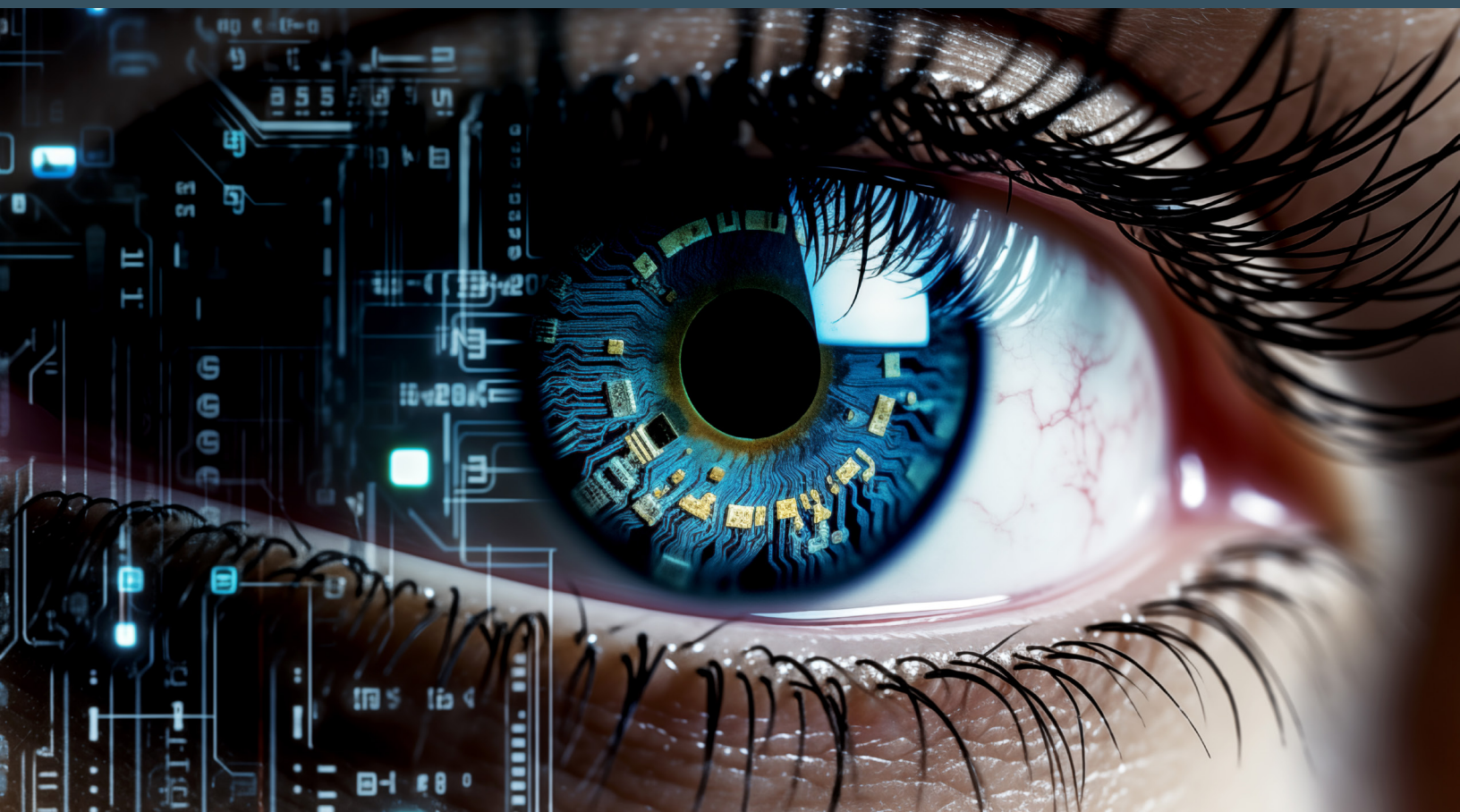
EXXELIA MICROPEN

WHITEPAPER

Revolutionizing Design with Micropen Direct-Write Sensors: Enabling Seamless Integration of Sensing Capabilities.

ABSTRACT

This white paper explores the transformative potential of Exxelia Micropen's proprietary direct-write sensor technology ("Micropenning"), a cutting-edge approach to integrating sensing capabilities directly into products and structures. By leveraging specialized functional inks, this additive manufacturing process offers unparalleled design flexibility, miniaturization, and seamless integration with diverse materials. This paper provides an in-depth analysis of direct-write sensors, comparing them with conventional embedded sensors, and highlighting the key advantages and considerations for engineers across various disciplines. Additionally, we delve into a specific application of direct-write sensors in the rapidly evolving field of medical devices, with a focus on renal denervation and catheter-based technologies.



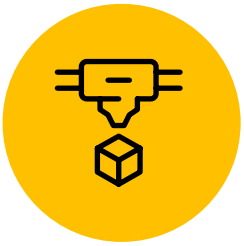
Introduction

Sensors play a critical role in modern engineering design, enabling monitoring, control, and optimization across a multitude of industries. Traditionally, sensors have been attached or embedded using techniques that can be limiting in terms of placement, form factor, and compatibility. Direct-write sensor technology emerges as a disruptive innovation, offering a pathway to overcoming these limitations and unlocking new possibilities in sensor design and implementation.

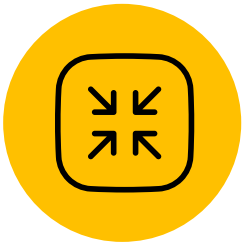
What is Micropenning Direct-Write Sensor Technology?

Direct-write sensor technology is an additive manufacturing process that utilizes specialized functional inks containing conductive, semiconductive, or dielectric materials. These inks are precisely deposited onto a substrate using proprietary printing technology. By carefully controlling the ink composition and deposition patterns, intricate sensor structures can be created directly on the desired surface.

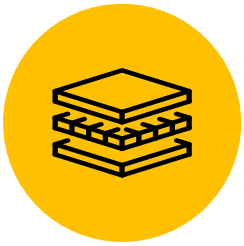
Advantages of Direct-Write Sensors



Unparalleled Design Flexibility: Micropen's direct-write sensors can be printed on virtually any substrate, including rigid, flexible, and even curved surfaces.

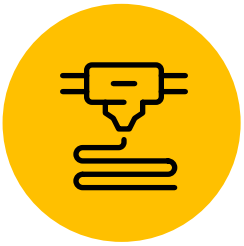


Miniaturization: The additive nature enables the creation of miniature sensor elements, leading to compact and lightweight sensor systems.



Material Compatibility: Direct-write sensors can be printed on a wide range of materials, including metals, plastics, ceramics, and even textiles.

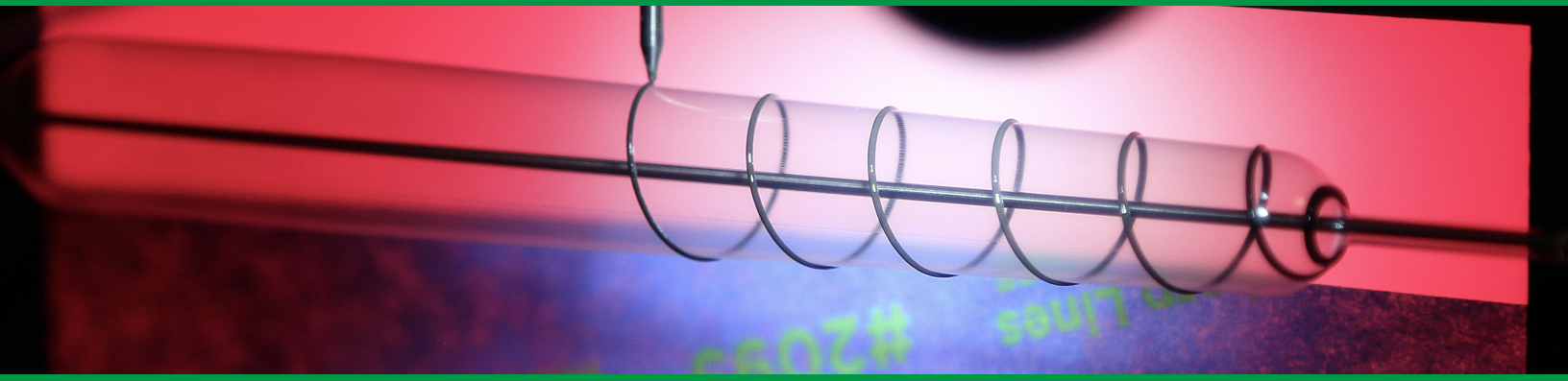
Enhanced Sensor Coverage: Direct-write techniques allow for the precise placement of multiple sensor elements across a larger area.



Customization: Micropen can tailor the properties of functional inks to create sensors with specific electrical characteristics.

Direct-Write Sensors vs. Conventionally Embedded Sensors

	Direct-Write Sensors	Conventionally Embedded Sensors
Design Flexibility	High	Limited
Miniaturization	High	Limited
Material Compatibility	High	Limited
Sensor Coverage	High	Limited
Customization	High	Limited
Integration	Seamless	Complex
Reliability	High	Moderate
Cost	Application dependent	Application dependent
Prototype Production Time	Fast prototyping	Slower prototypes
Applications	Complex geometries, flexible substrates, large-area sensing, custom designs	Standard form factors, rigid substrates, established sensor types



Four Applications of Direct-Write Sensors (with Technical Considerations)

1

RO Markers on Catheter Balloon:

The ability to print radiopaque markers directly onto the balloon aids in X-ray visualization, eliminating the need for potentially damaging swaging methods.

2

Wearable Electronics:

Integrate thin-film sensors for physiological parameters, including electrical impulse, stimulation, and temperature monitoring.

3

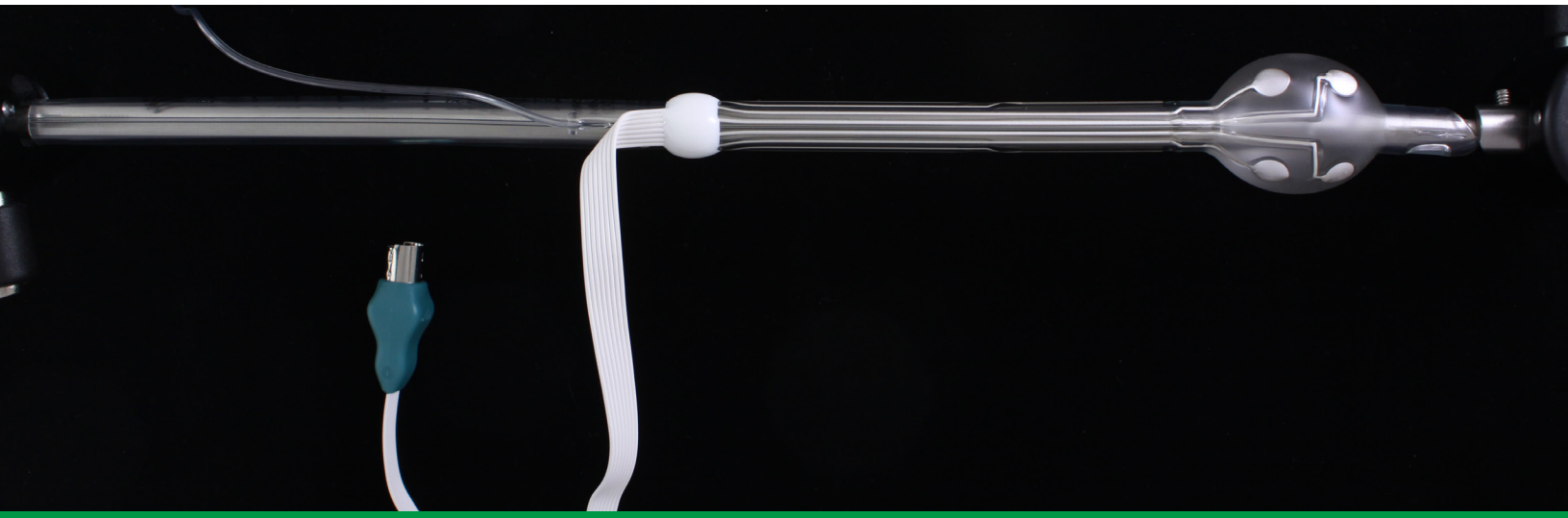
Environmental Monitoring:

Print arrays of electrochemical sensors onto flexible substrates for pollutant detection.

4

RF Ablation:

Printed patterns can provide ablation, heat, and temperature monitoring.



Micropen Direct-Write Sensors in Medical Devices: A New Frontier

Micropenning technology is revolutionizing the design and functionality of medical devices. In particular, catheter-based interventions are benefiting from this innovation.

Renal Denervation:

Direct-write electrodes enable precise energy delivery to renal nerves for ablation, a critical step in treating drug-resistant hypertension. The flexibility of the electrodes maintains the suppleness of the catheter balloon, ensuring reliable performance.

Other Applications:

Neurostimulation: Direct-write electrodes can be integrated into catheters for targeted nerve stimulation therapies.

Vocal Cord Paralysis and Dysphagia: Electrodes printed on catheters and ETT can stimulate muscles in the throat for improved swallowing and speech function.

Stomach Motility and Congestive Heart Failure: Catheter-based sensors can monitor pressure and other physiological parameters, aiding in diagnosis and treatment.

Soft Robotics: Embed strain-sensitive inks directly into soft robotic actuators for precise control.

Advantages of Direct-Write Sensors in Medical Devices

Flexibility and Conformability

Maintains the pliability of devices like catheter balloons, even after multiple inflations and deflations.

High Conductivity

High-solids inks enable high conductivity electrodes for accurate sensing and stimulation.

Customization

Customization: Ink properties can be tailored to meet specific electrochemical requirements, allowing for diverse applications.

Versatility

Technology is applicable to various medical devices, including catheters, flexible neural stimulation arrays, and instrumented endotracheal tubes.

Safety

Micropenning is a safe-bonding technology that does not have the risk of separating the sensor from the structure wall as can occur with swaging or other attachment techniques.

Conclusion

Micropenning direct-write sensor technology is transforming the landscape of sensor integration, offering unprecedented design freedom, miniaturization, and material compatibility across many industries including aerospace, electronics, medical, and wearables. In the medical field, it is enabling the development of innovative catheter-based devices with enhanced functionality and precision. By embracing this technology, engineers and medical device manufacturers can unlock new possibilities for diagnosis, treatment, and patient care. Micropenning is particularly valuable as a technology to add bio-compatible sensors to implantable and wearable medical devices.

Consult with a Micropen engineer to see if we can make your vision come true.

Micropen has helped many design engineers solve problems that other technology cannot handle. And we are particularly experienced in providing a quick prototype as well as a solution for manufacturing at scale. For more information, visit Micropen.com.

Why Exxelia Micropen?

Exxelia Micropen has been a pioneer in medical device development with Micropen printed electronics technology for 25+ years. We are ISO 13485 certified, and we have the expertise to collaborate with you end-to-end, from initial design concept through production.

Links to Exxelia Micropen Resources:

Overview Video

Substrates & Inks

Medical Applications

Contact Us:
micropen.com
585-624-2610
micropensales@exxelia.com