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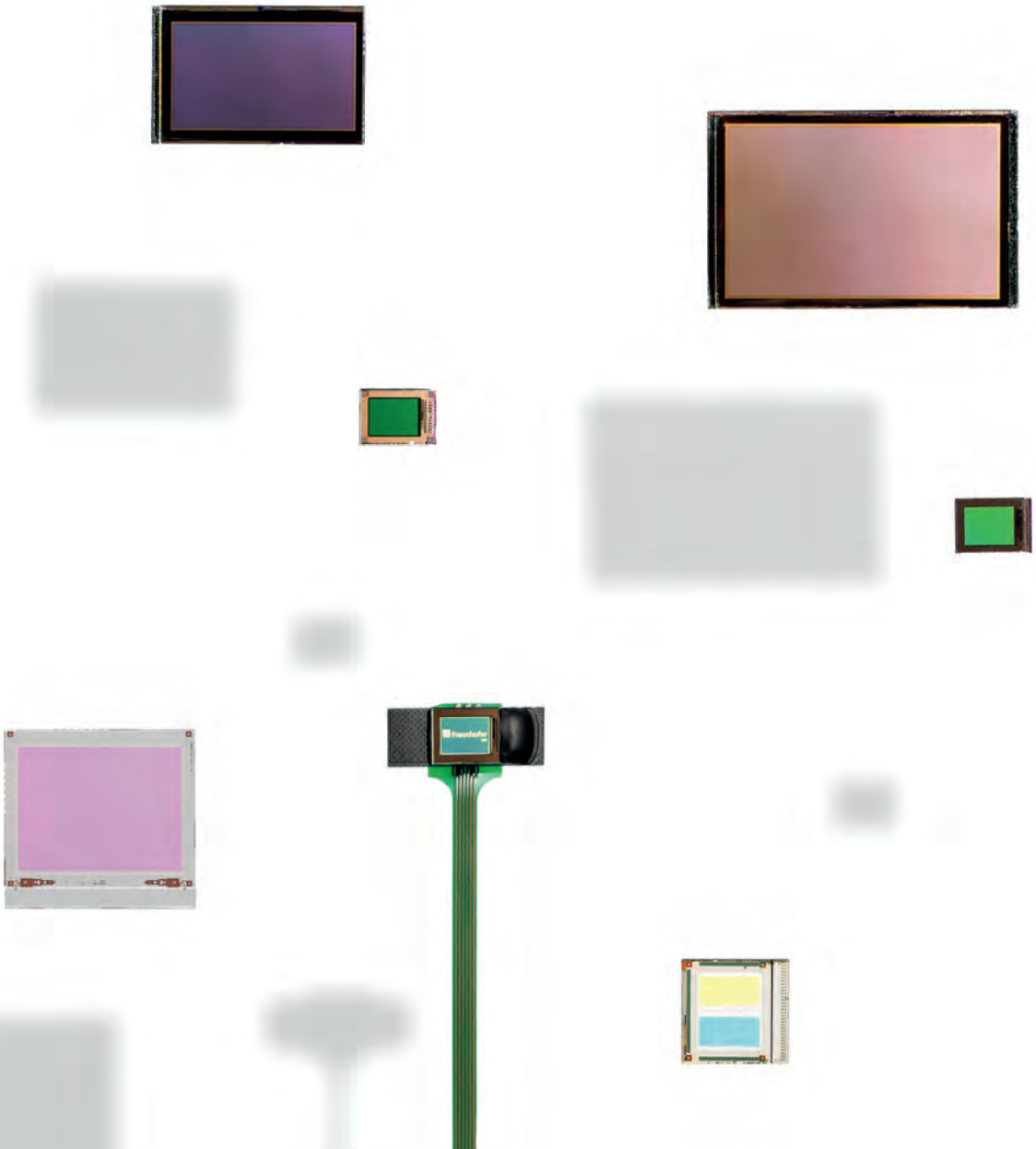
FRAUNHOFER INSTITUTE FOR ORGANIC ELECTRONICS, ELECTRON BEAM AND PLASMA TECHNOLOGY FEP

BACKPLANES FOR DISPLAYS AND SENSORS, EVALUATION KITS



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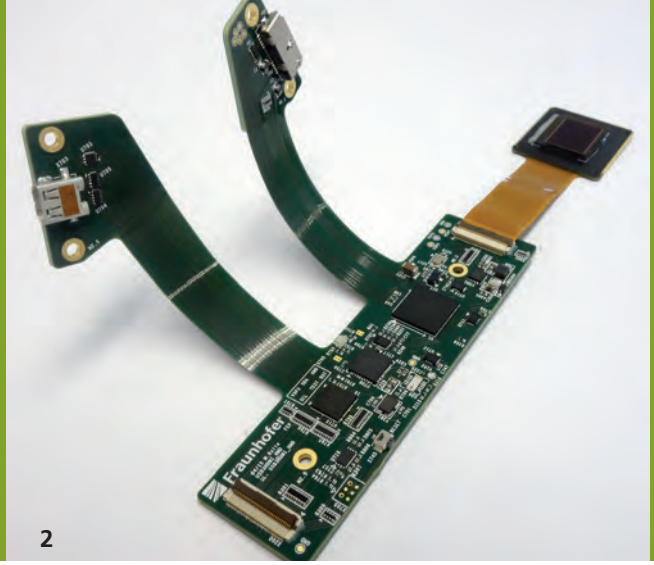


2

Technology and Service

Augmented Reality (AR) and Virtual Reality (VR) have arrived in the age of digitalization and industry 4.0 both in everyday work and private life. For professional applications, a third scenario can be considered: the Look-Around display, which provides instructions or detailed information about the working environment or about machine status.

Currently available data glasses are evolving rapidly and the improvement of ergonomics, construction depth or running time is being worked on at full speed, thus making compact, powerful and user-friendly data glasses become reality.

The heart of all data glasses are their displays. For each application, certain parameters will affect user acceptance of the system, with each parameter, such as optical performance or power consumption, having a different significance for the respective application.

The Fraunhofer FEP has many years of know-how in the development and manufacture of such application-specific OLED microdisplays. This includes all steps from the initial idea to the backplane design, from the design of the organic components to production in the range from a few prototypes to small series.

Our microdisplays are based on the monolithic integration of OLEDs on silicon chips to control the individual pixels. These chips or wafers can also be used to drive and read out alternative active layers. Examples would be display technologies based on quantum dots or micro LEDs.

Our research and development work at Fraunhofer FEP focuses on the development of OLED microdisplays for AR and VR data glasses as well as for use in sensor applications. The display concept and parameters such as resolution, pixel size and integrated additional functions can be varied within a wide range for specific projects or customers. The spectrum ranges from ultra-low power displays for small and lightweight data glasses to high-resolution HD displays for VR glasses and viewfinders up to bidirectional displays with embedded image sensor functionality for fingerprint sensors or eyetracking data glasses. Besides the integration of OLED or a combination of OLED and photodiodes for bidirectional microdisplays, we also offer the integration of organic photodiodes (OPD) as sensors on a CMOS readout circuit.

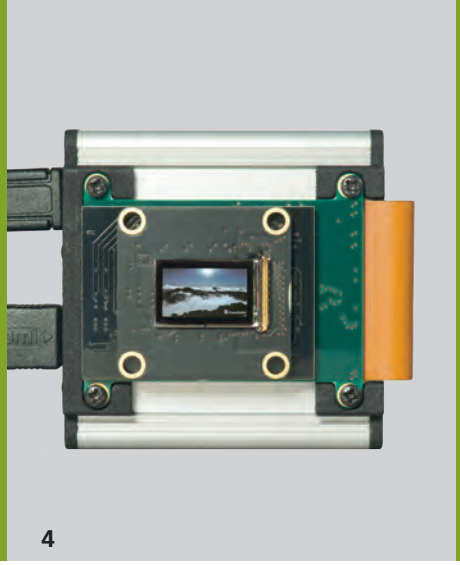
Furthermore, we use our competencies and technologies for the development of special sensor ASICs using e. g. OLEDs and photodiodes for the detection and selection of certain substances in gases as a basis for universally adaptable sensor platforms. In addition to technology and component development, we are also available for initial application studies, the production of single pieces through to small series and technology consulting and transfer.

In order to facilitate an uncomplicated transfer of the mentioned technologies and components such as microdisplays into customer-specific applications, the Fraunhofer FEP offers a selection of evaluation kits which address the various application areas such as Look-Around, AR, VR and Mixed Reality as well as gas sensor technology.

More detailed information about all available evaluation kits can be found on our website.

https://s.fhg.de/DTR

3



4

5

Evaluation Kits as Development Tools

Ultra-low power OLED microdisplays

Industrial application scenarios require the display of focused, graphical information instead of video streams. Parameters such as ergonomics, compactness and runtime of the battery play a crucial role.
Ultra-low power displays are particularly suitable for this purpose. These have a limited resolution, but an innovative display backplane design can reduce power consumption to a fraction of approx. 1 mW in typical operation, allowing small, light-weight systems with longer battery life. These displays are controlled via a SPI interface and could be realized in different monochrome colors whereas typically warm white is preferred which can achieve a very high brightness of > 35.000 cd/m². Furthermore, a second version of the microdisplay architecture is available using red and green sub-pixels thus realizing a colored microdisplay which comes with a typical peak brightness of 5.000 cd/m². Both types benefit from a wide brightness tuning range enabling applications under day and night conditions.

VUAL1120:
0.19" screen diagonal, 320 × 240 pixels, 11.8 µm × 11.8 µm pixel pitch, monochrome warm white with 4 Bit color depth
VURG1120:
0.19" screen diagonal, 320 × 240 pixels, two sub-pixels red and green (other configuration on request), 11.8 µm × 5.9 µm sub-pixel pitch, bi-color using 4 Bit color depth per color channel realizing colors in the range of green - yellow - red

720p microdisplays

The 720p microdisplays were specially developed for use in industrial AR glasses, where, for example, real-time superimposition of data or support scenarios are frequently required. Here, high frame rates and contrast ratios play a role together with low power consumption.

With a resolution of 1280 × 720 pixels, a screen diagonal of 0.64 inches and a pixel pitch of 11 µm, the 720p microdisplay offers high-quality images with low power consumption of typically ranging from 100 mW at 60 Hz to 160 mW at 120 Hz, for example. In addition, they offer simple control electronics for uncomplicated integration into wearables. The evaluation kit contains a 720p OLED microdisplay and a driving electronics which enables HDMI video interface as well as power and configuration via USB. The following versions are available as evaluation kits:

HUCW1010:
0.64" screen diagonal, 1280 × 720 pixels, 11 µm pixel pitch, 24 Bit color depth
HURG1010:
1280 × 720 pixels with red and green sub-pixels, bi-color using 8 Bit color depth per color channel thus implementing 16 Bit RG color depth. Intended for high luminance and low power applications.
HUGL1010:
monochrome green with 8 Bit color depth
HUAL1010:
monochrome warm white with 8 Bit color depth

High-resolution WUXGA OLED microdisplays

The WUXGA OLED microdisplays are suitable for VR applications with special requirements in terms of resolution, image quality, frame rates and size. They offer a resolution of 1920 × 1200 pixels on a 1 inch diagonal with a pixel pitch of 11 µm (2300 ppi) and allow high frame rates of up to 120 Hz. The display mode can be adjusted from Hold-Type to Impulse-Type to eliminate motion artifacts. The WUXGA OLED microdisplay achieves exceptionally high image quality with very high contrast ratios of 100 000 : 1 and very low power consumption. The evaluation kit includes a WUXGA OLED microdisplay and a driving electronics which enables HDMI video interface as well as power and configuration via USB. The following versions are available:

JUCW1010:
1" screen diagonal, 1920 x 1200 pixels, 11 µm pixel pitch, 24 Bit color depth
JUGL1010:
monochrome green with 8 Bit color depth
Performance:
140 mW@60 Hz
180 mW@90 Hz
220 mW@120 Hz

6


7

8

Bidirectional OLED microdisplays

Bidirectional microdisplays combine display and image sensor functions. This means that they can simultaneously display and capture images within one common active area. This is achieved by adding an additional sensor pixel to each RGBW pixel. Typical applications are intelligent data glasses with eye tracking and optical sensors (e. g. optical fingerprint sensors). The evaluation kit consists of a high-resolution SVGA microdisplay (800 × 600 pixels) with embedded SVGA image sensor, 16 µm pixel pitch and 0.63 inch screen diagonal. The associated control electronics enable easy connection of the display via HDMI and read-out of the image sensor via USB 3.0. A graphical user interface for Windows is provided for an easy configuration of the display. The following options are available:

EBCW1020:
0.63" screen diagonal, 800 x 600 pixels, 16 µm pixel pitch, 24 Bit color depth, image sensor with 8 Bit grayscale
EBGL1020:
monochrome green with 8 bit color depth, image sensor with 8 Bit grayscale

Sensors / Organic Photodiodes

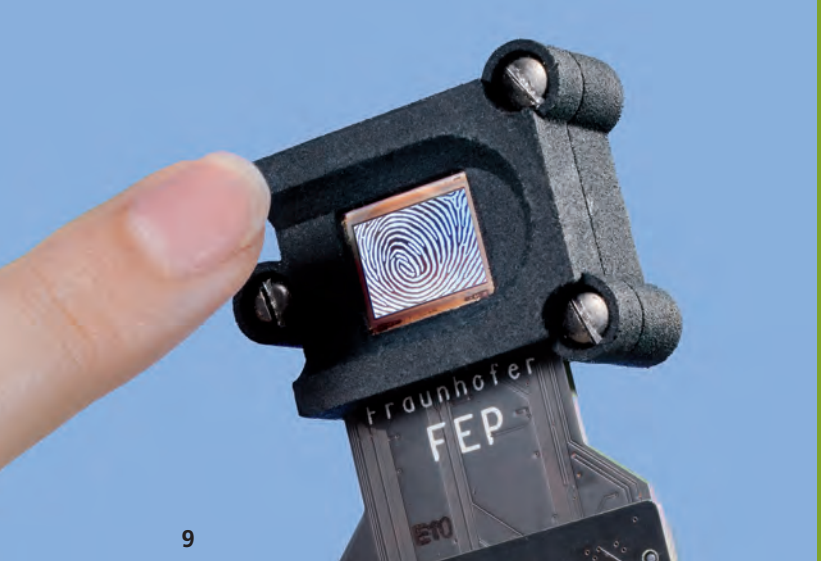
Organic photodiodes (OPD) are integrated monolithically and at wafer level on a powerful CMOS readout circuit. The advantage in comparison to established technologies is the possibility to adapt the spectral behavior according to the application. Perspectively also wave lengths outside the visible range can be detected without the use of expensive III-V semiconductors. The active layers can be processed by deposition within high vacuum, by liquid processes or by hybrid approaches. Fraunhofer FEP offers a development platform with different substrates, wafer layouts and processes for the development and evaluation of such layers and layer systems. An evaluation kit is available consisting of an SVGA image sensor, which uses an organic photodiode for detection. Read out is realized by a simple electronics via USB:

ESML1011:
0.63" screen diagonal, 800 x 600 pixels, 16 µm pixel pitch, monochrome image sensor, 8 Bit grayscale

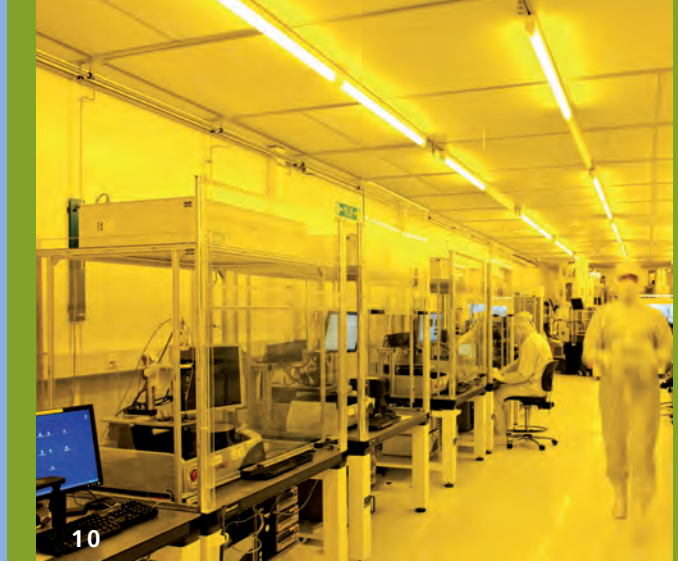
Universal optical sensor platform

A common method for measuring material properties (pH value, temperature, gas concentration, etc.) is the use of a sensor material whose optical properties change depending on the concentration. If this is optically excited to photoluminescence, the emitting light can be evaluated and conclusions can be drawn about the desired parameters. A specially developed sensor ASIC excites such sensor materials with the help of an integrated OLED and evaluates the emitting light via integrated photodiodes and amplifiers. With this evaluation kit the oxygen concentration of gases can be evaluated. The user has many degrees of freedom (e. g. excitation frequency and signal type). The decay time is a measured value for the oxygen concentration and is given as a parameter. For the process monitoring, temperature and air pressure are measured and reported in a gas box.

ASRL1010:
0.45" sensor chip, OLED areas red/blue or blue/blue, photodiodes with red color filters, sample layer for measuring the oxygen concentration



9



10

Silicon backplanes for customized and alternative applications

The display backplanes can also be used for alternative technologies in addition to OLEDs. These range from quantum dots (QDs) and Liquid-Crystal-on-Silicon (LCOS) to Micro-LEDs up to read out options of sensitive layers.
Apart from the mentioned fields of application, further branches such as medical and biotechnology as well as opto-genetics (e. g. by combining microscopic excitation light sources with embedded photodetectors) could be explored. The availability of the circuits and suitable control electronics reduces the NRE costs for experiments and enables a near-term evaluation at the same time.

Fraunhofer FEP is available and pleased to support customer-specific developments.
Please do not hesitate to contact us!

TITLE PHOTO

OLED microdisplays and sensors of Fraunhofer FEP

1 *OLED microdisplay evaluation kit*
2 *Example of a system electronics*
3 *Ultra-low power OLED microdisplay*
4 *720p OLED microdisplay*
5 *1 inch WUXGA OLED microdisplay*
6 *Bidirectional OLED microdisplay*
7 *Image sensor based on organic photodiodes on silicon. Background: NIR image*
8 *Universal optical sensor platform*
9 *Fingerprint sensor based on bidirectional OLED microdisplay*
10 *Microdisplay cleanroom of Fraunhofer FEP*

Funding references

Admont
www.admont-project.eu

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GLASS@SERVICE
www.fep.fraunhofer.de/glass-at-service

Bundesministerium für Wirtschaft und Energie
DLR Projektträger

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LOMID
www.lomid.eu

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