

INNOVATE WITHOUT THE HASSLE OF INNOVATING

PRINTED ELECTRONICS



INTRODUCTION

In 2050 there will be 24 billion interconnected devices.* Already today, countless devices rely on printed electronic technologies for function, form and flexibility. Henkel is a leader in specialized functional ink formulations for printed electronics.

With a broad portfolio of Loctite branded silver, carbon, dielectric and clear conductive inks, enabling leading-edge printed electronics for well over four decades and continue to develop next generation solutions in a strong partner ecosystem to accelerate the go to market of smart, seamlessly connected & data generating product innovations. Given the acceleration and digital transformation of markets, shorter product life cycles and changing customer requirements, the advantages of printed electronics are that they are thin, adaptable, lightweight and, above all, flexible. They refer to a process in which printing technology is used to produce various kinds of electronic goods, such as electronic circuits, displays, sensors or RFID (Radio Frequency Identification), to give some examples. Together with our partner ecosystem we can accelerate visionary product ideas with printed electronics from market exploration to go-to-market. We offer solutions across industries, such as healthcare, personal hygiene, consumer and industrial electronics, automotive as well as furniture and building. This makes previously unseen functionalities possible, enabling us to live in smart homes, improving our lives with smart healthcare products and creating smart solutions for mobility.

Materials

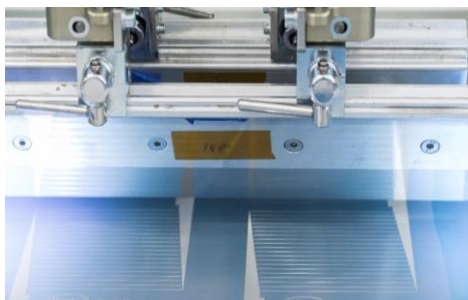
Processes

Sensor / Device



Functional Inks

- Silver inks
- Carbon inks
- Dielectric inks



Printing

- Application of ink on flexible substrate using:
- Screen Printing
 - Flexographic Printing
 - Rotogravure Printing
 - Other printing techniques



Flexible Electronic Device

- Flexible circuits & membrane switches
- ECG electrodes & wearables
- Intelligent / interactive surfaces
- Printed Antennas (RFID, 5G, ...)

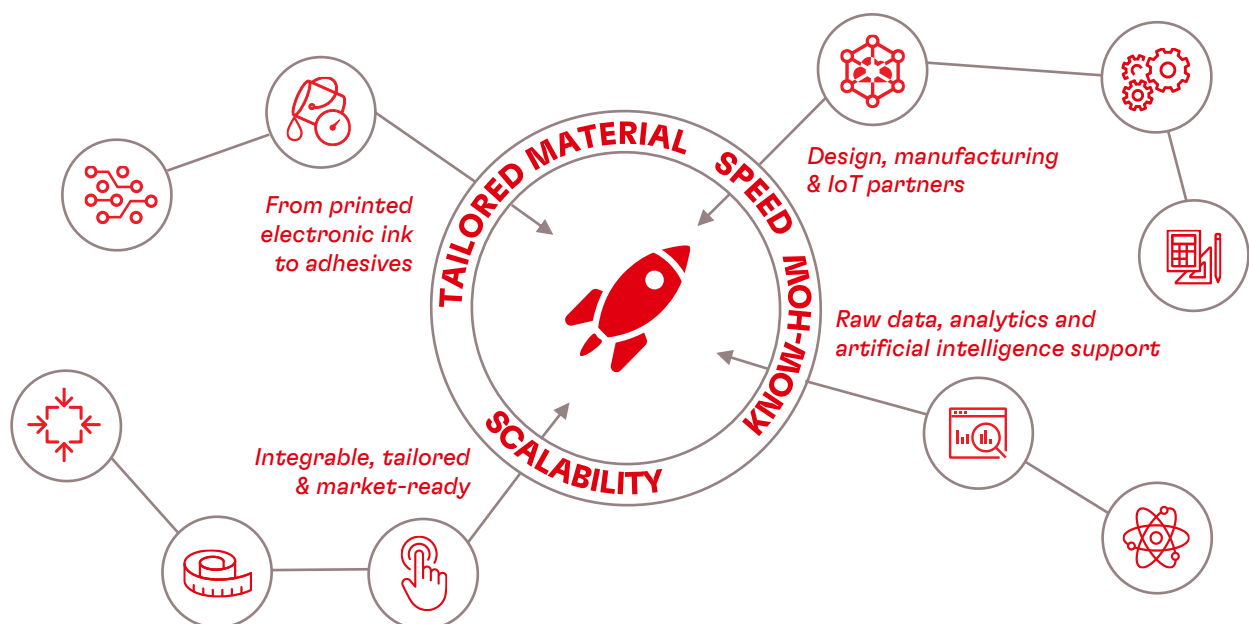
* According to Ericsson.com

LESS HASSLE, MORE INNOVATION ...

STRONG MATERIAL EXPERTISE	INDUSTRY EXPERTISE	PARTNER ECOSYSTEM	SOLUTION ENGINEERING
			
<p>More than four decades of experience within printed electronics and adhesive technologies</p>	<p>Strong cross-industry focus on market trends and transformation</p>	<p>We believe in strong business partnerships to accelerate innovation</p>	<p>Together with strong partners we create more than technologies - we enable scalable solutions</p>

...TOGETHER WITH OUR STRONG ECOSYSTEM OF PARTNERS

What starts with an ink that is transformed into a flexible, electrically conductive circuit can quickly become a fundamental innovation. In order to make a new idea transform into a custom, scalable, market ready solution at high speed, it takes a strong ecosystem of partners and collaboration along the value chain. Therefore, we work closely with our global network from the beginning of the design process to ensure required material performance, component and system interoperability as well as economics of scale in commercialization.



HENKEL PRINTED ELECTRONICS PRODUCT RANGE

STANDARD INK PORTFOLIO



CONDUCTIVE INKS

Conductive inks filled with silver or carbon for circuit, switch, and antenna printing



RESISTIVE INKS

Based on blends of silver, carbon and non-conductive pigments to adjust resistance levels for printed resistors, potentiometers, and heating elements



DIELECTRIC INKS

For printing dielectric layers, conformal coatings, and encapsulations

FUNCTIONAL INK PORTFOLIO



ELECTRODE INKS

Based on silver/silver chloride for biosensors, ECG electrodes, and transdermal drug delivery



PTC INKS

Based on carbon for self-regulating heating elements



EMI SHIELDING PAINTS

Processed by spray-coating or brushing

Overview Product Portfolio

STANDARD INKS

Conductive Silver Inks			Conductive Carbon Inks		Resistive Inks		Dielectric Inks	
Loctite ECI 1001 E&C	Loctite EDAG 479SS E&C	Loctite EDAG PD 004A E&C	Loctite ECI 7005 E&C	Loctite EDAG 109 E&C	Loctite ECI 7004LR E&C	Loctite ECI 7004HR E&C	Loctite NCI 9001 E&C	Loctite EDAG 452SS E&C
Loctite ECI 1010 E&C	Loctite ECI 1203 E&C	Loctite EDAG PF 410 E&C	Loctite ECI 7007 E&C	Loctite EDAG 965SS E&C	Loctite NCI 7002 E&C	Loctite EDAG 6017SS AE&C	Loctite EDAG 455B E&C	Loctite EDAG 455BC E&C
Loctite ECI 1011 E&C	Loctite ECI 1204 E&C	Loctite EDAG PM 406V1E&C	Loctite EDAG PF 407A E&C	Loctite EDAG PF 407C E&C	Loctite EDAG PM-404 E&C	Loctite EDAG M 2000 Series E&C	Loctite EDAG 465 E&C	Loctite EDAG ML 25208 E&C
Loctite ECI 1014 E&C	Loctite ECI 5005 E&C	Loctite EDAG M 4100 Series E&C	Loctite EDAG 440 AE&C		Loctite EDAG M 3000 Series E&C		Loctite EDAG 451SS E&C	Loctite EDAG ML 25265 E&C
Loctite ECI 1016 E&C	Loctite EDAG 460A E&C	Loctite EDAG PF 050 E&C					Loctite EDAG ML 25240 E&C	Loctite EDAG M 7000 Series E&C
Loctite ECI 1501 E&C	Loctite EDAG 461SS E&C							
Loctite ECI 1006 E&C	Loctite EDAG 725A (6S-61) E&C							

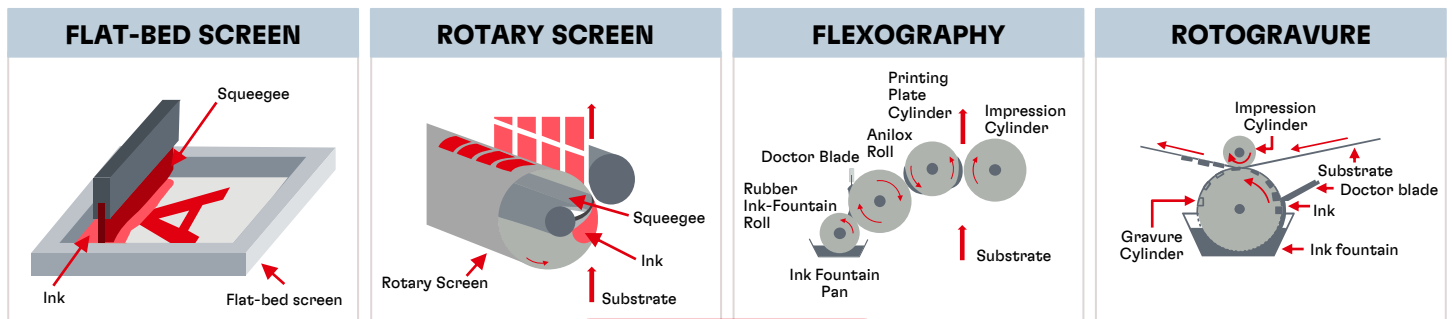
FUNCTIONAL INKS

Electrode Inks		PTC Inks		EMI Shielding Paints	
Loctite EDAG 7019 E&C	Loctite EDAG PE 007 E&C	Loctite ECI 8001 E&C	Loctite ECI 8090 E&C	Loctite EDAG 1415 M E&C	Loctite EDAG 437 E&C
Loctite EDAG PE 409 E&C	Loctite EDAG PE 428 E&C	Loctite ECI 8120 E&C	Loctite ECI 8060 HV E&C	Loctite EDAG 440 AS E&C	Loctite EDAG 6041 E&C
		Loctite NCI 8002 E&C	Loctite NCI 8092 E&C	Loctite EDAG SP 413 E&C	

PRINTING METHODS

Printed Electronic solutions can be created with diverse printing methods, such as screen printing as well as flexographic and gravure printing. The selection of a printing method depends upon multiple aspects such as the type and number of devices that are produced, the desired properties of the functional material and final application, the production capabilities of a plant, as well as the time-scope of production. Our team offers expertise for correct and successful material selection, printing and curing, testing, as well as access to a partner ecosystem to enable prototyping and high-volume manufacturing.

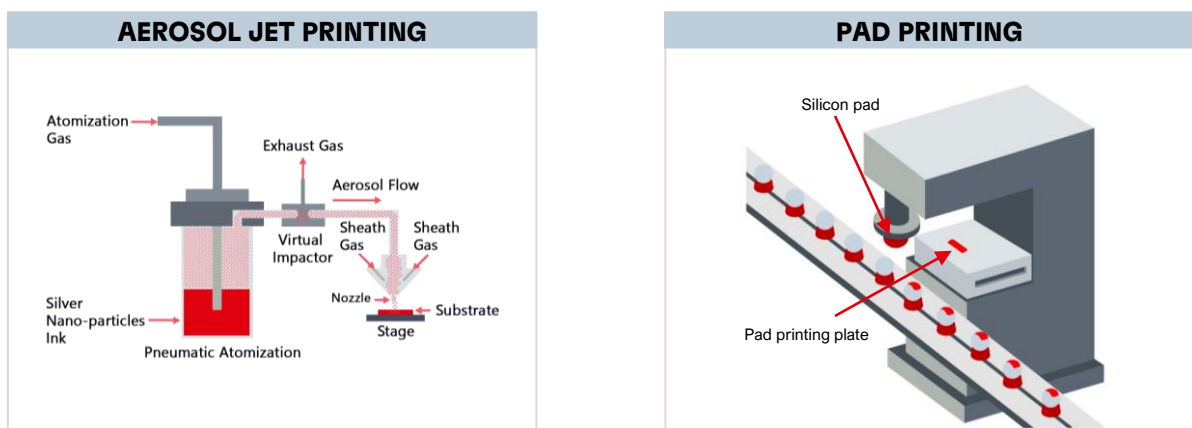
CONVENTIONAL PRINTING METHODS



Printing Speed

Advantage of screen printing is the ability to apply thick layers (5-25 μm), but it is a slower process in comparison with flexographic or gravure printing

3D PRINTING METHODS



MARKETS

SMART SURFACES



With the ongoing trend of IOT, our environment is increasingly becoming smart. This includes the transformation of simple surfaces into smart surfaces. By integrating or retrofitting functionalities beneath or above a surface a lot of new intelligent, interactive surfaces are created, allowing to collect meaningful data from the environment. With its' unique form factor printed electronics play a crucial role in this transformation. Flexible, thin and lightweight circuitry enabled by conductive inks and coatings offer a totally new design spectrum to IoT engineers and sensor hardware designers as well as IOT integrators, including the potential of adding different functionalities while being cost-effective at scale. These can be flexible foil heaters, leak detection sensors, liquid level sensors, force sensors (FSR) as well as capacitive sensors. Printed electronics smart surface technologies are applied across multiple markets, including building & construction, automotive, healthcare, logistics and many more.

HEALTHCARE



Across global healthcare systems, the demand for digital health technology and medical grade wearables enabling remote patient monitoring is constantly increasing. At the same time, the number of patients with chronic illnesses is increasing, which altogether enhances the pressure on our healthcare systems and the need for smart technical solutions that support and ensure the quality of healthcare around the world. Printed Electronics represent a key enabler to the next generation of wearable technology for remote monitoring. Henkel offers a large portfolio of Loctite branded conductive and dielectric inks to increase patient comfort and treatment efficiency, enabling long-term health data collection at our customers. Some key applications enabled with our technologies are biosensors such as glucose test strips, printed electrodes for biopotential measurements, TENS pads for muscle stimulation, iontophoresis pads for drug delivery, Printed heating elements for diagnostic test strips, printed heating blankets for improved patient safety and countless other medical electronic applications.

ANTENNA



With the trend of “Connectivity” new mobile communication standards, like enhanced mobile broadband (eMBB), massive machine-type connections (mMTC) or ultra-reliable low-latency communications (uRLLC), are increasingly deployed. This deployment is accompanied by an increasing implementation of system components, such as antennas, to reliably manage high volumes of mobile data processing and accelerate data transfer. By utilizing conductive inks and coatings, thin, flexible and lightweight antennas can be printed. Application fields for printed antennas range from traditional RFID antennas, to pad-printed 5G antennas to large antenna application built to communicate with satellites enabling high speed internet in remote areas around the globe. 5G pad-printed antennas are especially unique to the mobile communications industry as they revolutionize the processing to applicability on curved surfaces and its more environmentally friendly because no etching or electro-plating process is needed any more.

SMART SURFACES APPLICATION EXAMPLES

PRINTED PTC HEATERS FOR SMART LIVING

Heating sheds are an innovative solution especially in rooms where architecture requires a minimalistic design. In comparison to standard applications in which the incorporation of cables and wires requires a substantial manufacturing effort, the heat the flexible elements supply is uniform and can be integrated in both wall and floor heating. Henkel's PTC heater materials enable the production of self-regulating, uniform surface heating, avoiding overheating. The end user benefits not only from a heating element, but also from a durable, invisible heating solution adding value beneath the surface.



Henkel Technologies

- LOCTITE ECI 1010 E&C - Highly conductive silver ink with good mechanical performance
- LOCTITE EDAG 6017 SS E&C - Carbon ink with temperature stable resistance and blendable with non-conductive LOCTITE PM 404 E&C to adjust heater resistance and power
- LOCTITE ECI 8000 Series - Positive temperature coefficient carbon inks (PTC) for self-regulating heaters
- LOCTITE PF 455BC E&C - UV-curable dielectric ink with superior barrier properties

LEAKAGE DETECTION SENSOR

Commercial and industrial facilities hold large amounts of high value equipment and inventory. Despite regular inspection and maintenance, liquid leaks represent a common cause of unplanned downtime, productivity and economic loss. By utilizing resistive sensor technology, enabled by Henkel's conductive inks and coatings, thin, flexible and lightweight leakage detection sensors can be created. Their unique form factor allow to monitor for leakages in building across a large surface. Depending on the design, not only the presence of water but also the quantity can be detected, enabling early detection while reducing cost of down-time and maintenance acost in commercial settings.



Henkel Technologies

- LOCTITE EDAG 407C E&C - Highly conductive & versatile carbon ink
- LOCTITE PF 455BC E&C - UV-curable dielectric ink with superior barrier properties

SMART SURFACES

APPLICATION EXAMPLES FOR THE AUTOMOTIVE INDUSTRY

AUTOMOTIVE INTERIOR HEATING SYSTEMS

Innovative printed foil heaters are going to be widely used in EV (electric vehicle) interiors. The conformable, thin and lightweight heaters are easy to integrate in seats, arm rests, door and roof panels, glove boxes, sun visors among others. When using printed foils, the printed heaters are highly efficient because they can be integrated closer to the surface than wired heaters. Printed PTC heaters provide a very fast, consistent and uniform heat, save power consumption and provides additional safety at the same time.



Henkel Technologies

- LOCTITE ECI 1010 E&C - Highly conductive silver ink with good mechanical performance
- LOCTITE EDAG 6017 SS E&C - Carbon ink with temperature stable resistance and blendable with non-conductive LOCTITE PM 404 E&C to adjust heater resistance and power
- LOCTITE ECI 8000 Series - Positive temperature coefficient carbon inks (PTC) for self-regulating heaters
- LOCTITE PF 455BC E&C - UV-curable dielectric ink with superior barrier properties

ANTENNA APPLICATION EXAMPLES

PRINTED RFID ANTENNA

Radio Frequency Identification (RFID) is the wireless or contactless transfer of a digital ID and additional data between an RFID tag and a reader by means of electromagnetic waves. Tagging of physical objects allows businesses, organizations and consumers to assign a unique digital identity -- a digital twin -- to identify, authenticate, track, sense and engage with each object seamlessly. In contrast to other Auto-ID technologies like optical QR codes, RFID allows tags to be read without a line of sight at a distance of a few centimeters to more than 20 meters or 60 feet, depending on the type of RFID system. One typical example would be swiping a handheld reader over store racks and shelves to count inventory within seconds. Printed electronics RFID antennas, enabled by Loctite conductive inks, can be combined with other printed functionalities, produced in high volumes at low cost, and are providing a great form-factor capability. They are also manufactured using an additive process and are therefore more sustainable than etched antennas.



Henkel Technologies

- LOCTITE ECI 1010 E&C - Highly conductive silver ink with optimum mechanical performance
- LOCTITE ECI 1011 E&C - Very high conductive silver ink with fine particle size
- LOCTITE ECI 1016 E&C - Highly conductive silver ink with improved reliability and good mechanical performances
- LOCTITE PF 455 BC E&C - UV-curable dielectric ink with superior barrier properties

3D PRINTED 5G ANTENNAS

5G antennas are crucial to the ongoing industrial transformation and digitalization, reaching from automated mobility, across health, to real-time connectivity. Eventually the total number of antennas in smartphones will be around ten in one device to ensure the desired connectivity. Printed electronics technology, based on Loctite conductive inks, allow the creation of very thin printed antennas applicable to the surface of the frame or back cover of the phone. This solution saves space and has less environmental impact compared to other processing techniques.



Henkel Technologies

- LOCTITE ECI 1011 E&C - Very high conductive silver ink with fine particle size
- LOCTITE ECI 1203 E&C - Silver pad-printable ink for conductive pathways
- LOCTITE ECI 1204 E&C - Silver pad-printable ink with high abrasion resistance for contact points
- LOCTITE ECI 1205 E&C - Silver dispensable ink with good flowability allowing no voids after fill

HEALTHCARE APPLICATION EXAMPLES

SMART HEALTH PATCHES

Smart health patches are increasingly applied to enable long-term, remote patient monitoring. As part of a wearable device, they can continuously measure heart rate, respiration rate, ECG (Electrocardiogram), brain activity, movement and many other vital signs. The disposable patch in combination with a miniaturized, reusable hardware can be used to improve in-hospital data communication and patient treatment quality. By using wireless technology, healthcare professionals can increase quality of care, due to the availability of long-term medical-grade data, while decreasing the number of hospitalizations and costs. The innovative Henkel dry electrode adhesive, conductive inks, protective coatings, and skin-grade pressure sensitive adhesives provide manufacturers a full set of material solutions to design the next generation of medical grade wearable patches for reliable in-hospital and at home remote patient monitoring.



Henkel Technologies

- LOCTITE EDAG PE 409 E&C - Silver / silver chloride ink in 9:1 ratio with good compatibility with hydrogels
- LOCTITE ECI 1014 E&C - High conductive & stretchable silver ink
- LOCTITE Durotak 9264 - Acrylic, pressure sensitive dry electrode adhesive
- LOCTITE EDAG 452SS E&C - UV-curable dielectric ink with excellent flexibility and adhesion

SMART DIAPER

With Smart Adult Care, we transform a conventional diaper into a smart, connected medical device. This is a vital step into the future of patient-centered care. Equipped with a lightweight, flexible printed sensor and reusable pod the diaper enables caregivers to remotely monitor moisture, movement and temperature, providing valuable data and actionable advice for more efficient care. The complete solution was developed in line with medical grade safety standards.



Henkel Technologies

- LOCTITE ECI 7007 E&C – High speed printable highly conductive carbon ink

PRINTED BIOSENSOR

In the world of disposable medical products, reliability and repeatability are critical success factors. Printed biosensors and disposable test strips that are part of a point of care device depend on high quality printable conductive inks to provide features such as improved accuracy, enhanced performance while reducing cost in a price sensitive market. They can be used to measure for example pH, glucose or Covid-19. Formulated to be compatible with the human body and various interactive medical gels and reactive agents, Henkel's conductive & dielectric inks are making next generation point of care devices happen.



Henkel Technologies

- LOCTITE EDAG 7019 E&C - Silver / silver chloride ink in 8:2 ratio
- LOCTITE EDAG PE 407A E&C – Highly conductive carbon ink with good adhesion performance and flexibility
- LOCTITE EDAG 452SS E&C - UV-curable dielectric ink with excellent flexibility and adhesion

EXPLORE ENDLESS POSSIBILITIES WITH OUR SENSOR KITS

INKXPERIENCE KIT

The Sensor INKxperience Kit by Henkel Qhesive Solutions offers you a hands-on experience of four different types of printed electronics sensor functionalities, including a leak detection sensor, a non-contact liquid level sensor, a single and multi zone force sensitive resistor sensor as well as a positive temperature coefficient (PTC) heater. The INKxperience kit sensors are pre-configured with hardware and software, providing engineers with an easy setup for quick ideation, technology testing and first prototyping all out of one box. More information to found here: www.inkxperiencekit.com



ELECTRODE SENSOR DEMONSTRATOR

The Loctite Electrode Sensor Demonstrator Kit includes twelve functional dry adhesive electrode demonstrators for research and technical material validation. These electrodes combine a unique set of printed electronic materials and an innovative dry electrode adhesive within a flexible patch design. This unique material stack ensures long-term monitoring at good signal quality while enabling increased comfort of wear. More information to find here: <https://print-your-electronics-with-loctite.com/Loctite-Sensor-Demonstrator>



PRINTED ELECTRONICS SAMPLE SHOP

Our printed electronics sample shop offers a portfolio of high-quality samples for rapid prototyping and idea generation. We offer fast delivery in three days within Europe to allow you to quickly make your ideas come to life. In addition, we offer processing guidance to ensure easy testing of your printed electronics application idea. Whether you are new to printed electronics or a technology expert, we offer easy access to our ink technologies in small quantities. For more information visit our sample shop: <https://print-your-electronics-with-loctite.com>

The screenshot shows the top of the Henkel Printed Electronics Sample Shop website. At the top, there is a header bar with the email printed.electronics@henkel.com, a phone number [+49 \(0\)211-797-3122](tel:+49(0)211-797-3122), and a 'Contact' link. Below this is a navigation bar featuring the Henkel logo, a search bar with the text 'SEARCH', and links for 'HOME', 'SHOP', 'ABOUT', and 'PARTNERSHIPS'. There are also icons for a user profile and a shopping cart. The main banner area has a large, bold, red and white text 'THINK TOGETHER' on a blue background. Below the banner is a red bar with the text '+++ Fast delivery +++ Order your sample now! +++ Fast delivery +++ Order your sample now! +++'. The main content area is divided into two columns. The left column features a large, stylized graphic of a printed circuit board with the LOCTITE logo in the center. The right column contains the text 'WELCOME TO THE PRINTED ELECTRONICS SAMPLE SHOP' followed by a paragraph: 'We offer a wide range of different functional ink samples with different functionalities for smart product solutions across multiple markets such as automotive, medical, wearables, traditional electronics, and furniture & building. Simply select & test our LOCTITE® samples to accelerate and electrify your innovative product design.' Below this text is a red button with a shopping cart icon and the text 'Start shopping'. On the right side of the main content area, there are two circular icons: a telephone and an envelope.

SUSTAINABILITY – WE MAKE IT HAPPEN

PRINTED ELECTRONICS TECHNOLOGY CAN HAVE A POSITIVE IMPACT ON SUSTAINABILITY OF END-APPLICATIONS

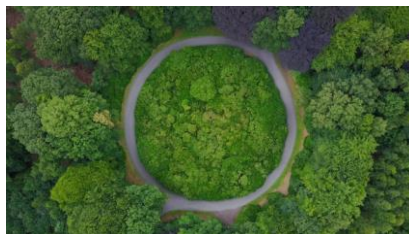
Henkel Adhesive Technologies is aiming to drive sustainable development and shape a viable future for the next generations. We see it as our responsibility to contribute to solving these challenges by enabling sustainability through material science and scientific know-how in bonding, sealing and coating. Amongst others, Technology plays a crucial role in reaching our goals but also enabling our customers to boost their contribution to sustainability.

Printed Electronics as a technology can have a positive impact on sustainability for end-applications by being an additive technology. Additive by allowing to print direct electrically conductive structures onto a desired substrate or surface as well as additive by complementing traditional electronics with a unique form factor being thin, flexible and lightweight. In summary printed electronics technology allows to reduce the BOM as opposed to traditional electronics while opening up a whole new set of possibilities in application design.

Beyond the end-application, there are several technology trends out in the industry with respect to sustainability, some examples being water-based inks, high-speed printable inks and high-performance inks. In line with our Henkel Adhesive Technologies strategy, we aim to continuously develop our material portfolio to offer sustainability through functionality within the end application as well as through the technology itself.



Climate: Decarbonizing our operations and raw materials and enabling emission reduction at our customers.



Circularity: Embedding circular practices in our own operations while enabling debonding and recyclability along the value chain.



Safety: Optimizing the chemical safety of our products and going beyond legal requirements.



**AMERICAS**

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