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THE NEXT-GEN DISPLAY: MICROLEDs

Bright and efficient, they could extend the life of your smart-watch battery

The race for the next great display technology may be nearing the finish line. British chipmaker Plessey Semiconductors claims it will be the first to market with a microLED display–a screen in which each pixel is made from bright, efficient gallium nitride-based LEDs. The company plans to begin selling a monochrome display in the first half of 2018. But Plessey is, in fact, a latecomer to a crowded field that includes big names like Apple, Facebook, and cash-caffeinated startups around the world.

They're all chasing a display that offers orders of magnitude more brightness and double or triple the efficiency of today's technologies. Though it's difficult to see microLEDs being practical for screens much bigger than smartphones, there are plenty of smaller displays that desperately need brightness and efficiency, especially for smart watches and augmented-reality systems.

"This is going to be a generational shift in technology," says Giorgio Anania, CEO of Aledia, a French startup, based in Grenoble, that's developing a nanowire-based microLED display. Investors seem to agree. In January, Aledia took in US $37 million, adding Intel Capital to its investors. Its Swedish nanowire competitor, Glo, got $15 million, with Google leading the investment in August.

But it was Apple that saw the value of this technology early on. It acquired microLED display startup LuxVue back in 2014. Judging by its patent portfolio, Apple has been growing its investment, according to Eric Virey, an analyst at Yole Développement. Facebook, through its Oculus VR division, is also among the early spenders, having acquired InfiniLED, of Cork, Ireland, in 2016.

BRIGHT LIGHT: This transparent microLED display from Plessey Semiconductors appears bright even against ambient light.

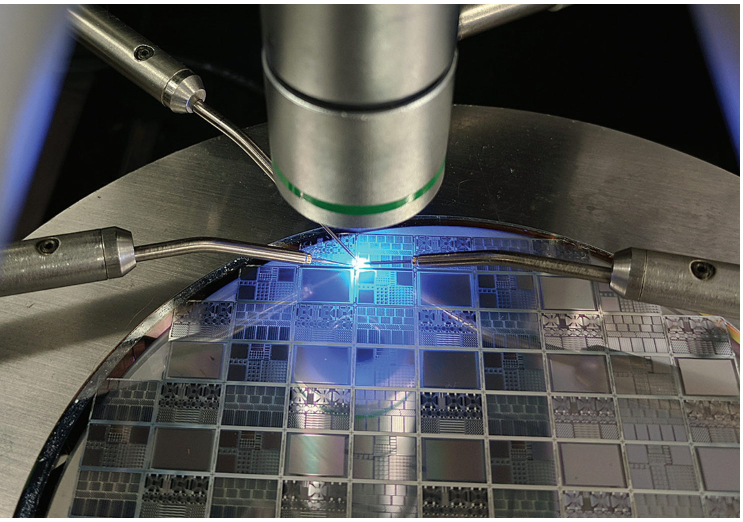
PLESSEY

The main advantages of using gallium nitride LEDs as pixels are brightness and efficiency. OLED displays, such as what you find on Samsung smartphones, typically throw off about 1,000 candelas per square meter, or nits, Virey explains. MicroLEDs should give you 100,000 nits or even 1 million. "Clearly that's overkill for a smartphone," he says, "but it's valuable for augmented reality and head-up displays," where the image is competing with the brightness of daylight.

Indeed, text was nearly invisible against anything but a black tablecloth when I tried a 1,000-nit LCD-based head-up display kit at the New York City offices of the startup Lumiode. But replacing the LCD with the company's 100,000-nit microLED unit produced clear-blue lettering even against the blue sky.

The other draw, efficiency, is no less impressive. LCDs and OLED displays are only around 5 to 7 percent efficient. But the efficiency of gallium nitride LEDs for lighting is closer to 70 percent. Efficiency degrades as you make the LEDs tinier and tinier, Anania points out, but even a 15-percent-efficient display "would be a revolution" because it would free VR systems from power cords and hugely extend smart-watch and smartphone battery life.

Right now, the revolution seems to be coming in two general flavors. Plessey and startups such as Lumiode and JB Displays are chasing what are called monolithic displays. In these, the gallium nitride LED pixels are produced in place on a chip and then connected as a unit to an array of silicon transistors that switch them on and off. The problem here is that it doesn't make



CLOSE UP: Lumiode employees examine a wafer containing microLEDs and thin-film transistors.

sense to build displays much bigger than a centimeter or two. It'd be a waste of silicon, which is expensive, and of gallium nitride, which is even more expensive.

So these firms are targeting the high-density displays needed for things like AR. Each has its own take on the technology, and much of that uniqueness has to do with dodging the fundamental thermal and crystalline mismatch between the silicon control matrix and the gallium nitride LEDs. This mismatch can cause stress-related dislocations in the LED crystal that can kill such a tiny device. Plessey's claim that it will be first is backed up by its considerable commercial experience growing gallium nitride LEDs on silicon substrate and making silicon backplanes, according to Myles Blake, marketing director at Plessey.

The second approach to microLED displays seems absurd on the face of it, yet it has the potential to work in smart-watch screens and larger displays. It involves dicing up wafers into individual microLEDs, making sure they're all working perfectly, and transferring each one to its proper place on the display (not necessarily in that order). A 42-mm Apple Watch has roughly 120,000 pixels, each one of three colors, so that might mean some 360,000 microLEDs. "You need a technology that can transfer 30,000 LEDs per second for a consumer application," says Virey.

Yet that's exactly the technology Apple is pursuing, and the company is thought to be nearing its goal. Apple did not respond to requests for comment. Virey estimates that Apple's and possibly other microLED displays will debut in products in 2019. Watch for signals in the supply chain about six months prior, he says.
—SAMUEL K. MOORE

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SENSOR NETWORK MONITORS 1,400-KM CANAL

100,000 sensors keep watch over China's huge water diversion project

As an engineering feat, China's massive South-to-North Water Diversion Project is a stunner. Three artificial canals in various stages of completion are being designed to reroute water from the country's rainy south to more than 200 million people a day in its parched north.

The massive Internet of things (IoT) network that quietly monitors the completed middle route is impressive in its own right. More than 100,000 individual sensors stud the 1,400-kilometer waterway, which connects the Danjiangkou reservoir to Beijing and Tianjin. For the past year, those sensors have been scanning for structural damage, tracking water quality and flow rates, and watching for intruders.

"The IoT monitoring system has detected and tracked 10-plus intruders and immediately reported all evidence to the local police," says Yang Yang, the technical lead for the IoT network and a professor at the Shanghai Institute of Microsystem and Information Technology (SIMIT), part of the Chinese Academy of Sciences. He says the system has even saved several people from drowning. His team will apply lessons learned from this network to other massive infrastructure projects, such as the eastern and western routes.

Yang and his team, including Zhang Wuxiong, an associate professor at SIMIT, began to plan the central canal's IoT network back in 2012 after spending two weeks traveling the length of the canal and assessing its needs.

They saw many challenges. The waterway traversed regions prone to earthquakes. The water's flow had to be controlled so that none of it was wasted. Water quality also needed to be checked periodically for pollutants or toxins. In some places, local villagers scaled the fence along the canal in order to fish or swim, creating safety risks.

LEFT: LUMIODE; RIGHT: CONSTRUCTION AND ADMINISTRATION BUREAU/SOUTH-TO-NORTH WATER DIVERSION MIDDLE ROUTE PROJECT (5)