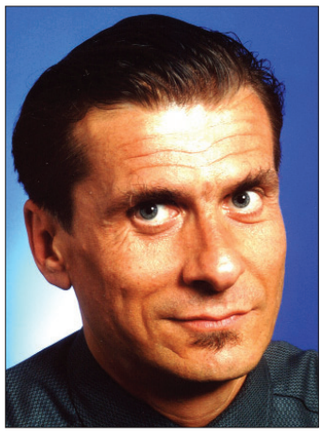
What are the real advantages of OLED-based displays?

Michael Becker, founder of Display Metrology and Systems in Germany and an expert in display characterization, considers what OLED displays have to offer.



Organic LEDs (OLEDs) have improved greatly during the last few years in terms of efficiency and lifetime, and several companies are now on the point of manufacture of OLED displays.

However, despite the reported progress of OLED performance, there are some questions for which I have not yet found any answers. Is the current OLED enthusiasm justified because the companies involved in R&D will achieve commercial success by pure momentum of their investments? Do OLED displays provide significant technical or visual improvements and/or cost reduction, or is it just one more hope for those who missed the LCD train?

When LCDs began to be manufactured on a large scale in the early 1980s, there was a pronounced functional demand which they could satisfy (calculators, watches, and so on), and almost no competition in their field of application. These days, however, most electronic display applications are covered. Will the technical improvements and/or cost advantages offered by OLEDs be significant enough for them to drive out LCDs from well established and proven applications?

I remember a similar situation in the mid-1990s, when parts of the display industry were excited by the promises of field-emission displays (*Displays Europe* Autumn 2001 p50).

Candidates for OLEDs

Which applications are the best candidates for replacing LCDs with OLEDs? Perhaps mobile communication or automotive instrumentation, both critical applications due to large variations in the ambient lighting conditions. Or maybe "fashion products" (for example mobile phones and PDAs) are ideal candidates, because their fashion cycle is shorter than the lifetime of the display.

The success of a display technology is largely dependent on the application of the final product in which the display is integrated, and on the market in which it is placed. These days, portable devices for communication and computing are driving a considerable portion of the market. That excludes bulky, heavy and fragile displays that need high voltage and power, such as vacuum fluorescent displays, field-emission displays and PDPs.

It is clearly a waste of energy to absorb about 90% of the backlight flux by a transmissive LCD with polarizers and colour filters, but these devices – far from perfect as the first super-twisted-nematic LCD screens were – have made portable computers possible.

Will OLED technology provide substantial improvements in computer monitors? In order to provide a resolution comparable to modern LCD screens, OLED displays require active matrices to address the pixels, and this time only polycrystalline silicon will do the job. There are only a limited number of companies worldwide that can manufacture such active matrices with the required size, resolution and yield. (An attractive and convincing combination is a microdisplay with OLED pixels on a CMOS substrate.)

When the problems of OLEDs have finally been solved, we will have a light, flat, emissive display with high colour saturation and fast image formation, and isotropic optical characteristics comparable to those of CRTs. Due to the specular nature of reflections from OLED displays, the contrast reduction due to ambient light will be less pronounced than in the case of CRTs. The thin front substrates of OLEDs also allow us to apply coatings for effective glare reduction, as in the case of LCD screens.

All emissive displays (transmissive backlit LCDs included) have one "natural enemy" – ambient light. To save energy and improve reduction of contrast, I would prefer transflective displays that make co-operative use of the light available "for free", instead of fighting it by increased intensity of emission, reducing device lifetime.

Reduced variations of all optical quantities with viewing direction as offered by OLEDs are nice to have, but at what price will they be offered? I'm currently quite happy with both my desktop LCD monitor and the LCD screen of my portable computer. Extensive R&D over the last few years has widened the viewing cone of LCD monitors and considerably reduced variations with viewing direction, so LCDs are no longer "privacy screens" by nature. New materials and driving schemes have also improved the dynamical properties, and large-area LCDs are starting to move into our living rooms as TVs.

It will be exciting to watch further investments in OLED R&D and in manufacturing equipment. How will this technology fare in competition with established and still improving LCD technology, and with re-emerging electro-optical effects for reflective paper-like displays based on electrochromism and electrophoresis?

The least I am expecting from this stimulating competition is a significant improvement in electro-optical properties, the ergonomic performance of electronic displays in general, LCDs included, and availability at affordable prices.