PRINT'UP
INSTITUTE

ANNUAL REPORT 2025

Printed electronics, a source of innovation

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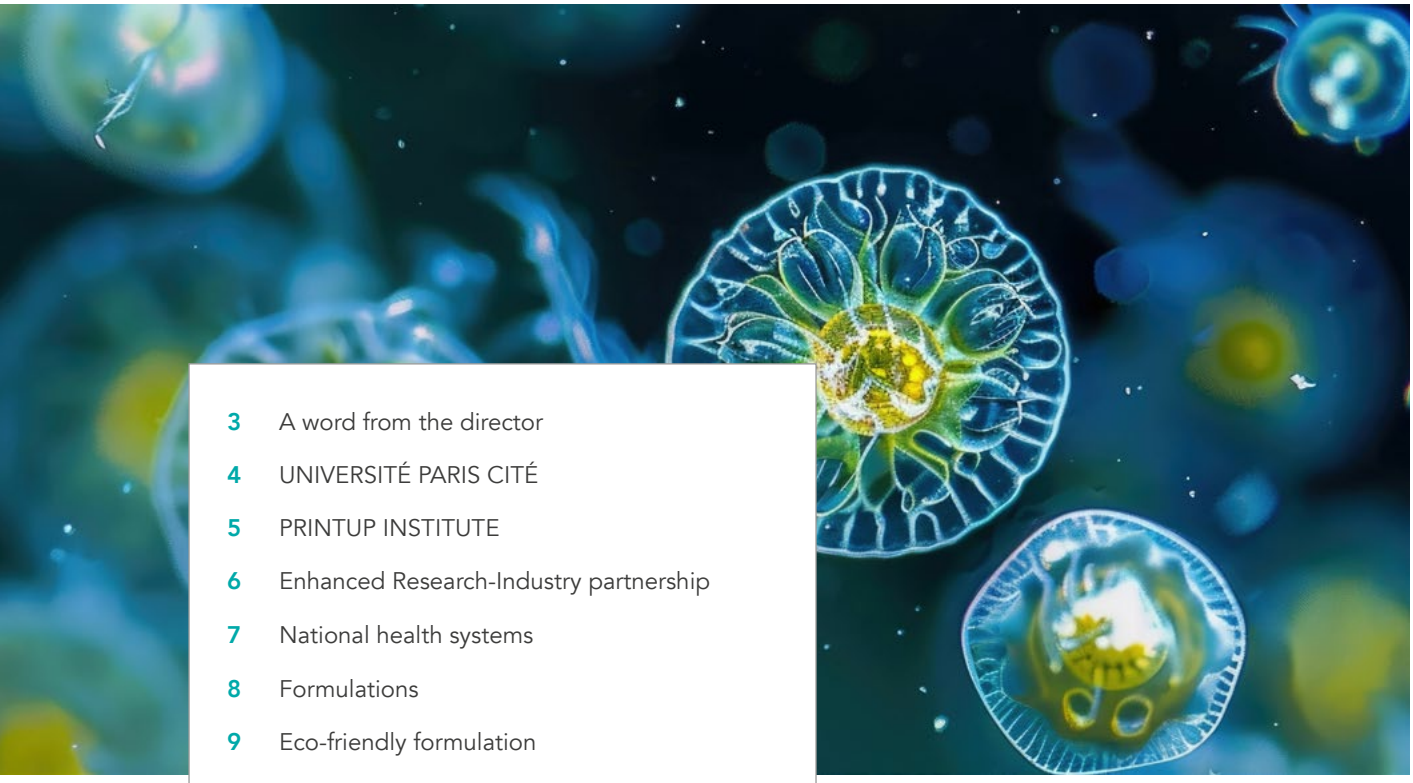
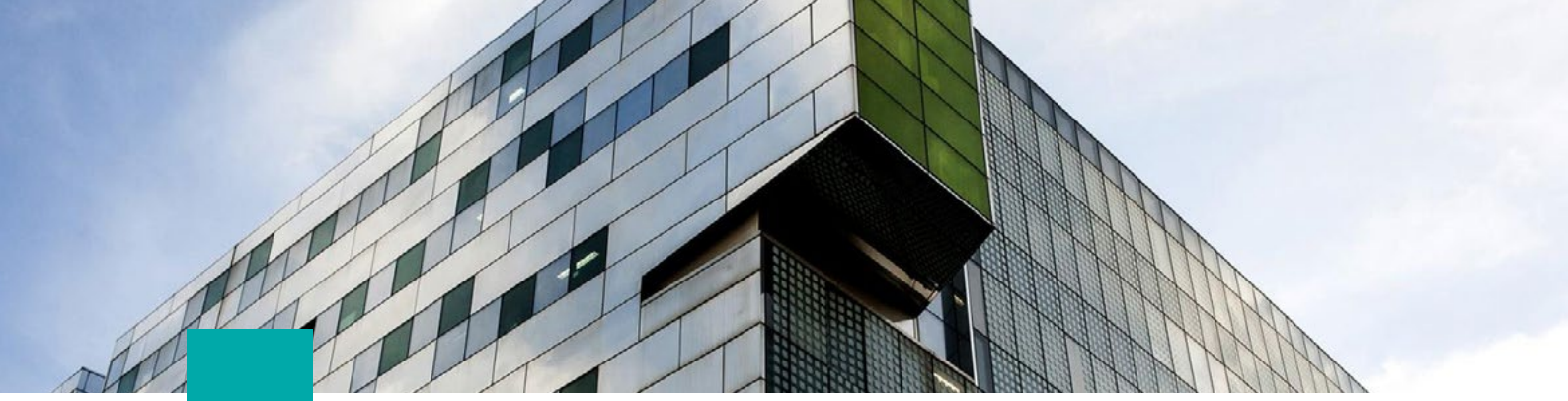




A WORD FROM THE DIRECTOR

From ink to data: an expanding ecosystem

The year 2025 reflects our ongoing commitment to research and innovation.

The launch of several research and development projects with industry demonstrates the relevance of our positioning and the trust we build with our partners.

We explore new possibilities in biosensing, starting four theses dedicated to these emerging topics. This work, carried out in our laboratories, strengthens our ability to anticipate future needs in terms of innovative sensors and diagnostic technologies.

Another highlight of the year was the development of strategic partnerships with a French competitiveness cluster and with leading professional organizations. These ecosystems of complementary skills aim to strengthen our impact.

In 2026, our growth strategy combines two approaches: consolidating our expertise and diversifying our activities. We will intensify our R&D efforts in the field of printed biosensors across the entire value chain, from ink formulation to advanced analytical performance characterization.

The other focus will be on expanding our network of strategic partnerships in order to integrate complementary technological assets: flexible and printed power supply systems, sensor control and communication modules, and data analysis using artificial intelligence.

These strategic objectives will accelerate the development of innovative, connected and mobile diagnostic devices within the institute.

I am grateful to the entire team of the institute for their commitment., Their creativity, rigor and cooperation spirit are a big strength. I also express my gratitude to our partners for their continuous trust.

Together, we pave the way for the printed technologies of tomorrow.

Professor Vincent NOËL, UNIVERSITÉ PARIS CITÉ, Director of the PRINTUP INSTITUTE

4 800 researchers and teachers

3 260 invited researchers

68 000 students

21 doctoral schools

113 research units

60e in the 2025 Shanghai ranking

5e in the 2025 CLARIVATE ranking

500 000 m² of real estate assets

Université Paris Cité

UNIVERSITÉ PARIS CITÉ is fundamentally multidisciplinary and develops high-level research activities.

It is particularly prominent in the fields of earth sciences, medicine and, more broadly, biology and health.

It brings together one of the largest groups of laboratories affiliated to the CNRS and INSERM.

It gathers a diverse expertise committed to environmental balance and global health.

In a rapidly evolving world, the university aims to build a unique academic community based on strong values:

- freedom of thought,
- contribution to major societal issues,
- the ambition for international excellence coupled with strong links to the local environment,
- respect for and promotion of equality,
- and scientific integrity.

The existence in the university's bylaws of a committee for ethics, professional conduct and scientific integrity align with these values.

«The PRINT'UP Institute illustrates the ability of UNIVERSITÉ PARIS CITÉ to bring together research, technology and partnerships. By strengthening our scientific collaborations with businesses, the institute positions our institution as a driver of innovation at the heart of a dynamic new industrial sector.»

Professor Edouard KAMINSKY, President of UNIVERSITÉ PARIS CITÉ

9 researchers

5 engineers

1 industry coordinator

11 PhD students

35 industrial partnerships

25 R&D projects

60 pieces of equipment

320 k€ equipment investment

PRINT'UP INSTITUTE

PRINTUP INSTITUTE, innovation catalyst at UNIVERSITÉ PARIS CITÉ

Located within the university, PRINTUP INSTITUTE completely aligns with the institution's scientific strategy, developing research dedicated to innovation in medical devices.

Its work focuses on three complementary areas:

- Designing printable materials and functional inks for applications in energy, the environment and health.
- Developing production-ready biosensors for the early diagnosis of emerging diseases and for environmental monitoring.
- Creating new additive manufacturing approaches that will increase possibilities for printed electronics.

By combining academic research and industrial capabilities, PRINTUP INSTITUTE promotes the rapid commercialization of technological innovations and reinforces the production in France and in Europe.

At the heart of the research, industry and healthcare ecosystem for printed electronics, the institute contributes to national and European industrial sovereignty, and the reduction of environmental impact.

PRINTUP INSTITUTE embodies a quest for excellence focused on responsible innovation and French competitiveness.

The institute: enhanced Research/Industry partnership

The institute offers its scientific expertise to carry out joint initiatives with companies in the form of services, partnerships, shared projects and developments.

SERVICES with dedicated experts and equipment to meet specific application needs.

- Rental of printing and characterization equipment that can be self-used or with assistance
- Formulation and adaptation of custom inks
- Design of printed sensors and biosensors for innovative detection solutions
- Testing and characterization of printed components: printability, adhesion and thermal stability tests; morphological, chemical, electrical, electrochemical and spectroscopic characterization
- Manufacturing of small series of printed components, ideal for prototypes or clinical trials.

"CIFRE" THESES that facilitate skills and knowledge transfer between academia and industry: doctoral students conduct research while meeting the specific needs of the private sector in France.

COLLABORATIVE PROJECTS in the field of printed electronics.
Backed by unique research expertise and prototyping capabilities, the institute is involved in numerous collaborative projects Health - Research - Industry.

PARTNERSHIP AGREEMENTS to develop specific research programmes. Tailor-made to define the scope of co-development, manage intellectual property issues and establish a hosting contract at the institute's premises.

JOINT LABORATORIES between a company and the institute on a common scientific theme for a period of five years.

PRINTUP INSTITUTE in 2025: €200,000 in services, three CIFRE theses in progress, ten collaborative projects, including three with industrial partners worth €1.8 million, five partnership agreements and a joint laboratory

Contributing to the sustainability of national healthcare systems

In France and in Europe, the healthcare system is currently facing growing challenges related to its economic viability and environmental impact. Ensuring its sustainability requires rethinking organizational models to address current and future constraints, be they health-related, demographic or ecological.

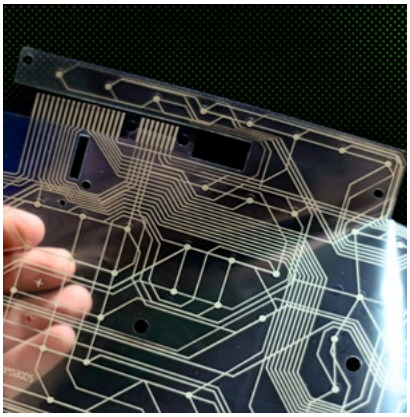
Therefore, the development and integration of printed sensors and biosensors represents a path of technological innovation that could support a sustainable transformation of healthcare systems.

Sensors continuously collect physiological data, such as body temperature, heart rate, pH or humidity levels, while biosensors are specifically designed to detect and measure the presence of molecules of biological interest, such as proteins, hormones or nucleic acid fragments.

Their printed design makes these devices lighter, more flexible and more accessible, facilitating their integration into a variety of medical applications, including outside the hospital setting. The use of these technologies also helps individual and regular patient monitoring. It allows earlier detection of physiological imbalances, better anticipation of complications and more rational use of hospital resources.

Ultimately, the adoption of these solutions should enhance the performance of healthcare systems while limiting their expenses.

FORMULATIONS



Printed electronics expands its integration into applications requiring increasingly complex, modular and integrated functions. At the heart of this evolution is a strategic part: functional inks which can be conductive, semiconductive and catalytic.

Nanomaterial-based inks

Recent advances have highlighted the growing importance of nanomaterials in functional inks.

Their nanoscale structure gives the final material mechanical, electrical or optical properties that are essential in multiple applications. Their compatibility with digital printing processes makes them ready for industrialization.

However, difficulties still exist to exploit the potential of nanomaterials fully. The main one is formulating inks with a high nanomaterial content while preventing aggregation.

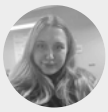
Another one is the poor compatibility of most nanomaterials with hydroalcoholic solvents, which is often circumvented with toxic organic solvents.

The institute's expertise in functionalizing nanomaterials is crucial to overcome these difficulties and to design nanomaterial coatings that guarantee the stability of suspensions and do not change the properties of the final printed material.

Catalytic inks: a new generation of functional inks

Current developments in the field of functional inks converge towards the design of a new generation of inks, for catalysis, electrocatalysis and photocatalysis applications. Research focuses on systems based on metal, oxide or hybrid nanoparticles, which provide a high density of catalytic sites while reducing the use of noble metals thanks to the growing use of nickel, copper, iron or transition oxides.

Integrating structured carbonaceous supports (graphene, nanotubes) improves the dispersion, conductivity and stability of the active layers. In addition, inks for electrocatalysis and photocatalysis improve significantly, driven by the need for advanced sensors and devices for energy harvesting, storage and production.



N. JACHIM's thesis: *a new generation of electrocatalytic inks based on platinum nanoparticles coated with hydrogel for enzymatic assays.*

A. BRACHFELD's thesis with IFREMER: *the transformation of metal nanoparticles for the detection of heavy metals traces in the oceans.*

Eco-friendly formulation as a strategic requirement

Eco-design of functional inks through their life cycle is a major challenge to reduce the environmental impact of printed electronics, a rapidly expanding sector currently focusing on short-lived products that are difficult to recycle.

Today, printed devices often use multi-layer plastic substrates onto which inks adhere strongly. This configuration prevents effective separation of materials during recycling, thus limiting the recovery of conductive or functional components.

In response to these limitations, it is essential to develop inks that are compatible with existing recycling streams, or even with composting or controlled biodegradation processes. It means dropping binders often derived from petrochemicals, additives or problematic nanomaterials, and replace them with bio-based, soluble or easily reusable components. Another strategy is to design single-material devices or to use easily detachable layers to simplify disassembly and improve the circularity of materials.

Eco-design is a major cross-cutting trend to reduce environmental impact, with the development of aqueous formulations, abundant materials and precursors that can be activated in situ.

The institute has identified three priority areas to align with the eco-friendly requirement:

- Research and Development: to design new generations of functional inks, especially photocatalytic and electrocatalytic inks.
- Advanced characterization: to acquire equipment and methodological developments for physicochemical characterization at all stages, from the synthesis of ink components to the printed material.
- Industrialization: to support partners in the adoption of inkjet, screen printing and micro dispensing processes adapted to new formulations.

SENSORS AND BIOSENSORS

A word from Professor Benoit PIRO, UNIVERSITÉ PARIS CITÉ, co-founder of PRINTUP INSTITUTE

Biosensors are strategically important because they provide rapid, accurate and accessible diagnostics, which are essential for modern healthcare, prevention and health crisis management. Their integration into connected devices and continuous monitoring systems makes them a fundamental technological asset for personalized medicine and the future of our healthcare systems.

Continuous and personalized health monitoring

Integrated into watches, textiles or skin patches, sensors provide continuous and often non-invasive monitoring of physiological parameters. The miniaturization of electronics, use of flexible materials and emergence of energy harvesting technologies contribute to the development of quiet and autonomous sensors. Combined with embedded artificial intelligence, these devices can interpret data locally, thus increasing the processing speed and reducing the amount of data transferred to a cloud.

Demand for real-time biosensors is growing. These devices, which are based on electrochemical, optical or microfluidic technologies, provide instant detection of physiological changes. They become increasingly fast, with response times in the order of seconds. Some can be implanted or semi-implanted to ensure a continuous internal monitoring. Real-time analysis from artificial intelligence can issue warnings as soon as an anomaly is detected, significantly enhancing prevention.

Artificial intelligence also improves sensor accuracy by filtering out noise and automatically calibrating measurements. It becomes possible to interpret complex biological signals by comparing multiple chemical and actimetric measurements, paving the way for predictive diagnostics able to anticipate physiological events. Consequently, sensors are more accurate and reliable, adapting in real time to the user's profile.

Prevention: towards a higher number of biomarkers accessible to detection

New biosensors' targets shift towards biomarkers which are more subtle and more extensive than blood glucose, backing the move towards personalized and preventive medicine. Detection of molecules linked to metabolism and chronic diseases is a challenge and remains central in many R&D projects.

Biosensors also begin to target cellular ageing markers, such as glycation products. In the field of infectious diseases, the simultaneous detection of multiple pathogens or their toxins is trending. Analytes derived from microbiota are new targets of interest due to their central role in immunity, metabolism regulation and the physiopathology of many medical fields.

Electrical or electrochemical biosensors are easier to manufacture and integrate, more energy-efficient and more robust than optical biosensors. They are the preferred choice for the development of mobile diagnostic tools. Thin, strong and conformable, these printed sensors can be integrated onto or into any type of object.

Economical (low manufacturing costs) and sustainable (additive printing), they are strategic assets for the European Union.

D. L. NGUYEN's thesis: *Gas-permeable gate transistors. Application to the diagnosis of SIBO (Small Intestinal Bacterial Overgrowth).*

Within the artificial intelligence and biosensors field, the institute sets up international collaborations. For instance, it develops edge computing approaches to process biosensor signals as part of a European project and the "LabCom" MEDSENSORS.

Printed electronics and artificial intelligence bring a new generation of self-learning sensors

Data is the foundation on which artificial intelligence systems make decisions and improve. Biosensors detect elements related to living organisms, such as the presence of a virus, bacteria or some markers in our bodies. Thanks to sensors and biosensors, artificial intelligence learns and acts in real time.

Recent advances in printed electronics make it possible to manufacture smart sensors: AI is integrated into the architecture of the sensor itself.

Rather than sending all the data to a cloud, processing is done directly on the sensor or nearby via a small computing unit. It brings many benefits such as real-time detection, reduced energy consumption (fewer transmissions) and increased confidentiality (no transfer of sensitive data).

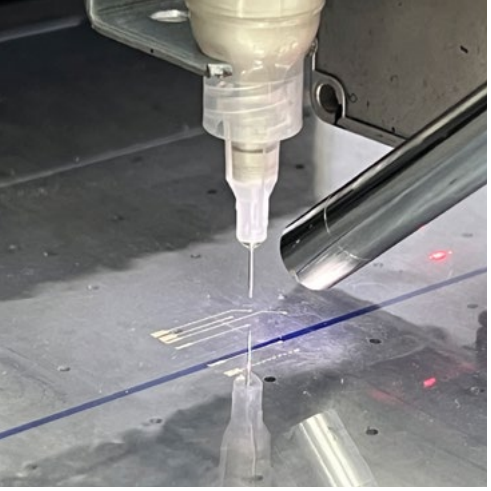
Our technology is booming with the rise of IoT and AI and it is a huge technical and societal breakthrough which will have a major impact in the field of healthcare.

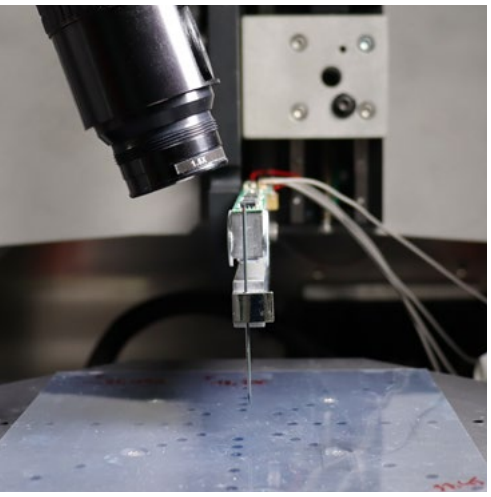
K. THU NGO's thesis with LINXENS: *a multi-analyte electrochemical platform to monitor the quality of recreational waters.*

E. ZELOU's thesis: *the ultimate detection limits of RNA and DNA under real conditions with carbon nanotube-based chemistor networks.*

N. BALAJI's thesis: *an electrolytic gate field effect transistor to detect gases in breath.*

L. LIU's thesis: *flexible and portable electrochemical biosensors modified with peptides to monitor sweat biomarkers.*





2D AND 3D PRINTING

Integrating sensing functions into medical devices such as orthoses and implants is a necessity to improve real-time monitoring, custom treatments and patient safety.

Printed sensors are thin and lightweight. However, rigid and bulky traditional components still handle their control and communication systems. In some cases, transferring these components to the orthosis or implant limits the therapeutic effect of the device. New integration approaches need to be developed.

Structural electronics is a promising one to consider. It means integrating electronic functions into a mechanical structure at the design stage to make it both load-bearing and intelligent. Therefore, the global objective is to reduce mass, volume, interconnections and assembly operations during manufacturing.

Multi-axis 3D printing and printed electronics

Combining multi-axis 3D printing and digital printed electronics brings many advantages. It enables manufacturing complex mechanical parts in a single step that integrate electronic functions directly.

Multi-axis printing provides total geometric freedom, making it possible to deposit circuits on non-flat surfaces, while digital printed electronics accurately add tracks, sensors or antennas.

Combining these two technologies opens an efficient and scalable path to transform materials and structures into active systems. Structural electronics brings a new design approach to objects, prostheses and equipment. This approach transforms passive devices into intelligent ones able to interact with patients and healthcare staff non-stop

The institute and its partners have expanded their capabilities in 2025 and will continue, especially through the acquisition of a brand-new generation of equipment combining 2D and 3D printing. This topic gathers several projects under development, including the ANR (French National Research Agency) eSPLINT project with BELINK HIRECT and URB2I.

A word from Dr Giorgio MATTANA, UNIVERSITÉ PARIS CITÉ

In recent years, the institute's research activities on thermoelectric generators have converged towards printed electronics.

Printed thermoelectric generators: an emerging innovation for autonomous medical devices

The energy autonomy of wearable medical devices remains a big challenge. When developing smaller sensors, smart skin patches and remote monitoring solutions, it requires rethinking power supply, with a focus on local and sustainable sources.

Harvesting the body heat energy is very promising for this matter: it converts an available temperature gradient into electricity, while maintaining the lightness, flexibility and comfort required for devices worn on the body. Therefore, printed thermoelectric generators position themself as a key enabler for truly autonomous medical devices.

Materials and processes for printable components

Recent scientific advances in material science have led to the development of organic semiconductors and of thermoelectric composites which are compatible with printing processes. They are performant enough to generate energy from low thermal gradients characteristic of the human body.

In coming years, challenge will be to leverage printing technologies to integrate ultra-thin, conformable thermoelectric generators onto or into medical devices. The scientific community focuses effort on improving resistance to mechanical stress, durability in air and performance over extended periods of time. The goal is to ensure consistent performance in various conditions without the need for a strict manufacturing or storage setting.

To achieve this, innovations are expected from the formulation of organic or hybrid thermoelectric inks and from the arrangement of different layers of materials.

Applications and possibilities for connected health

Combining high-performance materials, advanced printing processes and optimized architecture accelerates the design of flexible thermoelectric systems working with low thermal gradients and providing efficient power for low-power sensors.

In 2025, PRINTUP INSTITUTE strengthened its cutting-edge expertise in the field of printed thermoelectric generators applied to healthcare. These generators demonstrated remarkable mechanical robustness in bending tests and prolonged stability in ambient conditions. They prove the feasibility of minimalist modules able to harvest energy from thermal gradients relevant to medical applications.

L. CHOPPLET's thesis: organic thermoelectric systems to power mobile biosensors.

LE CLUB

The PRINTUP INSTITUTE club gathers skills and knowledge across the entire value chain, from fundamental research to industry ready for mass production of electronic components in France and Europe.

It meets four to five times a year at the institute. The first few months were spent structuring the club, drawing up a non-disclosure agreement, a code of conduct and a nomenclature. Current work is about the impact of printed electronics on the various health specialties.

Forward thinking at market events

The institute was a partner of the medical device start-up day organized by SNITEM in France. It took part in MEDINOV, the leading French trade fair in the medical sector. There were numerous constructive professional contacts. To develop its activities in complementary markets related to healthcare, the institute participated in the research area of the COSMETIC 360 trade fair.

Shared stands at technology trade shows

PRINTUP INSTITUTE has exhibited at trade shows related to printed electronics in Europe and shared its booth with club members for greater representation, especially at LOPEC event in Germany. In 2026 the ambition is to double the surface area of the PRINTUP INSTITUTE booths at these events.

International representation

PRINTUP INSTITUTE continues to promote its activities at conferences and scientific events across five continents. In 2025, the institute participated in about thirty international conferences.

The essential role of the PRINTUP INSTITUTE club is to enhance cooperation within the printed electronics ecosystem.

The combination of technological, industrial and societal factors drives demand for printed electronics across various industries. Markets are looking for lighter devices that are manufactured in Europe and have a low environmental footprint.

In the healthcare industry, expectations focus on disposable, smart and economically viable medical devices, such as connected patches with flexible biosensors. The PRINTUP ecosystem works with each of its members to develop printed components for the rapid production of new systems and medical devices.

An ecosystem ready to respond to other industry needs

The automotive sector continues to integrate more printed electronics. Manufacturers look for reliable and robust printed components to support vehicle electrification, the expansion of human-machine interfaces and the integration of low-cost sensors.

In defense, printed electronics is attractive to meet strategic challenges in terms of reliability, weight reduction and technological discretion. Stakeholders look for solutions that can sustain extreme environments.

In the aeronautics and space sectors, expectations converge towards weight optimization, improved predictive maintenance and the integration of electronic functions into complex structures. Printed electronics is seen as an essential lever to support this transition.

Printed electronics and the environment

Printed electronics is an opportunity to strengthen resource management capabilities. Stakeholders look for lightweight, energy-efficient electronic solutions which can be deployed on a large scale to improve real-time measurement and analysis of environmental parameters. Printed sensors for air, water and soil quality or for pollutant detection are among the most awaited technologies. They help create a denser territorial network and more accurate monitoring of environmental changes.

The PRINTUP INSTITUTE club combines research and industry expertise to meet the demand for innovation in printed electronics in various markets, especially the healthcare sector.

PRINT'UP INSTITUTE

Within the university, PRINTUP INSTITUTE specializes in the formulation of functional inks and printed electronics processes. The institute's development focuses on research for functional inks and printed biosensors and on sensors for complex environments.

The institute is ready to meet the innovation and industrialization needs of your projects. Scientific experts share their know-how in the form of services and research collaborations.

Club PRINTUP INSTITUTE

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