

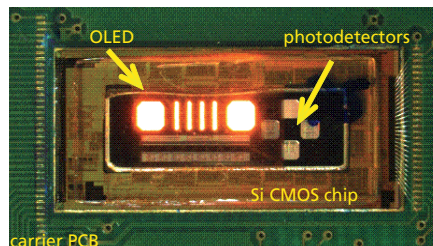
Optical fingerprint sensor based on a bidirectional microdisplay

Smart optoelectronic microsensors by OLED-on-Silicon

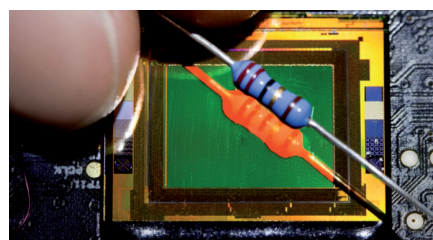
Since the beginning of silicon-based microelectronics, the combination of circuits and integrated sensors, in particular photodetectors (e.g. image sensors), has continued to develop. However, there is a specific area that cannot be covered by this technology inherently due to the silicon bandgap – efficient photoemission. This has so far been reserved to the III-V semiconductor industry and prevents the monolithic integration of light-emitting optoelectronic devices into silicon processes which are common in microsystems manufacturing. Light-emitting components for optoelectronic sensors have to be added in a hybrid way, which increases cost and reduces reliability. Fraunhofer IPMS now presents a solution.

Organic light emitting diodes (OLED) are the perfect solution. The highly efficient OLED layers can be monolithically integrated on top of silicon CMOS backplanes (referred to as “OLED-on-Silicon”).

Optoelectronic devices manufactured in this way can be designed as highly-integrated micro-scale optical illumination components and detection units on a smart single chip (adding on-chip signal processing capabilities). These can be realized by single elements (e. g., OLED-photodiode combination), in segments, or as arrays.



OLED-on-Silicon sensor test chip



Feedback demonstrator

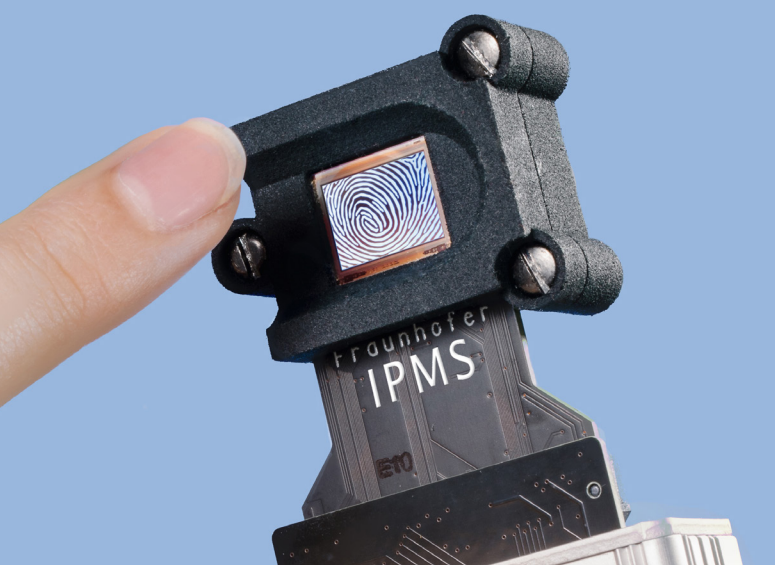
Contact

Ines Schedwill
+49 351 8823-238
ines.schedwill@
ipms.fraunhofer.de

Bernd Richter
+49 351 8823-285
bernd.richter@
ipms.fraunhofer.de

Fraunhofer Institute for
Photonic Microsystems IPMS
Maria-Reiche-Straße 2
01109 Dresden, Germany

www.ipms.fraunhofer.de



Fingerprint application



Sample of detected fingerprint

Perspective

Based on OLED-on-silicon technology, we anticipate a new generation of optoelectronic components with the following advantages:

- Monolithic OLED integration
- Real solid-state device (no moving parts, no fluids, ...)
- Reduced number of system components
- Lower size, weight and costs of the system
- Highly precise optical adjustment of the OLED emitter with respect to the integrated photodiodes
- Freely selectable shaped and designed OLED-on-silicon light sources allow new approaches in dimensional sensors
- Wafer level integration of beam-steering micro-optics

Further exploitation opportunities of OLED-on-Silicon optical sensor technology beyond the scope of this project can be expected, e. g., single-chip reflection light barriers, optical sensors requiring embedded illumination (slope sensors, stray light sensors, wave front sensors, single-chip optical heads for 3D shape detection by patterned illumination, ...), lab-on-chip modules with embedded microfluidics, excitation and sensors, optical fingerprint sensors, chip-to-chip communication and OLED-based print heads. This shows the broad market potential of this new technology and devices in several areas apart from biomedicine and biotechnology (including pharmacy), such as mechanical engineering, telecommunication, or automotive.

Development offer

- OLED-on-Silicon device integration
- R&D in OLED-based integrated optoelectronics
- Electronics design (backplane (integrated circuitry / ASIC, control, interface, ...))
- System design (sensor electronics, packaging, module)
- Product development and qualification
- Pilot production (small to medium volume fabrication)

Applications

Fingerprint sensor

- OLED for controlled finger illumination
- Photodiodes detect papillary lines as well as sweat pores with high resolution
- Microdisplay can still work as imaging device for notification, branding, ...

Particle flow sensor

- OLED stripes for fluid illumination, photodiodes for detection
- Light reflection depending on local fluid velocity and particle density
- Analyzing photocurrents and correlation functions, the fluid particle velocity can be calculated

Optical inspection

- Patterned illumination and detection of pattern distortion
- Dimensional optical measuring of surface topology

Opto-coupler

- OLED as embedded light source for integrated opto-couplers (e. g., in drivers, controllers,...)

Biosensors

- OLED for fluorescence excitation
- Photodiodes for detection

Prototypes

- Bidirectional devices
- Brightness: > 1000 cd/m²
- OLED emitter in RGB / NIR / UV
- Customer specific display and camera resolution, e. g., QVGA, XGA, ...
- Active matrix diagonal size typically < 1,0"