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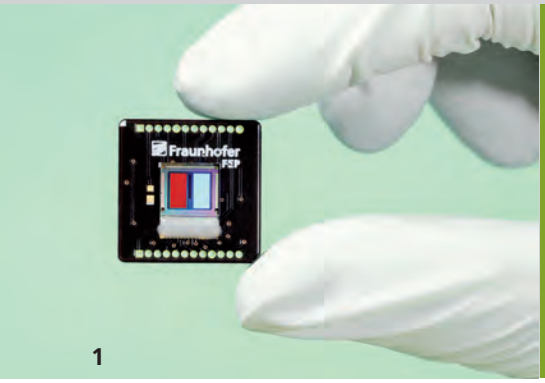

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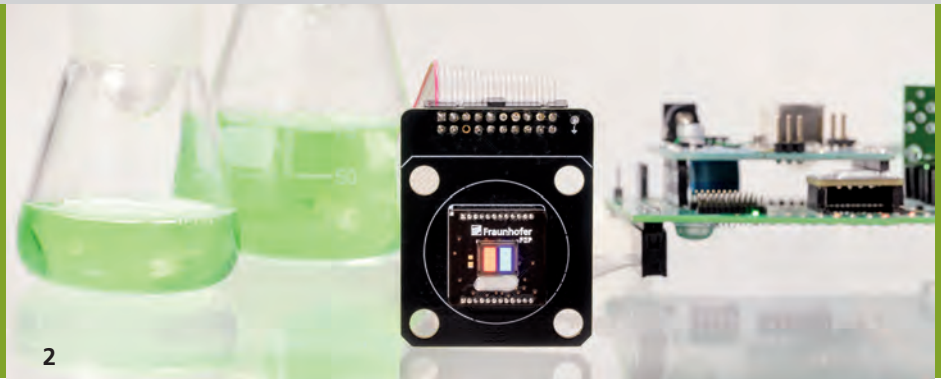

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1 *Prototype of the miniaturized phosphorescence sensor*
2 *Sensor platform with external control*

UNIVERSAL OPTICAL SENSOR PLATFORM

Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP

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Introduction

In the context of digitalization and the increasingly comprehensive monitoring of processes, automated workflows in chemistry, pharmacy, biomedicine and the environment, the selection of sensors is almost immeasurable and is increasingly being adapted to the specific application. Depending on the requirements and parameters, such as the substance or object to be detected, the response time and the sensitivity range, the right sensor has to be found.

A common method for measuring material properties (pH value, temperature, concentration, etc.) is the use of a sensor material, which changes in its optical properties depending on the concentration. If this sensor material is optically excited to photoluminescence and the emitted light is measured, it is possible to conclude the state of the sensor material and thus the selected parameter.

Two typical scenarios for the measurement of process parameters or concentrations are the direct contact of the sensor with the medium or the introduction of a sensor layer into the reaction chamber and excitation & selection via a fiber optic cable to the external electronics. Some sensor layers can be sterilized prior to use, making them disposables for biological and medical procedures.

These optical sensors are popular alternatives to more expensive and larger measurement technology and convince by their easy handling and integration capability into existing systems. They also convince with their low susceptibility to faults and simple maintenance.

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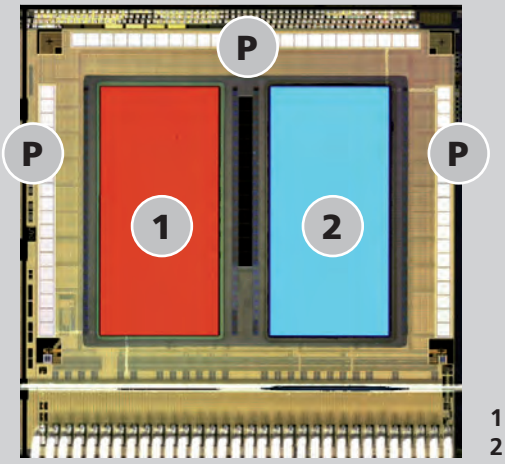
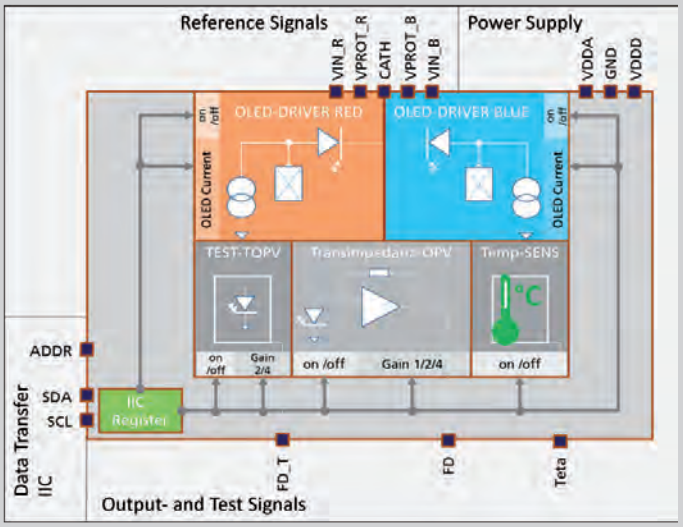


1 red OLED
2 blue OLED
P Photodiodes

3



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Technology

The Fraunhofer FEP has many years of know-how in the development of organic electronics in combination with CMOS design, user software and electrical control. Using organic light emitting diodes and a specially developed CMOS backplane design, a sensor platform for optical excitation and selection of sensor layers was realized. There are two OLED dots as well as photodiodes and the control and readout electronics for emission and detection of light on the chips. The emission wavelength of the light emitting diodes can be adjusted in the visible and adjacent spectral range and thus enables the excitation of different sensor materials for different parameter measurements. By integrating color filters with adapted characteristics depending on the dye in the sensor layer, the sensor chip can be designed for a wide range of applications and combinations with sensor materials and is therefore versatile.

Customer-specific sensor platform

The sensor chip has three large photodiode fields, each of which is covered by color filters. The optical properties of the color filters can be designed according to the application. The sensor layer determines the necessary spectral properties of the color filters and the OLED emission wavelength emission wavelength. For example, the dyes used to detect the pH value and the oxygen concentration have different excitation wavelengths and therefore different emission wavelengths. The color filters and excitation-OLED of the sensor are adapted to the dye and are therefore highly compatible with the large number of sensor layers of commercial manufacturers.

This sensor platform is versatile and can also be used without the phosphorescent sensor layers to evaluate single or multi-color periodic light signals over time. The integrated photodiodes and variable filter characteristics allow a wide range of applications for electro-optical measurements.

Application example: Oxygen sensor

A sensor for measuring the oxygen concentration in gases is available as a technology demonstrator. Sensor layers specially developed at the Fraunhofer FEP or commercial sensor spots can be used. A blue light-emitting diode excites the dye layer and the response phosphorescence signal is detected and evaluated in the CMOS backplane chip. Using a calibration curve, the oxygen concentration is calculated from the decay time of the dye response.

Key data of the sensor platform

- 2 different excitation OLEDs
- CMOS sensor chip-internal drivers
- Modulation of light emitting diodes from at least 0.1 – 40 kHz
- Brightness adjustment of the light emitting diodes
- 3 separate photodiode fields with color filters
- Chip-internal sensor front end
- Optical excitation and detection in the visible and adjacent spectral range
- Integrated temperature sensor
- Data Transfer: IIC
- Communication: USB, Bluetooth
- Optional: sensor chip-internal, programmable microcontroller
- Chip dimensions 8×8 mm²

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3 *Microscope mount: Sensor chip*
4 *Block diagram: Sensor chip*

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