JOANNEUM RESEARCH MATERIALS

PyzoFlex®

a fully printed piezoelectric energy converter for sensor applications

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In organic and large-area printed electronics smart sensors for detection of physical forces are very promising with respect to novel user interface applications. Over the last decade, touch sensing devices have become more and more important. Multi-touch screens are now the de-facto standard in mobile devices such as phones and tablets, depth cameras are increasingly being used to capture gestural input in the living room and beyond. This rise in adoption of such 'natural' user interfaces shows there is a great deal of user demand for simpler ways of navigating information and content, where the computer interface is not a barrier, but enables them to accomplish tasks more quickly and easily.

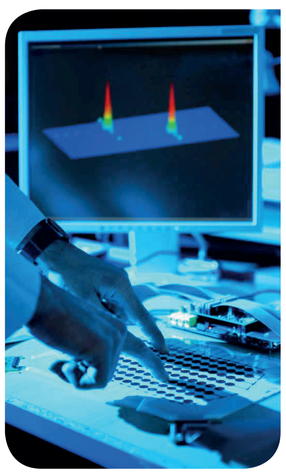
We present the development of a printable sensor technology – PyzoFlex®. Such a PyzoFlex® sensor is based on the ferroelectric material PVDF:TrFE which supports both – the pyro- and the piezoelectric effect that can be used for sensing pressures on large, bended surfaces. The sensor foil is constructed by a sandwich structure of four layers that can easily be printed onto any substrate (e.g. plastic foils, paper, and textiles). The resulting PyzoFlex® sensors are sensitive to pressure- and temperature changes, bendable, energy-efficient, and they are realized sheet to sheet by a screen-printing routine. Even a hovering input-mode is feasible due to the pyroelectric effect within the sensor material. Since the PyzoFlex® sensor acts as a piezoelectric energy converter; any deformation of the sensor foil caused by – e.g. a touch of a human finger – is converted into electric energy. The charges being generated by such a deformation can be measured as a voltage between the electrodes of the sensor setup. An important advantage of the PyzoFlex®-technology is the energy self-sufficient sensing principle. The sensor can be driven in a passive (high impedance) mode and any user interaction directly generates electric charges indicating the pressure being applied. On this account the PyzoFlex® sensing concept can also be used for energy harvesting purposes.

Within this work we printed sensors for proving the energy harvesting principle. The sensor set-up can be printed as single layers or as double layers for increasing the signal output. By using a piezo-stamp a sensor area of 0.5 cm^2 was activated. This area correlates with the input-area of a human finger. A charge of 2.8 nC/cm^2 (single layer) and 5.4 nC/cm^2 (double layer) was generated within the sensor with a resulting output power of 0.65 $\mu W/cm^2$ to 2.5 $\mu W/cm^2$, respectively. This is sufficiently enough power to activate wireless sensor networks for heating/climate control in areas of smart living or to use this foil as burglar-alarm systems as well as fall detection systems in context of Ambient Assisted Living (AAL).

PyzoFlex® pressure sensing device

Pyroelectricity

… is the ability of certain materials to generate a temporary voltage when they are heated or cooled. The change in temperature modifies the positions of the atoms slightly this change in polarization gives rise to a voltage across the crystal.



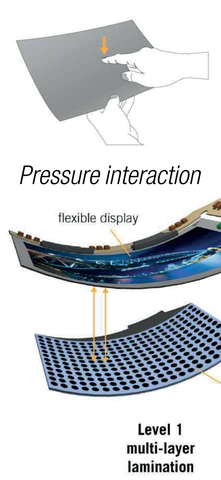
Piezoelectricity

The word piezoelectricity means electricity resulting from pressure. It is the electric charge that accumulates in certain solid materials in response to applied mechanical stress.

Flexibility

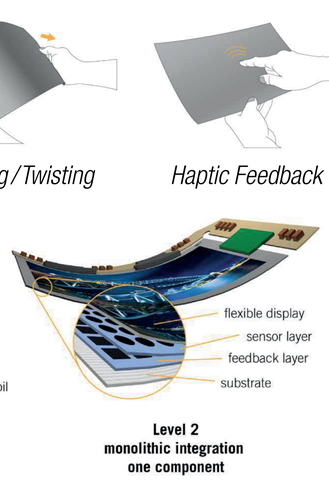
- Capable of being bent or flexed; pliable.
- Capable of being bent repeatedly without injury or damage.

Applications



Pressure interaction

Level 1
multi-layer
lamination



Bending/Twisting

Level 2
monolithic integration
one component

Haptic Feedback

+ Flexible Components

In this project, we develop and evaluate an novel touch and feedback interfaces based on large-area printed piezoelectric sensors and relaxor polymers for integration with flexible displays.

+ Novel Interaction

With the integration of these flexible touch-, feedback- and display layers, we will enter the next level of human machine interaction by enabling intuitive input like bending, pressure and hand gestures.

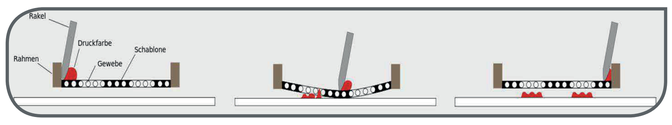
= Innovative Use-Cases

The application scenarios for a pressure-sensitive flexible electrophoretic display range from interactive (bendable) devices (e.g. interactive smart cards) to curved interactive kiosk displays in public spaces.

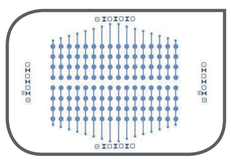
Production

PyzoFlex®

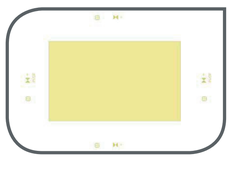
Substrate:
Melinex ST 726



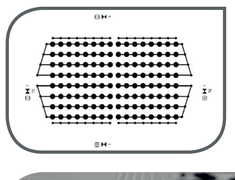
Bottom-electrode:
PEDOT: SV3/4 (HC Starck)
100 °C for ≥ 3 Minutes



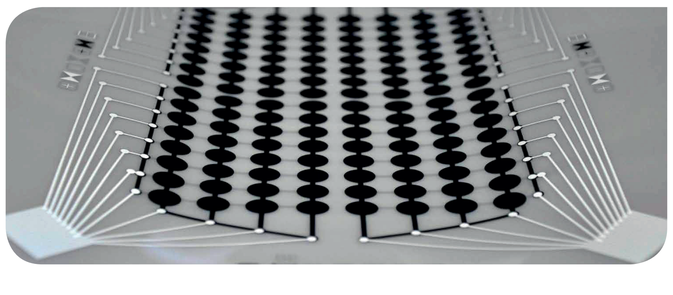
Sensor Active Material:
PVDF:TrFE: own Synthesis
100 °C for ≥ 5 Minutes



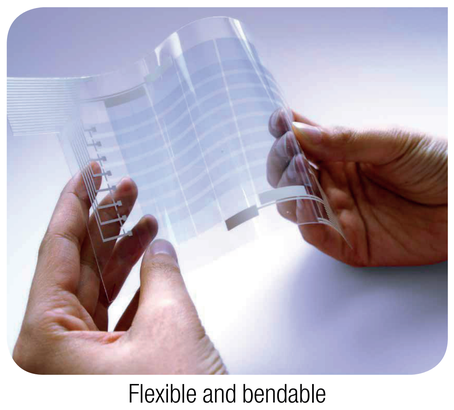
Coverelectrode:
Carbon: DuPont 7201
100 °C for ≥ 3 Minutes



Conductor-Lines:
Ag: DuPont 5000
100 °C for ≥ 3 Minutes



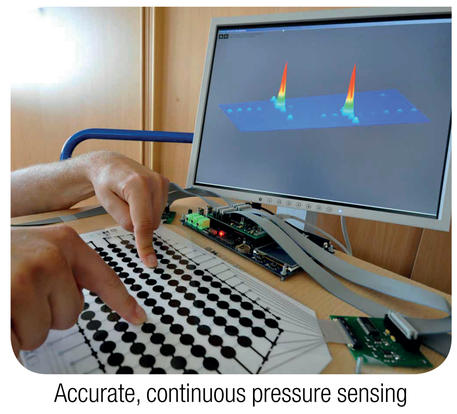
Advantages



Flexible and bendable
Transparent

Scalability

Printable on any Substrate,
even Paper & Textiles



Accurate, continuous pressure sensing

FLASHED
Flexible Large Area Sensors for
Highly Enhanced Displays

www.flashed-project.eu

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COOPERATION