Microdisplays are tiny, high-resolution displays designed for use with a magnifying optical system. These non-direct-view devices are typically used in projection systems such as portable projectors or rear-projection TVs, or in the virtual display viewfinders found in camcorders or head-mounted display systems. These latter applications are typically referred to as near-to-eye (NTE).

Over the last several years, the projection-systems segment of the microdisplay market has moved steadily forward, but the NTE segment has experienced several ups and downs. The segment is now in a reevaluation and consolidation phase as hopes of rapid adoption of the products that use this type of microdisplay have not been fulfilled.

It is not the performance of the microdisplays that is the problem. As CRT-based viewfinder replacements, microdisplay-based solutions are more compact, use less power, and provide a technology path to higher resolutions. There have been few technical advances lately because most companies are concentrating on refining manufacturing techniques, or in many cases, just simply trying to survive. This aspect of survival has overshadowed the industry.

So how did such a situation arise? Factors include delays in microdisplay development, the general worldwide economic slowdown, the collapse of the financial markets, caution from product integrators, the slow rollout of support services like wireless 3G, and the unknown variable of consumer acceptance of novel products. The result is that anticipated revenue from microdisplay sales did not materialize, which caused financial hardships at several companies.
At the end of 2001, the landscape looked pretty bleak on several fronts (see sidebar). Things have improved in recent months, however. The advantages of microdisplays for NTE applications have not gone away. After a brief consolidation phase, the segment appears to be getting back on track to power a whole range of next-generation products.

For example, eMagin (Hopewell Junction, N.Y.) manufactures its organic-light-emitting-diode (OLED) displays by outsourcing the silicon wafer that contains all of the control electronics. Using a single cluster tool, it deposits the white-light-emitting organic layers and electrodes on top of the silicon. A second automated machine manufactures the colored filters that are placed over the display to produce a full-color image.

While the company is ultimately targeting consumer applications with its SVGA resolution (800 x 600 pixels) displays, it is now fulfilling a backlog of orders for commercial customers and shipping hundreds of OLED microdisplays per month to Kaiser Electro-Optics (San Jose, CA) for use in helmet-mounted displays for the U.S. Army’s Land Warrior Program.

“This is our first production order with reasonable volumes,” says eMagin president and CEO Gary Jones. By passing the U.S. Army’s rigorous ruggedization requirements, he thinks the company’s display technology has been validated for use in consumer applications as well. “We feel that our OLEDs are the best solution for situations where ruggedness, very wide temperature operation, instant on, and vibration insensitivity are very important,” he says.

the hopes of EVF

The heart of the NTE microdisplay market is in electronic viewfinders (EVF) for digital still and video cameras (see figure 1). Millions of products with EVFs are produced each year, which makes it a tempting high-volume market for microdisplay producers. These displays are typically less than a quarter inch diagonal and lower than average in resolution—around QVGA (320 x 240 pixels)—making them economical to manufacture. The bad news is that the unit price of the display or EVF module is low—perhaps $10 to $25—so manufacturers need to sell millions to make significant revenue.

Displaytech (Longmont, CO) entered this market in 2001. By the end of 2001, it had produced about 1 million microdisplays—impressive indeed, but not enough to make the company profitable. To succeed, Displaytech must increase volumes, which it plans to do this summer by providing displays to a new high-volume digital-camera customer (see figure 2 on page 20). The company is not focused on technology development but volume manufacturing. By

climbing out of the valley

The year 2001 may have started off with a bang for NTE microdisplay developers, but it ended with a whimper. Liquid-crystal-on-silicon (LCOS) microdisplay developer Zight (Boulder, CO), formerly Colorado Microdisplay, was touted as a major force in the SVGA-class part of the NTE market segment, in which its LCOS panels were to be used in head-mounted display systems and handheld viewing devices. By the year’s end, the company had run out of money and was planning to auction off its assets.

At the last minute, however, Three-Five Systems (Tempe, AZ) stepped in to acquire Zight’s major assets and intellectual property. (See oemagazine, May 2002, page 14.) The deal means that Three-Five will take over manufacturing of the panels; in turn, new customers can go ahead with planned product launches, while existing customers know that they will be fully supported.

No white knight arrived for inViso (Sunnyvale, CA) in the fall of 2001, however, as it also ran out of money in the absence of customer orders and had to close its doors. InViso had also developed an SVGA-resolution LCOS panel for use in head-mounted and bring-to-the-eye mobile Internet appliances. Its proprietory optics are quite good, providing very nice image quality, so we would not be surprised to see the assets and intellectual property of the company acquired by someone—maybe even Three-Five.

Financing problems also became an issue for OLED-on-silicon microdisplay developer eMagin, which had to lay off two-thirds of its workforce at year-end due to cash-flow problems. Now, the company appears to have solved its financial troubles, as it has raised $2.5 million and has received additional commitments for as much as $15 million.

Displaytech suffered several layoffs throughout 2001 and announced recently that it would restructure the company to focus exclusively on the emerging microdisplay-based EVF segment. It discontinued microdisplay-based projection development, laid off workers, and appointed a new CEO to follow through with this plan. This move followed its failed efforts with Samsung Electronics (Seoul, Korea) to commercialize a high-definition rear-projection TV. “We needed to focus heavily on EVF in order to best grow the company,” says Displaytech’s new CEO, Richard Barton. “With limited resources, it was just not possible to give projection and EVFs the support they each needed. With an established and growing business in EVF, this was clearly the right segment to focus on.”

Taking a contrary path is Epson (Tokyo, Japan), a maker of transmissive high-temperature polysilicon LCDs. It has pulled out of making these displays for viewfinders and will focus on the projection market instead. —C.C.
early 2003, it plans to be producing about 1 million displays per quarter.

Meanwhile, Kopin (Taunton, MA) is in the same boat, as it must increase production in a bid to become profitable. Recently, the company scored new design wins for EVF in camcorder products from Panasonic (Osaka, Japan) and Hitachi (Tokyo, Japan) using the company’s CyberDisplay 320, a QVGA monochrome display. These contracts should finally allow Kopin’s CyberDisplay division to move into the black.

To help win these contracts, Kopin developed a redesigned package for its microdisplay that does not use a polarizer or a frame. This allows for easier integration into the end product. The polarizer is placed on an out-of-focus optical surface in the viewfinder as a way to improve overall packaging yield.

Other development continues worldwide on microdisplays—mostly for projection systems but some still for NTE uses. For example, at Nanyang Technical University (Singapore), researchers have developed a silicon backplane design for a QVGA-resolution liquid-crystal-on-silicon (LCOS) panel that is fast enough to support field-sequential color operation. The university is also working on emissive OLED-on-silicon microdisplays.

Planar Systems (Beaverton, OR), which has been very quiet about its active matrix electroluminescent (AMEL) microdisplay technology, is back with an improved analog device. Previous versions of the AMEL display were all digital devices; the analog version was developed to address luminance variations and noise from electronic coupling. It features a new color pixel design with a more-saturated blue (one of the technology's shortcomings) and a higher white color temperature.

For designers who are looking to use a microdisplay in an NTE application, performance and system integration issues are always important. But the stability, profitability, and long-term survival of a supplier is just as critical because the loss of a vendor can mean products don’t launch or cannot be serviced—either of which can have a big financial impact on a company.

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Figure 2 A QVGA display is used in digital cameras and camcorder viewfinders.