The Fraunhofer FEP - MicroLED introduction (MicroLED Library document)

The **Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP** is one out of 76 institutes and research units of the Fraunhofer-Gesellschaft e. V., the largest European institution for applied research. The core competences of Fraunhofer FEP are electron beam technologies, vacuum thin film deposition techniques and technologies for organic electronics, microdisplay technology and sensorics. Main activities target development and adaption of the thin film deposition technologies to a wide range of industrial applications. Fraunhofer FEP runs multiple pilot scale vacuum coating systems.

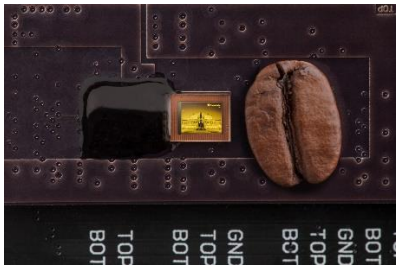
Furthermore, Fraunhofer FEP has a unique position in designing microelectronic circuits and components with application- and customer-specific adaptations of silicon circuit foundries' CMOS processes that allow these finished wafers to be subsequently processed with OLED coatings, for example. This subsequent processing is used in particular for augmenting silicon CMOS wafer functionality with optical and photonic components, such as for high-resolution OLED microdisplays.

OLED microdisplays offer a wide range of applications, whether in industrial environments, such as logistics, or in the private area as fitness trackers or navigation devices. In order to ensure a user-friendly application and still guarantee a highly efficient device, Fraunhofer FEP has been working for many years on the further development and functionalization of OLED microdisplays, which can be integrated in various forms.

OLED microdisplays by Fraunhofer FEP © Fraunhofer FEP

OLED microdisplay with a resolution of 1440 × 1080 pixels and the world's smallest pixels of 2.5 micrometers

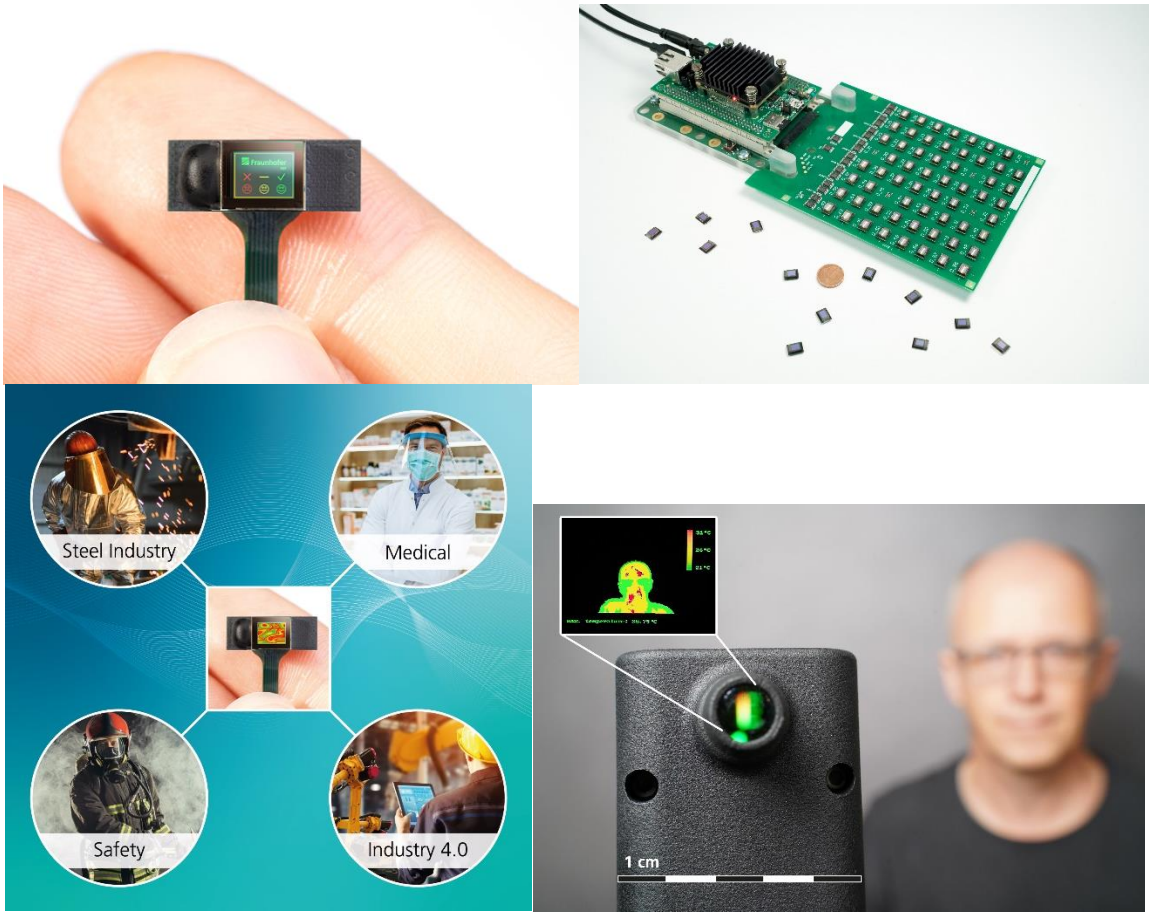
OLED microdisplays have so far been developed mainly on 200 mm wafers.
These conventional CMOS technologies and the associated backplane design have so far limited the number and size of pixels. At the Fraunhofer FEP, OLED microdisplays have now been realized for the first time in a 28-nanometer backplane technology on 300-mm wafers within the "Backplane" project funded by the Saxon State Ministry of Economics, Labor and Transport. Devices with a display diagonal of 0.18 inches and pixel sizes of only 2.5 micrometers could be produced. This corresponds to a pixel density of 10,000 dpi - an unprecedented level in the global OLED microdisplay market.



OLED microdisplay with a resolution of 1440 × 1080 pixels and the world's smallest pixels of 2.5 micrometers

Ultra-low power OLED microdisplays for wearables

For a focused display of graphical information in industrial application scenarios, ultra-low power microdisplays are suitable due to parameters such as ergonomics, compactness and battery life. Through an innovative design of the display backplane the power consumption can be reduced to 1 mW and a longer battery life can be achieved. The displays are controlled via an SPI interface and can reach a brightness > 35.000 cd/m² in different monochrome colors. A second version of the display architecture enables red and green subpixels with a typical peak brightness of 5,000 cd/m².



Ultra-low power OLED microdisplay and possible applications scenarios
© Fraunhofer FEP, photographer: Claudia Jacquemin

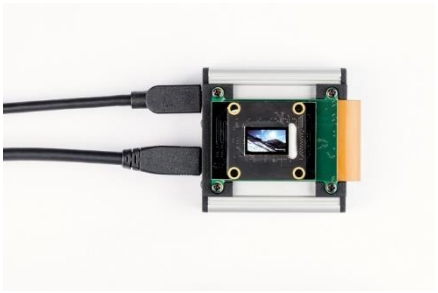
WUXGA OLED microdisplays

The WUXGA OLED microdisplay is suitable for various VR applications due to their resolution, image quality and refresh rate. With 1 inch screen diagonal at a resolution of 1920 × 1200 pixels and a pixel pitch of 1 µm (2300 ppi), a high frame rate of up to 120 Hz is possible. The display mode can be flexibly configured from Hold-Type to Impulse-Type, thus enabling the elimination of motion artifacts. In addition to the high frame rate, the WUXGA OLED microdisplay features very high contrast ratios of 100 000 : 1 with low power consumption at the same time.

1-inch WUXGA OLED microdisplay © Fraunhofer FEP

720p OLED microdisplays for AR applications

The 720p microdisplays were specially developed for application in industrial AR glasses, where, for example, a real-time overlay of data or support scenarios are frequently to be superimposed. High frame rates and contrast ratios, as well as low power consumption at the same time, play an important role. With a resolution of 1280 × 720 pixels at a screen diagonal of 0.64 inches and a pixel pitch of 11 µm, the 720p microdisplay offers high-quality images at low power consumption in the uncomplicated integration into wearables.



720p OLED microdisplay for AR applications © Fraunhofer FEP, photographer: Claudia Jacquemin

Bidirectional OLED microdisplays

By combining display and image sensor functions, bidirectional microdisplays can simultaneously capture and render images in a common active area. To achieve this, each RGBW pixel is supplemented by an additional sensor pixel, which enables an application in smart data glasses with eye control as well as optical sensors, such as optical fingerprint sensors.

Bidirectional OLED microdisplay as fingerprint sensor © Fraunhofer FEP

Sensors

Organic photodiodes (OPD) are integrated monolithically and on wafer level on a powerful CMOS readout circuit. The advantage over established technologies is the possibility to adapt the spectral behavior to the application and to detect wavelengths outside the visible range without the use of expensive III-V semiconductors. The active layers can be processed by evaporation in high vacuum, by liquid processes or by a hybrid approach. Fraunhofer FEP offers a development platform consisting of different substrates, wafer layouts and processes for the development and evaluation of such layers or layer systems.

Organic photodiodes © Fraunhofer FEP