional materials into coatings, textiles, and composites, and addressing scalability and recyclability from the design stage, ThermoHarv advances sustainable, circular, and energy-efficient building solutions.

Centexbel contributes by identifying key building-sector applications for heat recovery and supporting demonstrator development. With expertise in printed electronics, functional coatings, textiles, and composites, Centexbel enables the integration of thermoelectric and pyroelectric materials via transfer and lamination techniques. It also ensures industrial scalability and circularity by evaluating recycling routes for sustainable, viable solutions in future buildings.

The initial prototyping was carried out using p-type and n-type semiconductor particles. As shown in Figure 1, the prototype has a corrugated, accordion-like geometry that allows it to be wrapped around a pipe. This folded, flexible structure increases the effective surface area while enabling close contact with curved surfaces, making it well suited for harvesting waste heat from pipes and other cylindrical building components.

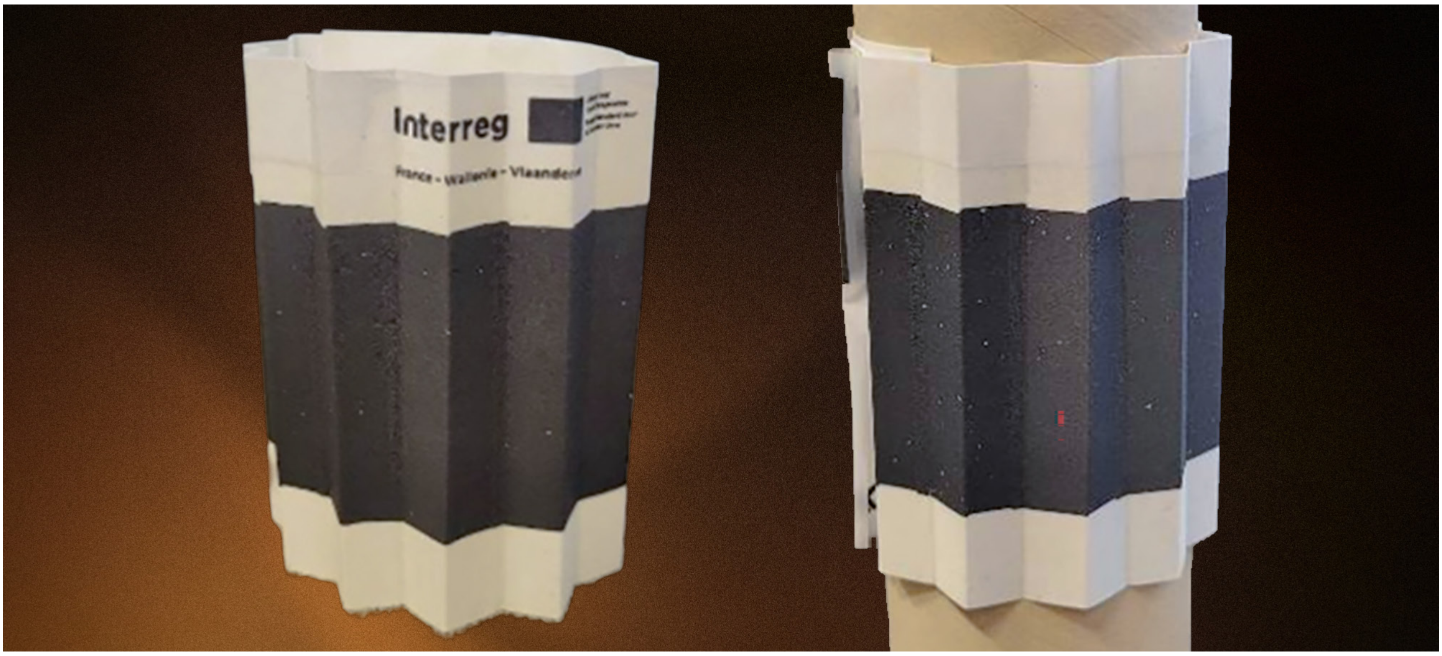


Figure 1.Initial thermoelectric prototyping

To enhance thermoelectric performance, it is essential to maximize the temperature difference (ΔT) between the hot and cold sides, which requires efficient heat dissipation from the cold side. As an initial cooling solution, a textile-based vapor chamber has been developed (Figure 2).

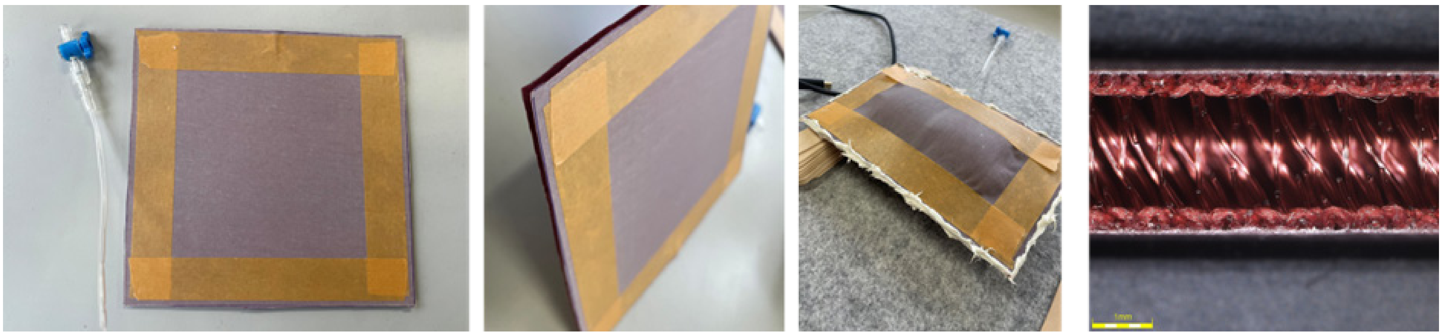
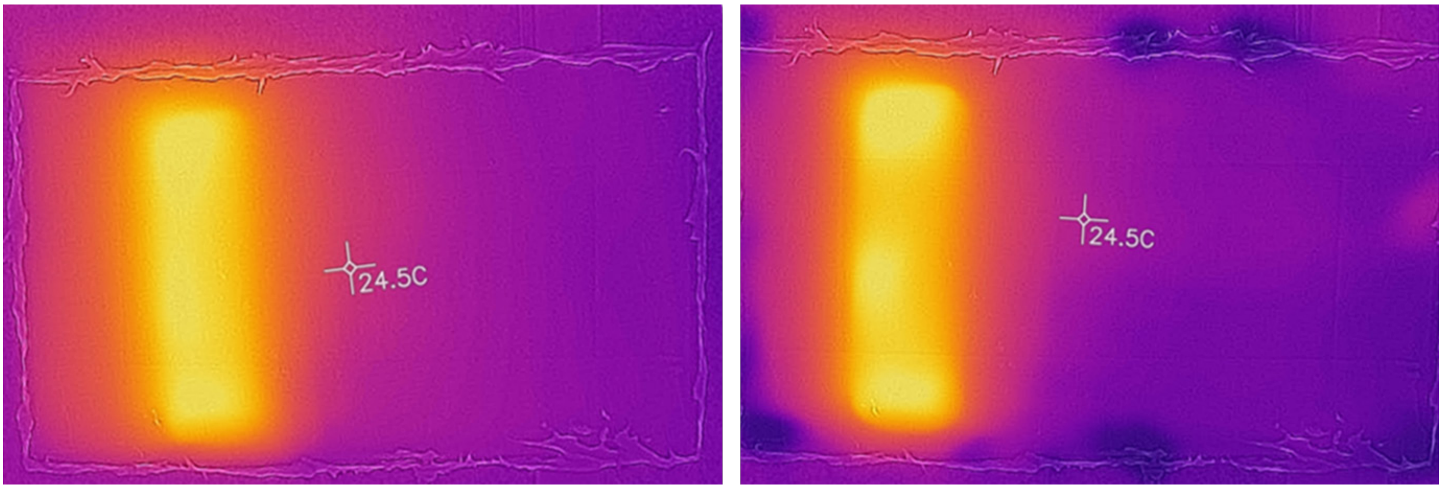


Figure 2. Textile-based vapor chamber designed to enhance thermoelectric performance by efficiently dissipating heat from the cold side, maximizing the temperature difference (ΔT).

This chamber features air-tight coatings on the top and bottom to contain the working fluid, while 3D knit spacer fabric in between creates internal channels for vapor flow and heat transfer. Such a design enables rapid heat removal from the thermoelectric element, sustaining higher power output over time. As shown in Figure 3, altered heat fluxes in the vapor chamber provide a clear indication that the principle works, though further analysis and optimization are needed, an encouraging result that supports continued exploration of this approach.



THERMOHARV

THERMOHARV is funded by the InterregVI France-Wallonie-Vlaanderen program, and co-financed by the Walloon Region and the Province of West-Flanders