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PyzoFlex®

- sense your future.

JOANNEUM RESEARCH

PIEZOTECH®

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Why Printed Sensors Provide the Leading Edge

A major benefit is the **form factor** of printed devices.
With total thicknesses in the range of 150 µm, completely new, and above all, **two-dimensional measurements** are possible and with minimal system weight at the same time - a decisive advantage in the logistics sector.
Furthermore, the production using printing techniques enables a very **cost-effective fabrication** and finally, a **significant advantage is given by the flexibility** of the resulting systems.
On the one hand, this relates to the physical appearance of the printed devices, as sensors can be printed on different types of substrates (e.g. PET-foil) and these devices can also be integrated into curved surfaces without any problems.
On the other hand, flexibility also refers to the **design**. Thus, the shape and size of the sensors, their number, and layout of possible pixels as well as the sensitivity and the measuring range, can and is tailor-made for each specific application.
Different types of sensors (temperature, moisture, etc.) can also be integrated on the same substrate. By equipping with further components (for signal processing, signal transmission, power supply, etc.), a complete sensor system for **easy and accurate monitoring of various parameters over large areas** can be assembled on a single substrate.

Superordinate Technology Platform

PyzoFlex solutions equip (existing) **surfaces** and (existing) **products**
with **additional functionality** and
thus **added value** (new fields of use, etc.)

fingerprint sensor, pressure level location, switch/button/slide, knock sensor

building control, energy- and security management, smart lighting for public and private spaces
control of light and air conditioning, burglar alarm, fall detection

predictive maintenance, condition monitoring, structural health analysis, acoustic event detection

seat occupancy, hands-on detection, energy harvesting, smart sensing interior

monitoring of vital parameters, smart sports equipment, smart footwear, tracking and tracing products

PyzoFlex®

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JOANNEUM RESEARCH MATERIALS

Overview

PyzoFlex®

- Mature technology for printed electro active polymers (eap) – detects changes in pressure, temperature, vibration, and energy harvesting feasible
- Easy production (various substrates as PET; TPU etc., and inks) – for adaption to the respective use-case
- Various surfaces and constructions – can be integrated onto/into form parts, textiles, floors, wood and many others – equipping standard-components with sensory functions
- Different sensing approaches (based on the product build-up/construction) – stiff/rigid or deformable
- Profound knowledge in hardware/read-out electronics
- Many years of experience in sensor & hardware design/adaption
- Partners for mass production already identified (foil and hardware)

An optimized and tailor-made sensor system for the respective application is realized

PyzoFlex®

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Tailor-made Solutions

of PyzoFlex®

JOANNEUM RESEARCH/PyzoFlex®-Technology offers numerous new technical features:

(i) scalability & adaptation in size and shape

(ii) very low installation height & integration into a wide range of surfaces

(iii) energy friendly solution & stability in harsh environments

(iv) integrability in industrial (production) processes, … and many more

This technology can be applied in industrial settings/Industry 4.0 as a data collector and to support processes.

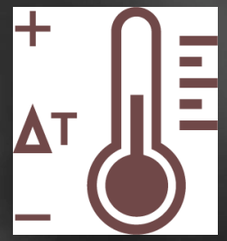
JOANNEUM RESEARCH/PyzoFlex® team has many years of experience in adapting sensor technology to the respective application - with regard to:

(i) the design/production of the foil-sensors

(ii) the hardware/signal processing/signal transmission unit

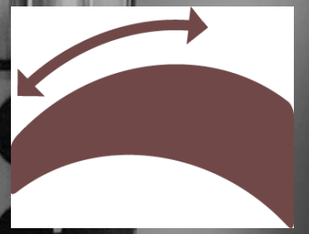
Allows for a direct combination with other sensors (temperature, humidity, etc.) on one substrate

Pyroelectric



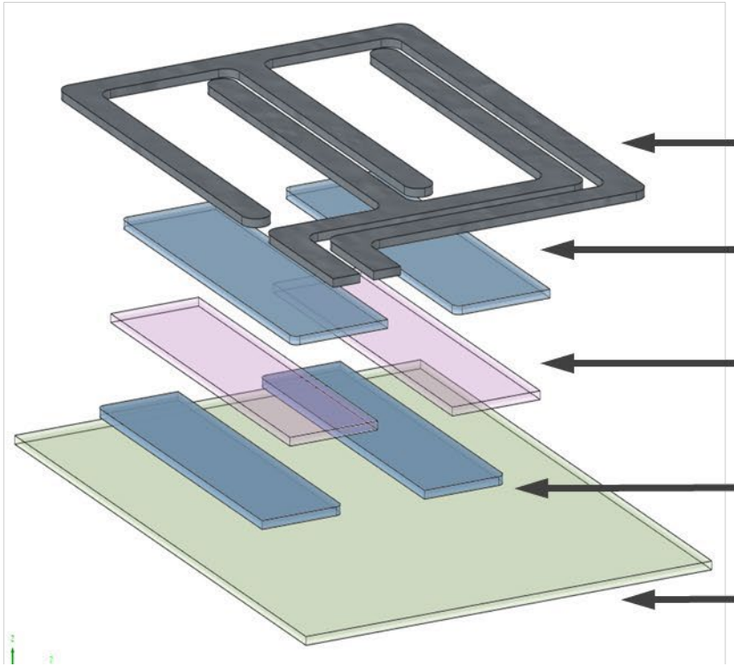
Piezoelectric

Flexible



Fabrication

of PyzoFlex®



Connection lines: Ag, Ag/C, etc.

Top electrode: PEDOT:PSS; Carbon etc.

Active sensor material: P(VDF:TrFE)

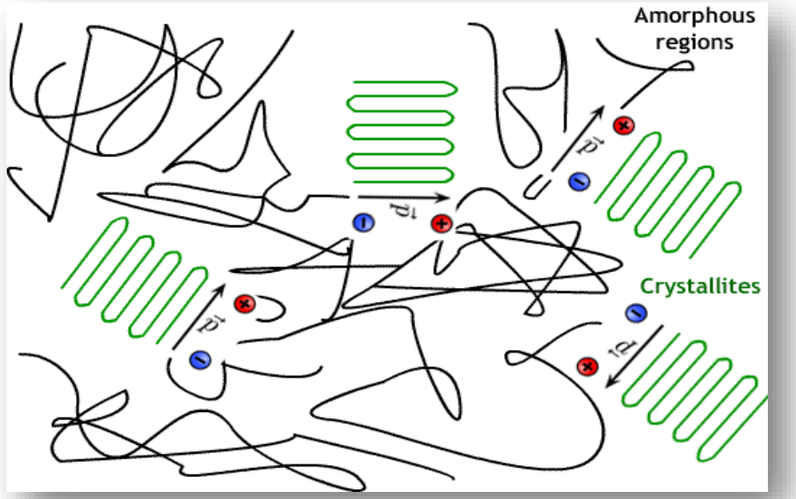
Bottom electrode: PEDOT:PSS

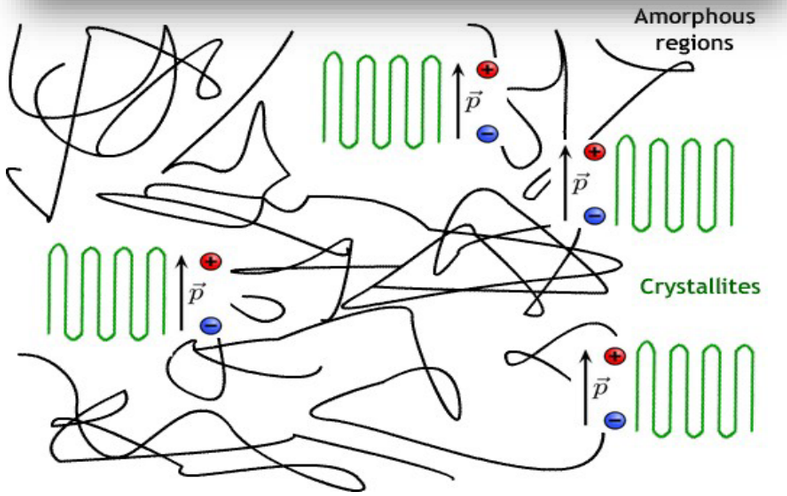
Substrate: PET, TPU, Paper, etc.

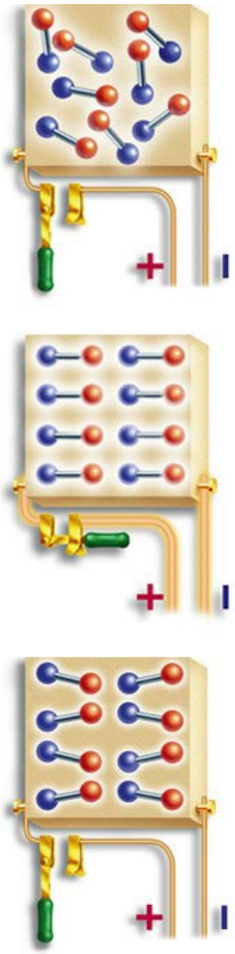
- Fully printed: screen printing (s2s or r2r)
- Cost efficient & easy
- Design depending on application:
  - specific sensor shapes
  - scalable (sensor number & sensor size)
- Various Substrates
- Ultrathin: ca. 15µm
- Highly durable & stable
- Quality control by poling process

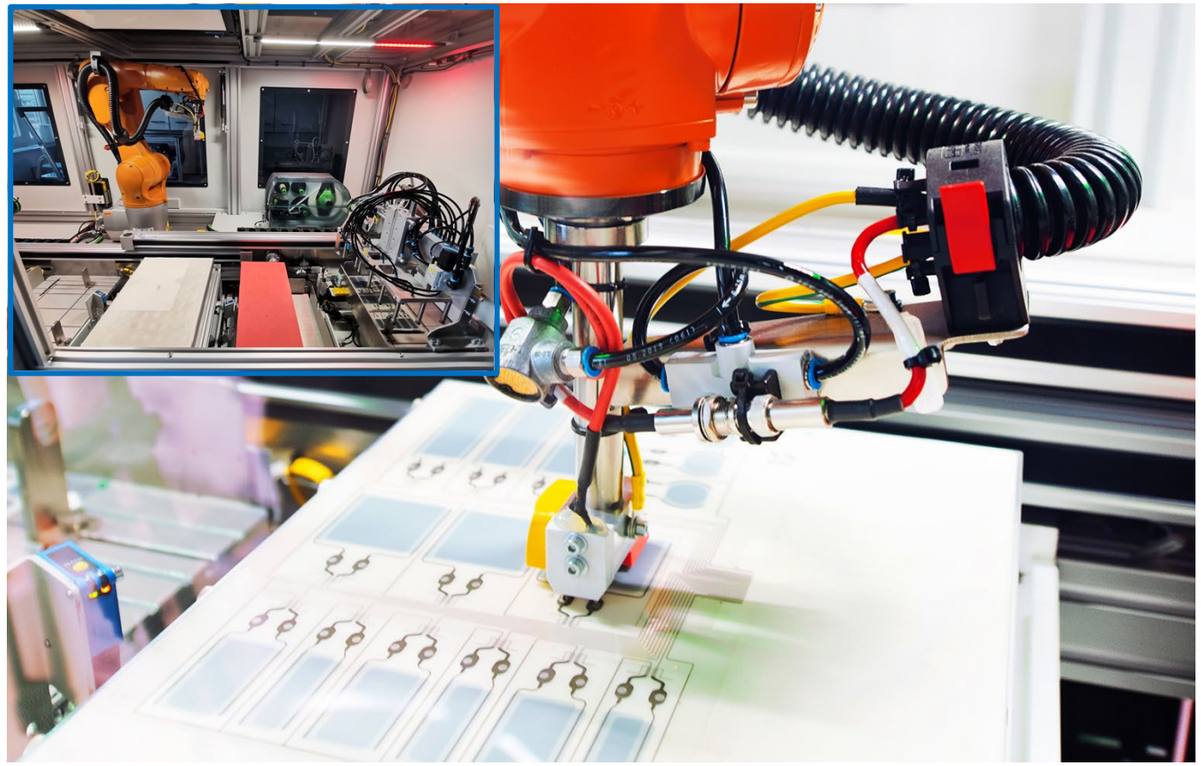
AC - Poling

of PyzoFlex®









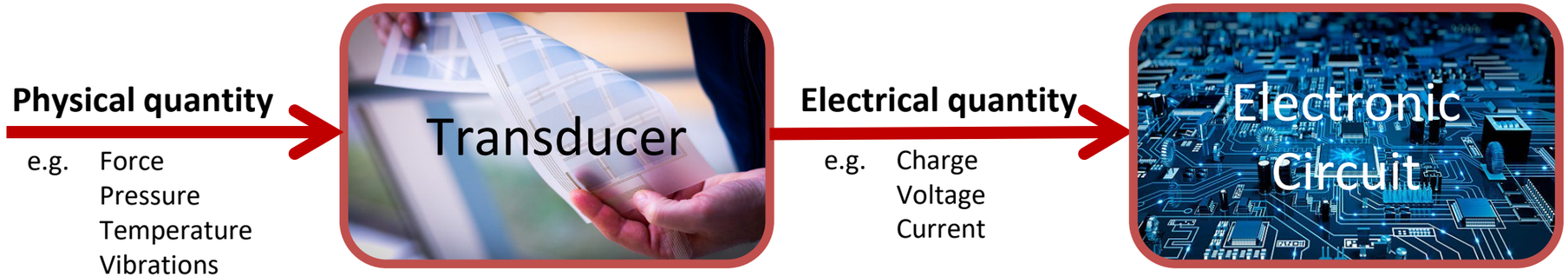
The poling system for large-area printed sensors (size A3) contributes to the quality testing and enhancement of sensors applied to foils.
This opens up new possibilities for innovative, future-oriented sensor technologies and products.

Variation in Geometry & Size

of PyzoFlex

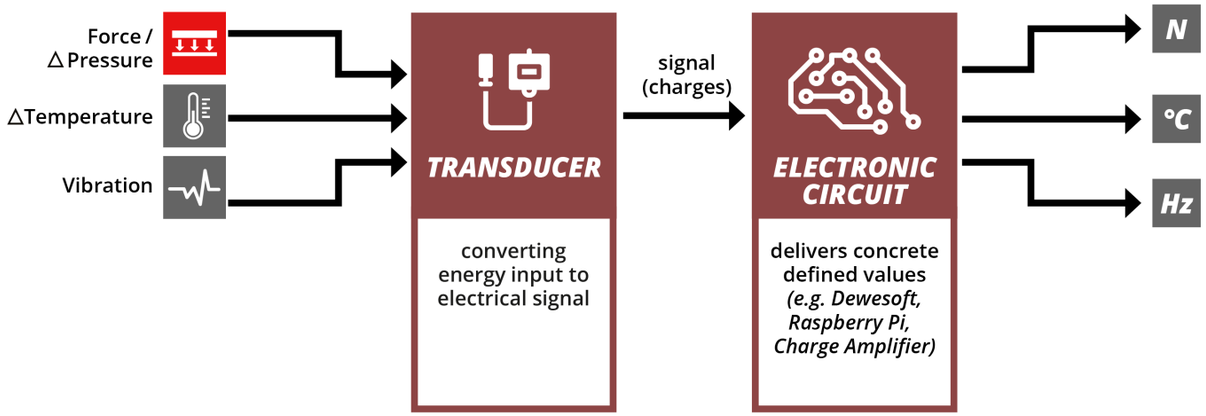
Working Principle

of PyzoFlex®



No Power Supply for Transducer required

- PyzoFlex® is an active sensor (provides charges) and needs therfore no additional power supply
- Only for passive sensors (e.g. strain gauge, FSR)



PyzoFlex® is no "off the shelf" system but is customized for each application: For each specific request, we have to fully understand the application and sensing setup in order to develop a tailor-made solution. For each specific request careful thought and consideration is invested into developing a solution that best meets the requirements of the customer's application.

Reliability

of PyzoFlex®

Test ID	Test name	Discription
TS	**Temperature Storage**	Keeping samples at 105°C for 24 hours
HW	**Hot Water Test**	Keeping samples in water at 99.9°C for 1 hour
1000H	**1000 Hours Test**	Keeping samples at 85°C and 85% humidity for 1000 hours (42 days)
ThSh	**Thermal Shock**	The samples are kept at alternating low and high temperatures. During the cold phase the samples are kept at -40°C for 30 min. During the hot phase they are kept at +85°C for 30 min. The test lasts 11 days.
UP	**Uniaxial Pressure Test**	A static pressure of 0.1 MPa is applied for 240 hours (10 days) at 85°C
MA	**Multiple Mechanical Actuation Test**	106 actuations are performed at a frequency of 1Hz. Within each actuation the pressure of p=0.01MPa at room temperature is applied.
Shr.	**Shrinkage Test**	A sample of a fixed size is placed into an oven at 90°C for 30 min and the ratio of the size after and before the test is determined.
Fl.	**Flammability Test**	The sample stripe of a prescribed length is set afire; the speed of the flame front is measured and classified by integers from 0 to 5.
BC	***Bending Cycles***	***4 million bending cycles (deflection ±1cm) without degradation.***
PC	***Pressure Cycles***	***2.5 million pressure loads (9 N/cm²) without degradation.***
QC	**Quality Control**	Quality controlled process by quantitative poling procedure.

Standard pre-tests in the automotive - successfully completed

Strengths and Benefits

of PyzoFlex®

- Pressure level detection
- Energy self sufficiency of transducer (energy-harvesting applications possible)
- Measuring in real-time
- Multimodal sensing:
  - *Δ temperature: -100°C to +130°C*
  - *Δ pressure/force: 30mN/cm² up to ≥40kN/cm²*
  - *frequency: 0,1Hz to MHz*
- Large area fabrication (scalability) @ low costs
- Hardware: multi-channel on FlexPCB (32 channels) & adaptation to a broad range of interfaces
- Energy saving „off“ mode (wake-up function)
- Very low overall thickness of the system (15µm + Substrate)
- Flexibility and bendability
- Applicable on curved surface
- Seamless surface integration
- Application specific build-ups and material compositions possible
- Customizable sensor design (in terms of geometry, material and size)
- Localized sensing
- High environmental stability (UV, abrasion etc.)

Value Chain

(currently tied up)

Please Note:

The sensor-foil is manufactured and poled by a MP according to design specifications. Following it is transferred to an ems (MP) and integrated with the hardware. After an end-of-line test, the system is delivered to the end customer – thus a two-stop shop.

PyzoFlex®

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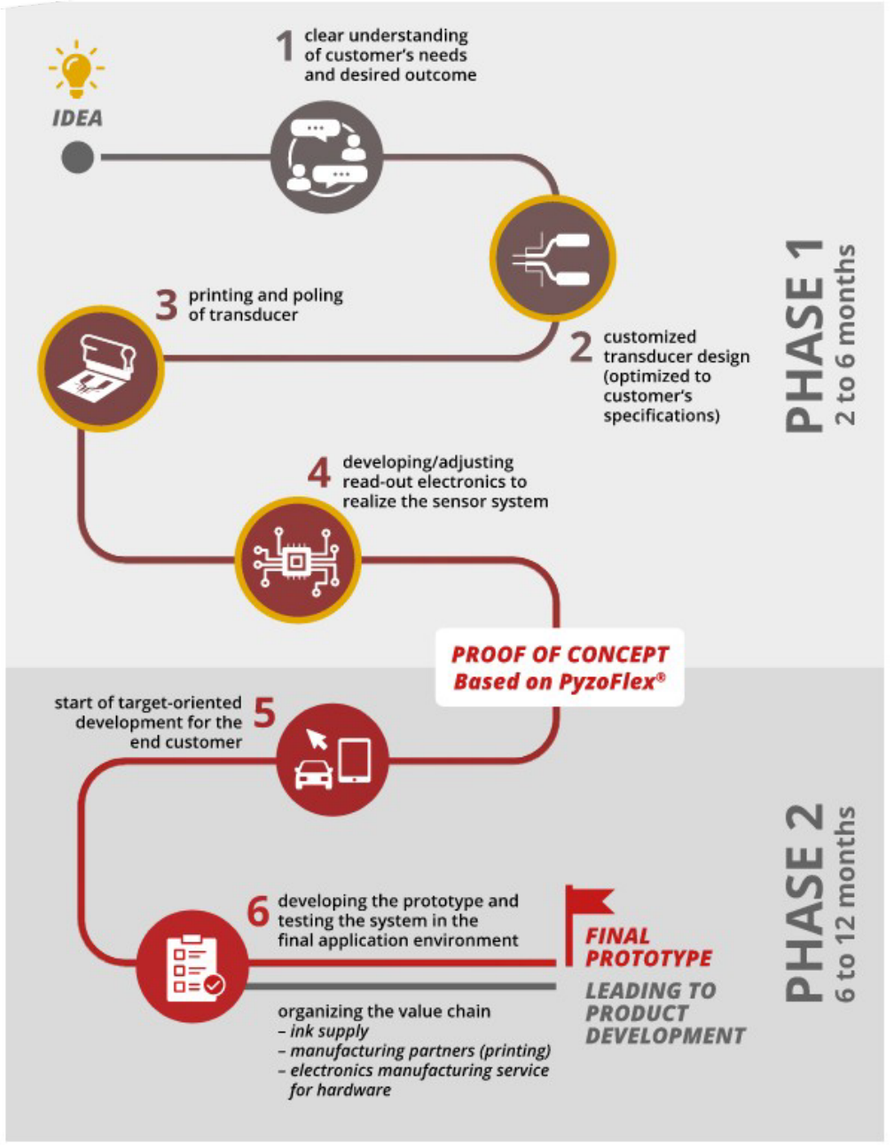

KEY SKILLS @ JOANNEUM RESEARCH

customized transducer design

We have experts who optimize the sensor in terms of size, shape and materials precisely for the desired application

printing and poling of transducer

Production (screen printing):

Here, too, we have many years of experience in the field of functional printing. We select the optimum substrates, printing pastes and process parameters to produce sensors of the highest quality.

developing/adjusting read-out electronics to realize the sensor system

Hardware:

Depending on the application environment and the type of excitation of the sensors, we develop a customized electronics/hardware for signal processing. Thanks to our experts the slightest signal can be measured and processed accordingly.

Following **phase 1** (pre-development/adaptation of the system to the respective requirement), prototypical development is carried out in **phase 2** leading to a final prototype. Then the **series transfer** takes place: we have manufacturing partners who produce and assemble the final system for the respective end customer.

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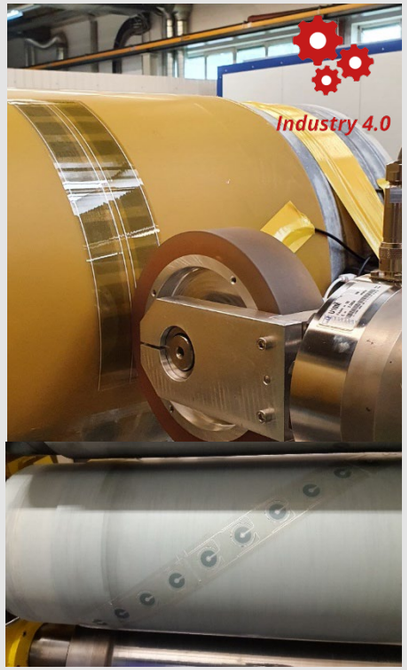
Demonstrators

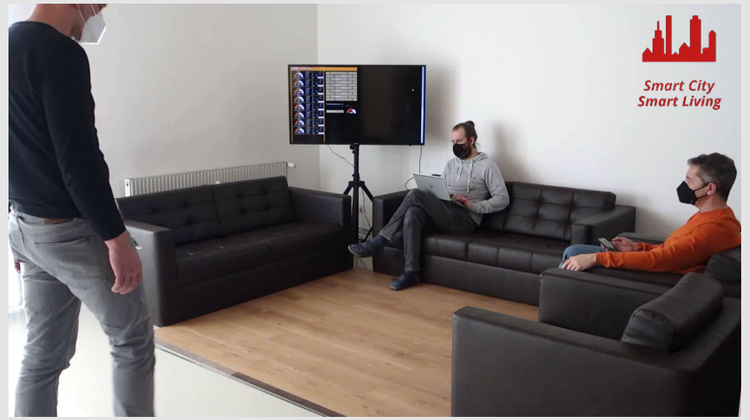
PyzoFlex® Sensors

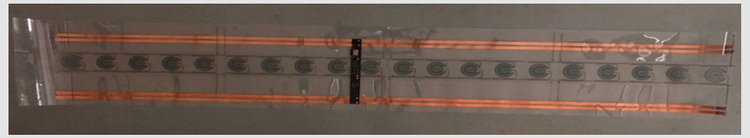
Industrial Sensors



Condition Monitoring

Smart Floor / Furniture





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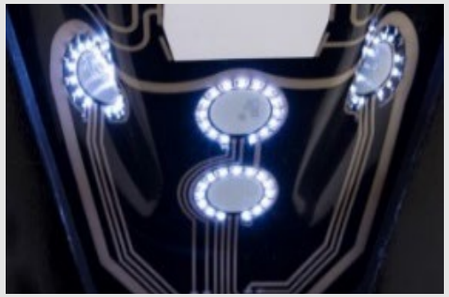
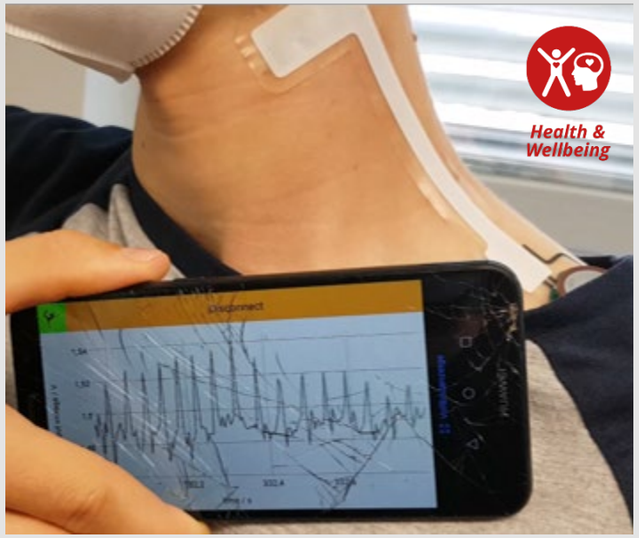
Demonstrators

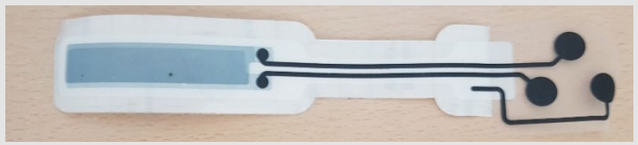
PyzoFlex® Sensors

User Interfaces (2D & 3D)

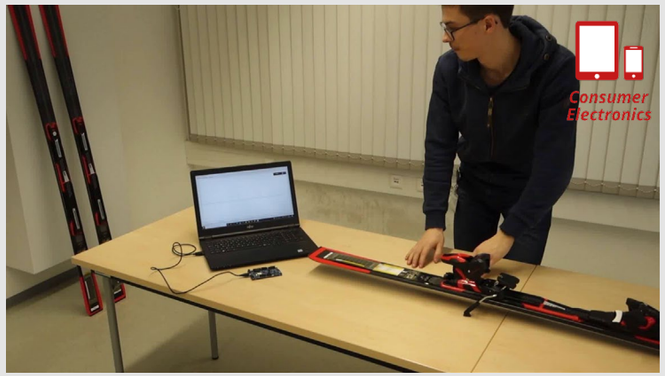


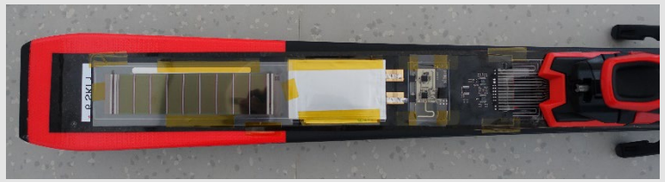
Medical Sensors

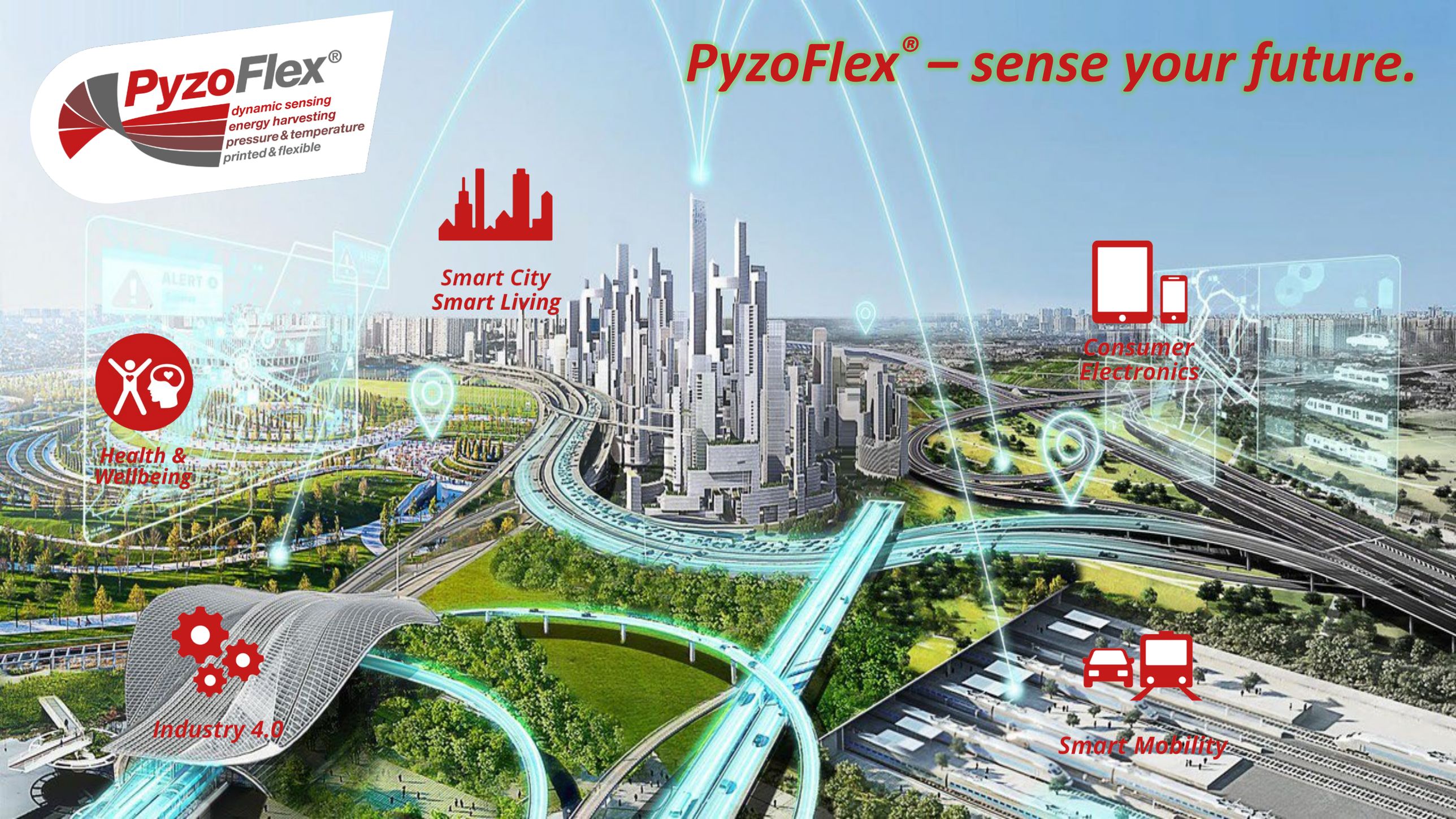




Smart Wearables






PyzoFlex®
dynamic sensing
energy harvesting
pressure & temperature
printed & flexible
PyzoFlex® – sense your future.
Smart City
Smart Living
Consumer
Electronics
Health &
Wellbeing
Industry 4.0
Smart Mobility

PyzoFlex®

https://www.pyzoflex.com/

Thank you!

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