Fraunhofer FEP

PRESS RELEASE

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Organic-on-silicon photonic platform for advanced imagers, microdisplays and sensors

Miniaturized optoelectronic systems with emitter and/or sensor functions on a single chip can be realized with OLED-on-silicon technology. Scientists at the Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP have now used this technology, which has reached industrial maturity in OLED microdisplays so far, to develop an advanced organic-on-silicon photonics platform that can enable new generations of microdisplays and image sensors. The latest research results will be presented and actual demonstrators will be showcased at Photonics West 2023, January 31 – February 2, 2023, in San Francisco, USA.

For more than a decade, researchers at Fraunhofer FEP in Dresden have been working on OLED-on-silicon technology. Highly efficient OLED layers are integrated monolithically on CMOS backplanes. This enables the development of optoelectronic components such as light-emitting microdisplays for a wide range of applications, e. g. in smart AR, VR or MR systems or other wearables and data glasses, as well as detection components such as organic photodiodes (OPD). Together with on-chip signal processing, they can also be integrated as a combination on a single chip.

OLED-on-silicon technology has now reached industrial maturity for OLED microdisplays as displays for AR/VR data glasses. They can be found in glasses for sports, as well as in helmets for navigation display or military applications. Nevertheless, there are a variety of other applications that can be addressed with an organic frontplane on an integrated CMOS backplane. Image sensors with organic photodiodes and non-imaging applications such as optical sensors can also benefit from this technology.

At Photonics West 2023, Fraunhofer FEP researchers will now present a universal Organic-on-silicon photonics platform that can be used to develop and realize devices for such different applications in a standardized, thus cost-effective way. For this purpose, the scientists will present the latest results of the various backplanes OPD image sensors, OLED-on-silicon microdisplays or an oxygen sensor have been implemented on.

Bernd Richter, deputy division manager for microdisplays and sensors at Fraunhofer FEP, explains the new platform: "Our new photonics platform consists of an organic frontplane on an integrated Si-CMOS backplane. It enables a wide range of applications and the cost-effective implementation of variations from microdisplays to image

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sensors and optical sensors. For example, low- and high-brightness microdisplays can be manufactured with various color schemes ranging from monochrome to selected color schemes to full color RGB/RGBW. Application-specific adjustments can be made by implementing other technologies, such as spectrum, intensity or modulation, light emission, OPD sensitivity through stack design or material selection, and implementation of filters or quantum dots. In doing so, the CMOS backplane does not have to be changed, which reduces costs enormously and offers high flexibility."

The technical capabilities of the platform have been demonstrated in three application scenarios using initial demonstrators:
The first application is an image sensor using a stacked approach of an OPD frontplane on a CMOS backplane for an extended spectral range. The integrated image sensor uses an OPD frontplane that is fully vacuum processed and achieves higher sensitivity than conventional CMOS image sensors in the near-infrared wavelength range. The result is an SVGA image sensor (resolution 800 × 600 pixels) with an active area of 12.8 × 9.6 mm², an image sensor size of 0.61'' and a pixel size of 16 × 16 µm².

Secondly, an application-specific microdisplay modification was realized using different OLED frontplanes with a universal 720p CMOS backplane. The RGBW version uses the full performance of the backplane. A white OLED with color filters was used – the standard approach for OLED microdisplays. This development shows the possibilities of the technology platform by integrating multiple filters. In addition, a two-color RGRG version has been developed, resulting in a significant increase in luminance. This approach can be further optimized in efficiency and brightness. A third version dealt with the implementation of a monochrome stack for particularly high brightness as well as the possibility to double the resolution.

Furthermore, with the OLED-on-silicon platform, a third application possibility was implemented in the field of chemical sensing. Here the OLED is used as excitation light source and an integrated optical phosphorescence sensor is realized. As an example, this process was demonstrated by an optical oxygen sensor.

All these applications benefit from the technological development of OLED-on-silicon technology, which has now been transferred to the new Organic-on-silicon platform, enabling more efficient development cycles. Fraunhofer FEP scientists will be available for further discussions during Photonics West at the institute's booth no. 4515.

Application examples for the new Organic-on-silicon photonics platform for advanced image sensors, microdisplays and non-imaging sensors
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Fraunhofer FEP at SPIE Photonics West and SPIE AR VR MR 2023

SPIE Photonics West: booth no. 4515
SPIE AR VR MR: booth no. 206

1 February 2023, 9:50 AM PST | AR | VR | MR Main Stage (Level 3 West)
Plenary Event, Invited Talks 3: Light Engines
High-resolution, ultra-low power OLED microdisplays for AR, VR, MR
Dr. Uwe Vogel, Fraunhofer FEP

2 February 2023, 9:30 AM PST | Moscone Center, Room 312 (Level 3 South)
Paper 12425-38: Organic-on-silicon photonic platform for advanced imagers and microdisplays
Bernd Richter, Fraunhofer FEP