Advanced OLED microdisplays for near-to-eye applications

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Abstract

Near-to-eye (NTE) projection is the major approach to head-mounted displays (HMD), often referred to as "Smart Glasses", which have gained much attention during the last few years. Microdisplays based on organic light-emitting diodes (OLEDs) achieve high optical performance with excellent contrast ratio and large dynamic range at low power consumption, making them suitable for such an application. Due to their emissive nature OLED microdisplays are particularly suited for see-through (ST-)NTE augmented-reality (AR) smart glasses, since they prevent a virtual grey-shaded monitor-like perception inside the user's field of view, which is caused by the insufficient backlight suppression of non-emissive microdisplays.

However, there is a set of microdisplay specification parameters that requires continuous improvement for wide exploitation in HMD applications, either professional or consumer:

- Sun-light conditions demand high-brightness (>5,000 cd/m²) in direct relation to OLED current/power efficiency and lifetime (regularly accompanied by elevated temperature operation),
- low pixel pitch, directly correlating to die size and cost
- low-power operation for long battery life, affected by OLED efficiency and backplane architecture,

- extended color gamut,
- embedded modes for user interaction, e.g., embedded sensors and emission/detection outside the VIS (i.e., NIR, UV).

In state-of-the-art applications the microdisplay typically acts as a purely unidirectional output device. With the integration of an additional image sensor, the functionality of the microdisplay can be extended to a “bidirectional” optical input/output device, aiming for implementation of eye-tracking capabilities in see-through (ST-)NTE applications to achieve gaze-based human-display-interaction.

OLED-on-Silicon technology has become vital to emissive microdisplays in near-to-eye displays, e.g., upcoming smart glasses. High-resolution OLED micro-patterning, embedded sensors and emission spectra outside the visible enable advanced features. Low-power active-matrix circuitry CMOS backplane architecture broadens the application range. Recent developments will be reported here.

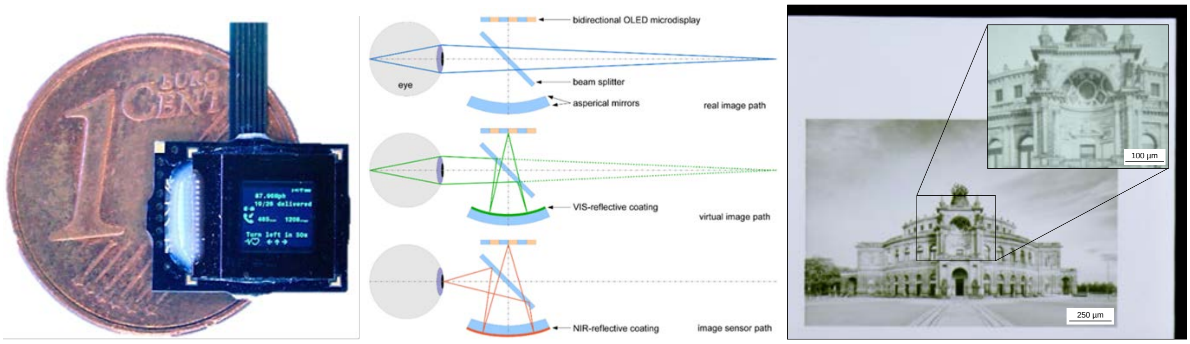

*Fig. 1. **Left**: Close-up view of 0.2” low-power OLED microdisplay; **Center**: imaging paths for bi-directional OLED microdisplays in HMD for eye-tracking; **Right**: Light microscope picture showing white OLED emission area with electron beam written high-resolution picture with varying electron doses for each point.*

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