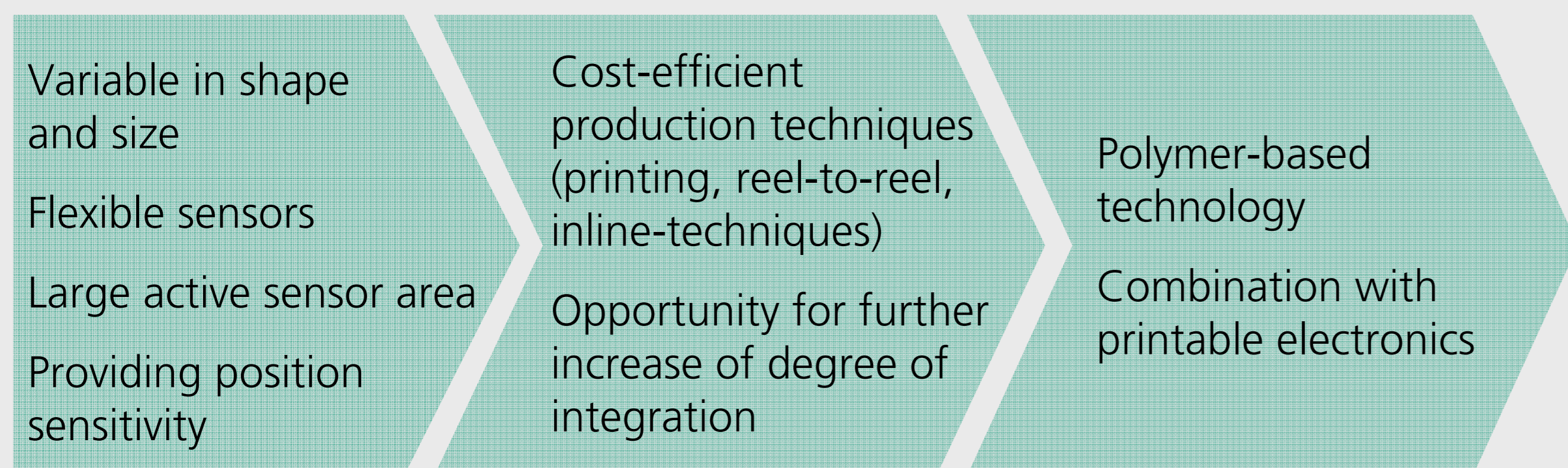


Combination of Polymer Sensors with Organic Electronics: Ideas and Developments

G. Domann, U. Helbig, Fraunhofer-Institut für Silicatforschung, Neunerplatz 2, D-97082 Würzburg (Germany);
M. Zirkl, B. Stadlober, Joanneum Forschungsgesellschaft mbH, Franz-Pichler-Str. 30, A-8160 Weiz (Austria)

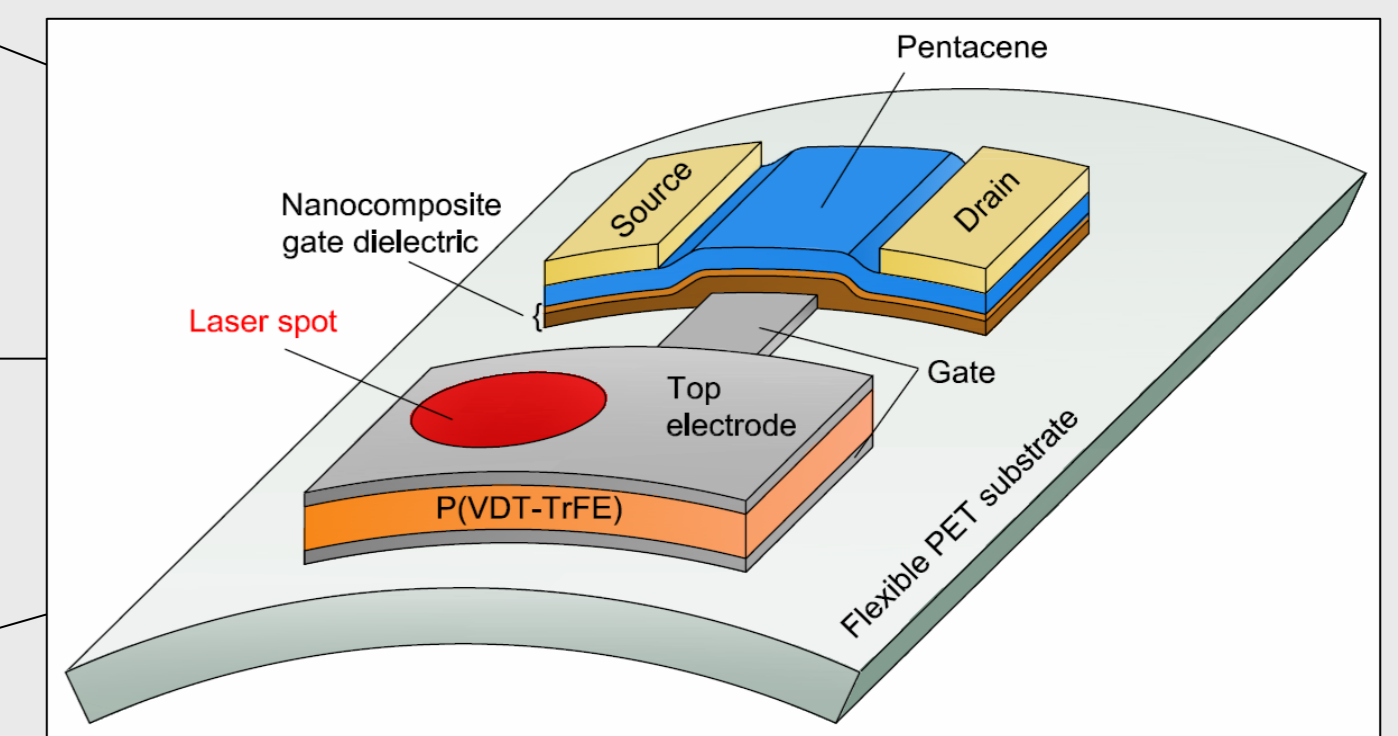
Introduction

Everyday items are more and more featured with sensor functions in order to increase the item's capability for self-controlling, self-monitoring or communication with other devices and people.



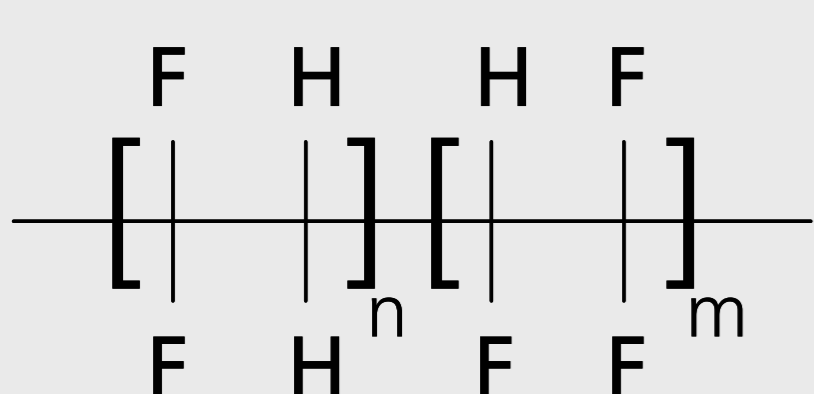
The Sensor Concept (Pressure changes and IR radiation)

- Org. semiconductors (pentacene, P3HT based) or electrochemical transistor
- Printable dielectric (polymers; ORMOCER®, nanocomposites)
- Printable Electrodes (for IR sensors: incl. IR-absorber)
- Piezo- or Pyroelectric Polymer; Electret Foams

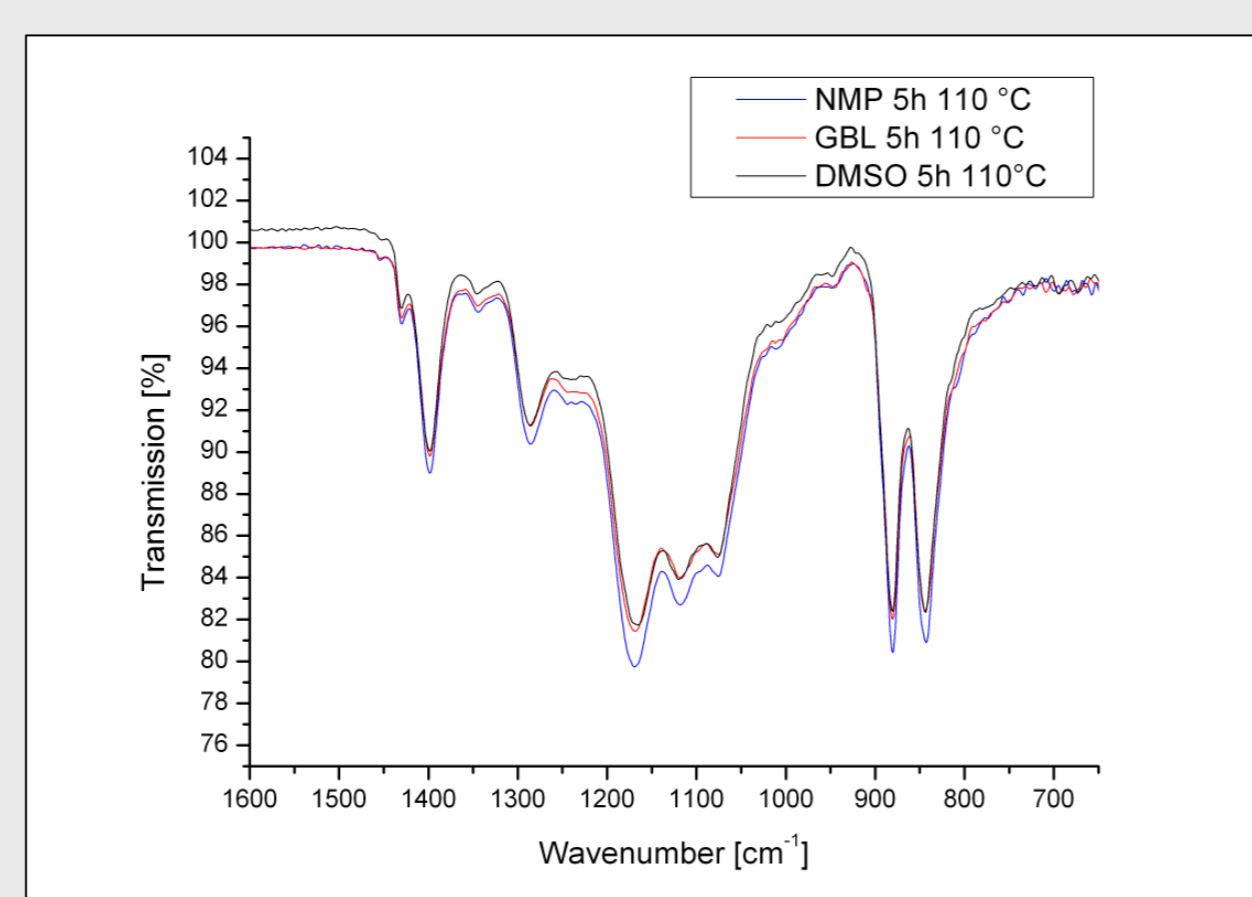


→ Sensor output controls transistor gate

P-VDF-TrFE Co-polymer



- Crystallizes directly in the ferroelectric phase
- Solution processable
- Variety of solvents possible

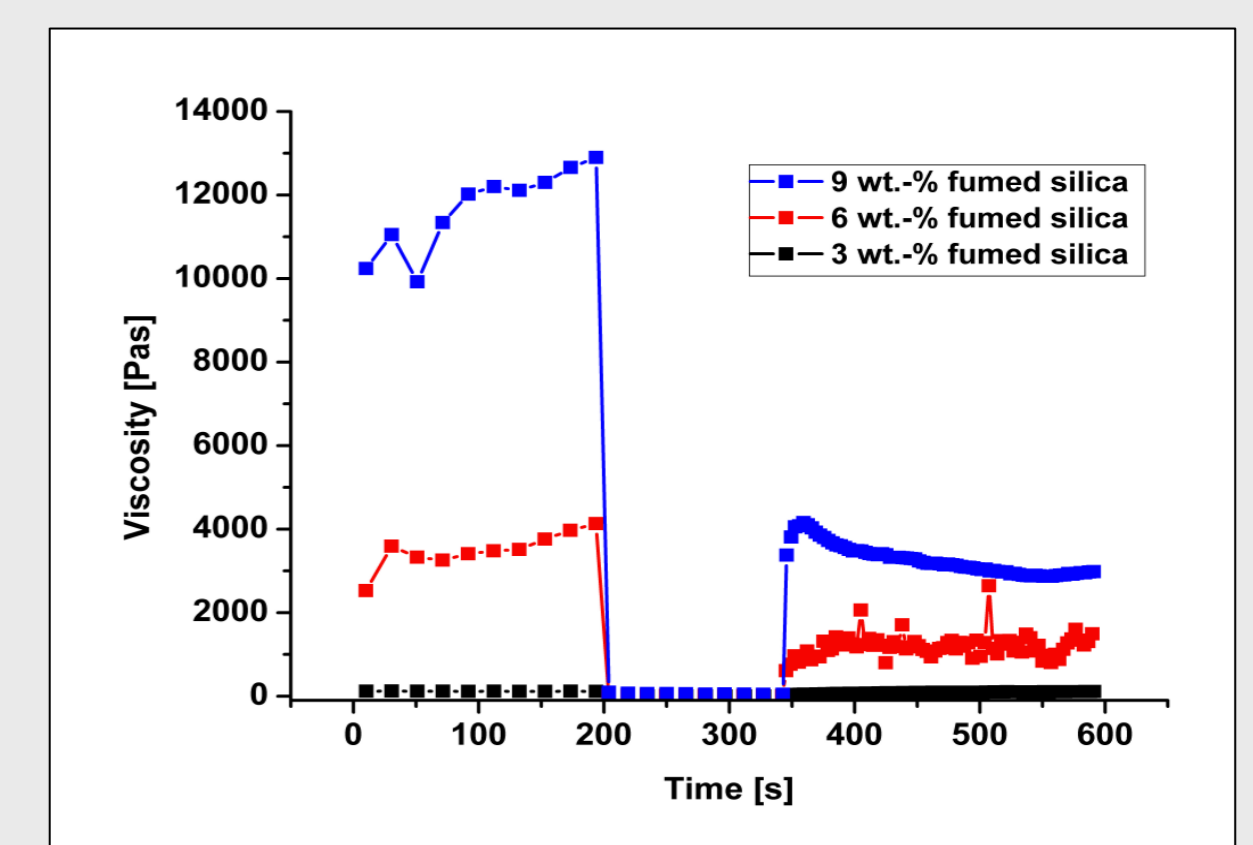


ATR-FTIR spectra
→ Ferroelectric phase confirmed

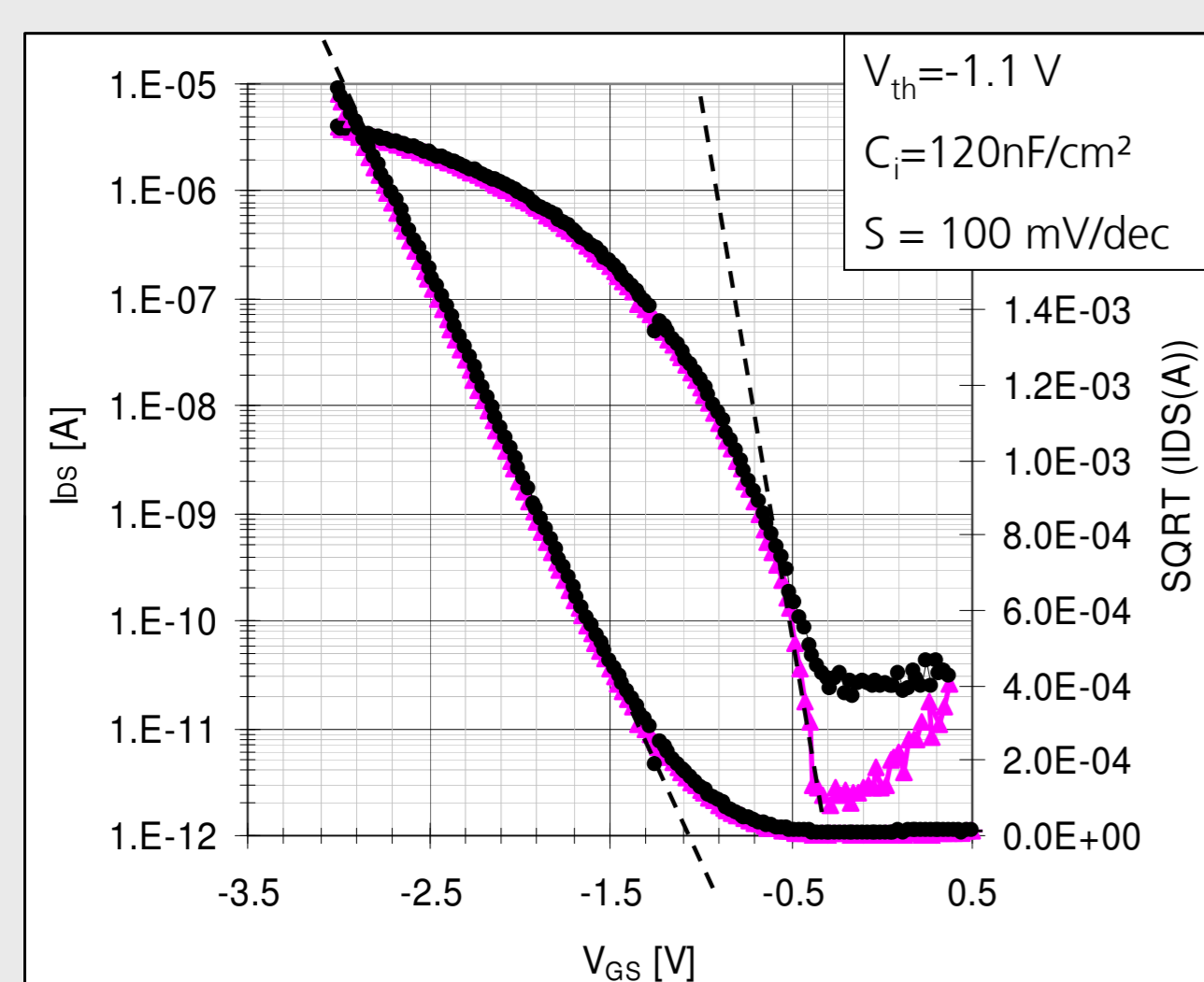
Formulation for Screen-Printing

During screen printing the ink is subjected to varying shear rates. Shear-thinning behavior is beneficial in order to achieve patterned structures.

- Test of additives to modify rheology behavior of P-VDF-TrFE formulations
- Measurement of viscosity in analogy to printing process: low shear rate – high shear rate – low shear rate

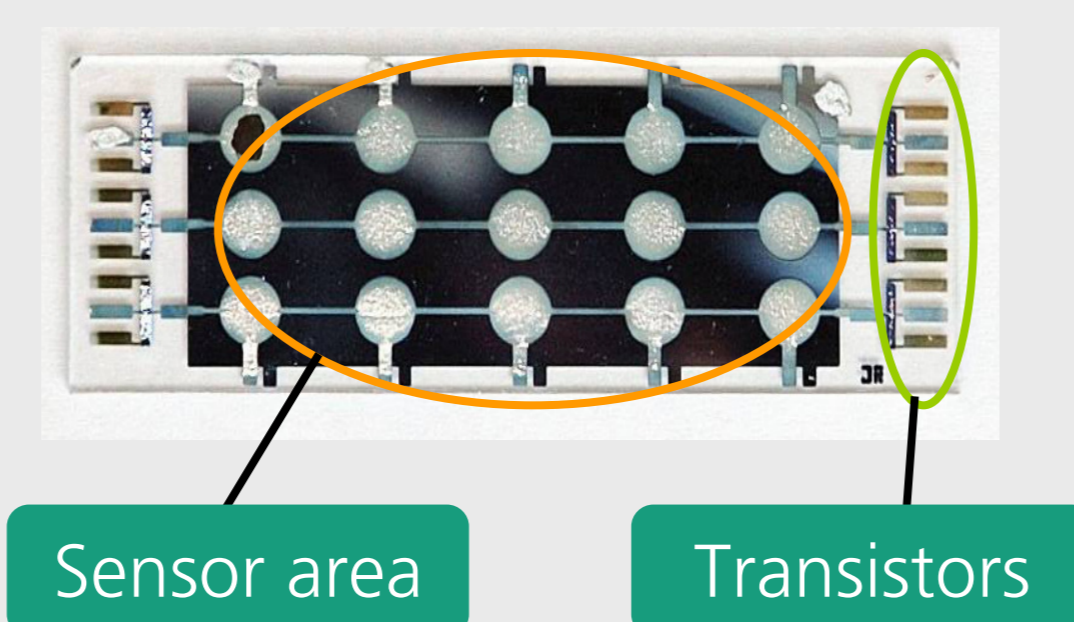
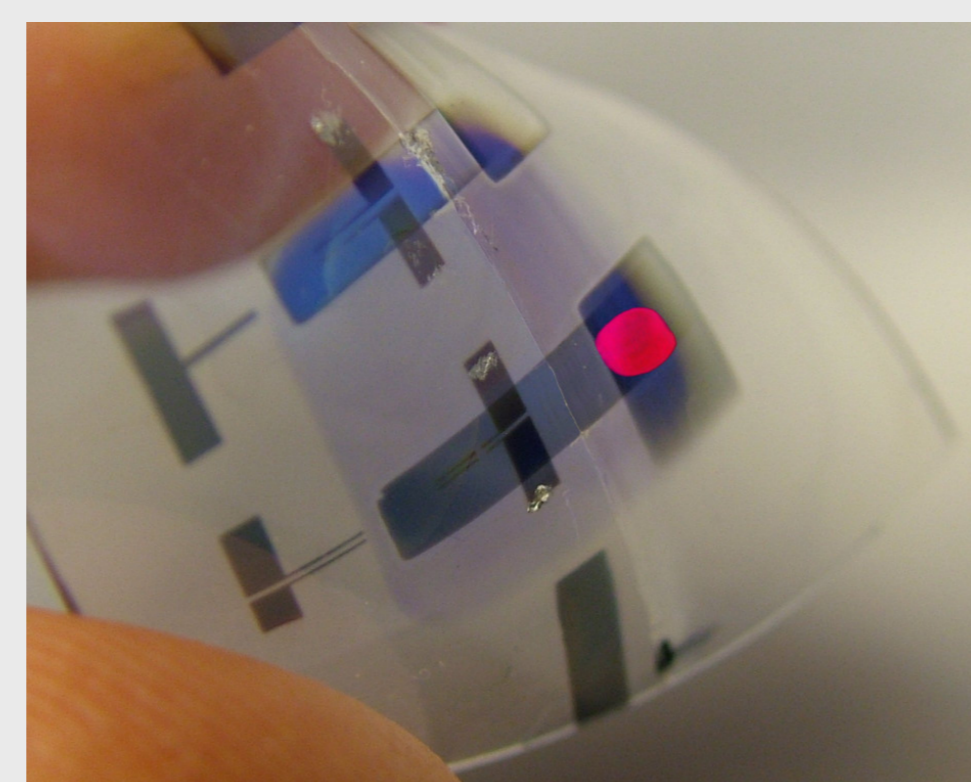


Integrated Transistors

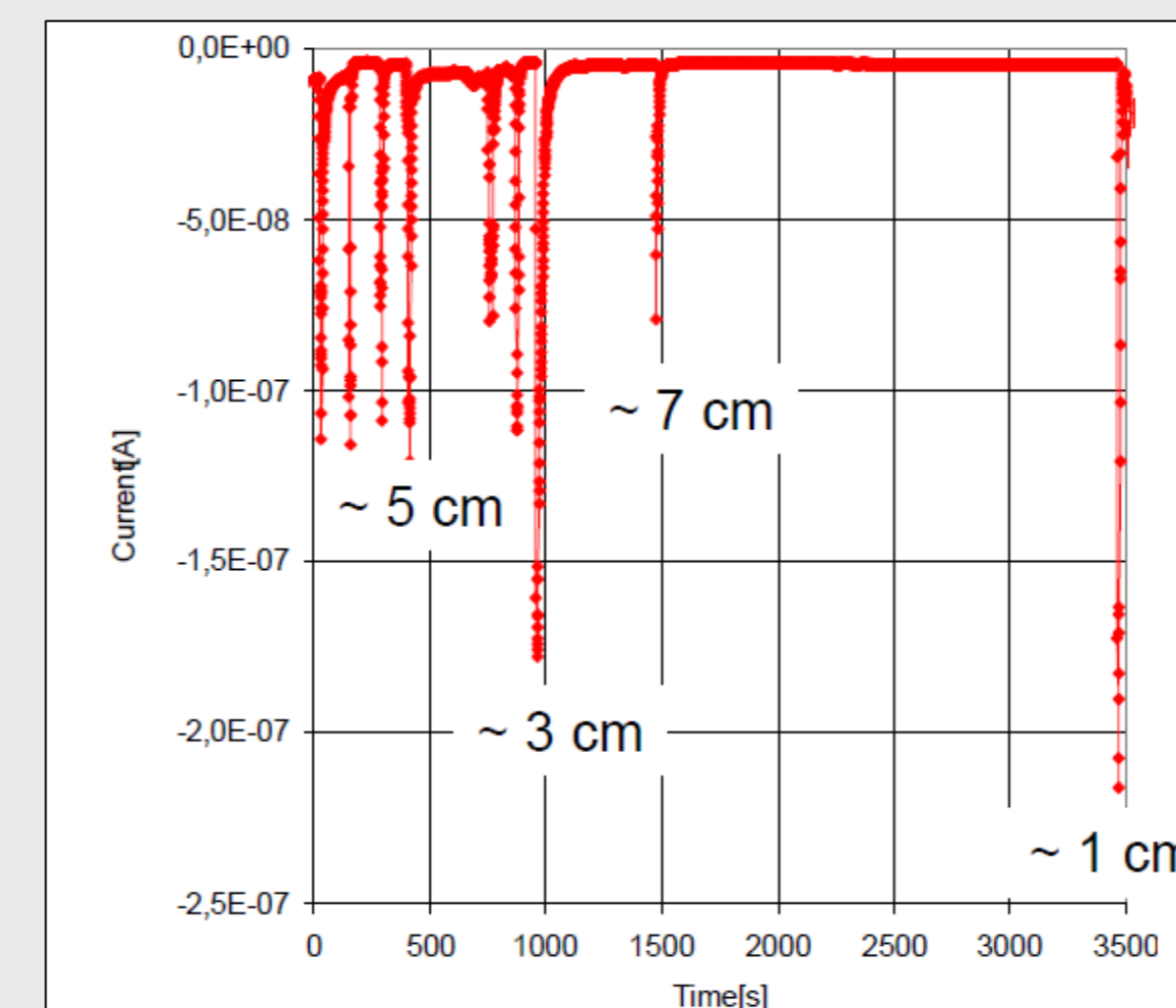


- Pentacene: Possible to fabricate low-voltage OTFTs with matched gate impedance
- Work on air stable P3HT based OTFTs and electrochemical transistors

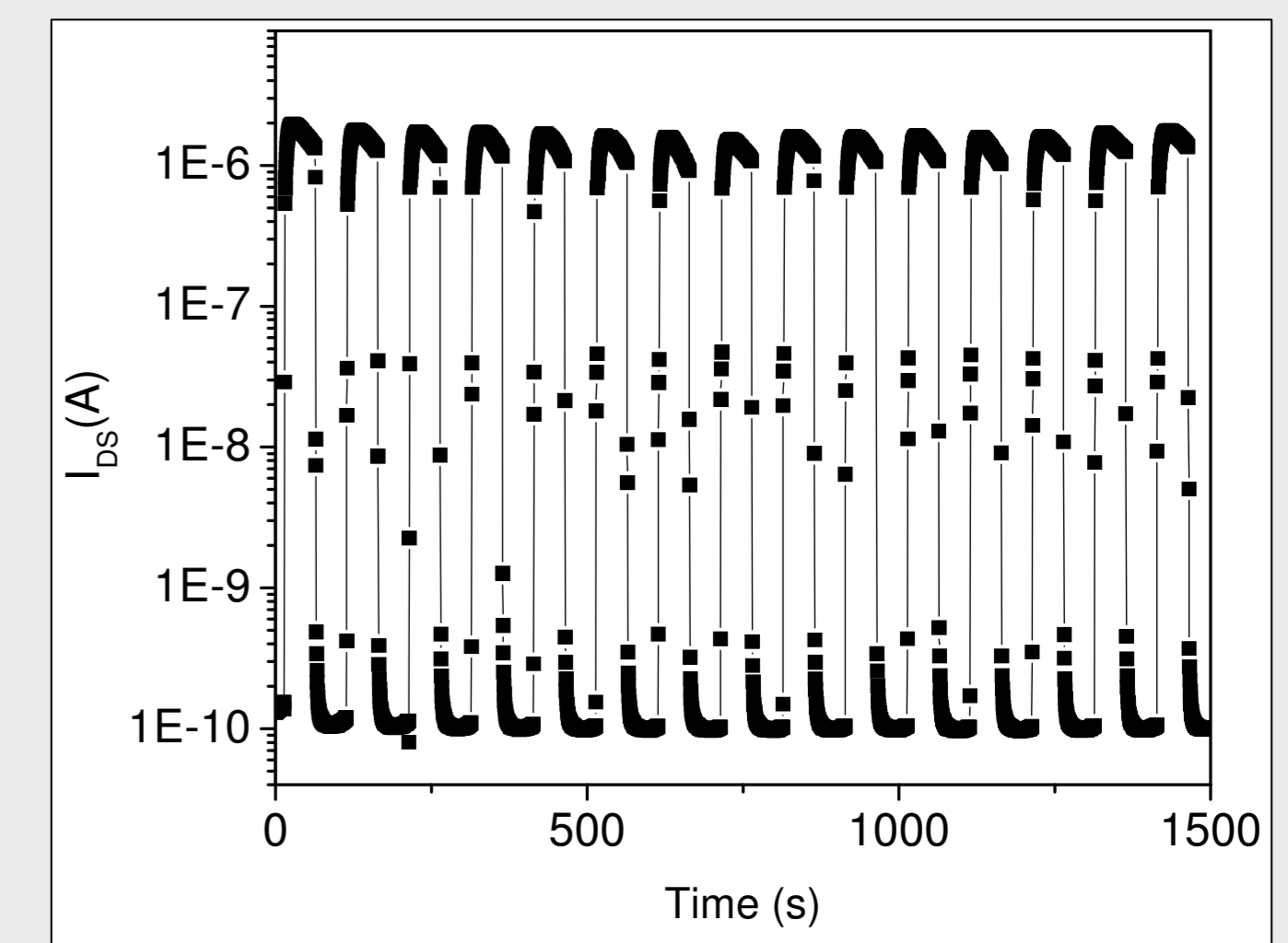
Lab Scale Device



Output Signals



- Detection of IR radiation of approaching finger tip



- Reproducible signal even after hundreds of cycles

Pyroelectric answer (@100 Hz): $I = 100 \text{ nA}/(\text{W} \cdot \mu\text{m} \cdot \text{cm}^2)$ $U = 50 \text{ mV}/(\text{W} \cdot \mu\text{m} \cdot \text{cm}^2)$

Conclusion and Acknowledgement

The presented sensor concept reveals a wide variety of possibilities in different application scenarios (life science, detection of human beings, contactless key pads, industry automation,...). Analogue to the discussed pyroelectric sensor concept piezoelectric sensors can be realized based on P-VDF-TrFE or electret foams. The sensor devices can be manufactured by reel-to-reel processes or inline-vacuum processes which means that high-throughput techniques can be applied. Organic TFTs and electrochemical transistors can be directly integrated. Additionally to the work presented, research is carried out to further increase life time of the integrated sensor devices together with the development of suited encapsulation processes.

These sensors are developed in the R&D project 3Plast which is funded by the European Union (Grant No 215036, see www.3plast-sensor.eu). Essential contribution to this work was done by Silvia Janietz (Fraunhofer IAP), Peter Bodö and Anurak Sawatdee (Acreo)