FUTURE DISPLAYS

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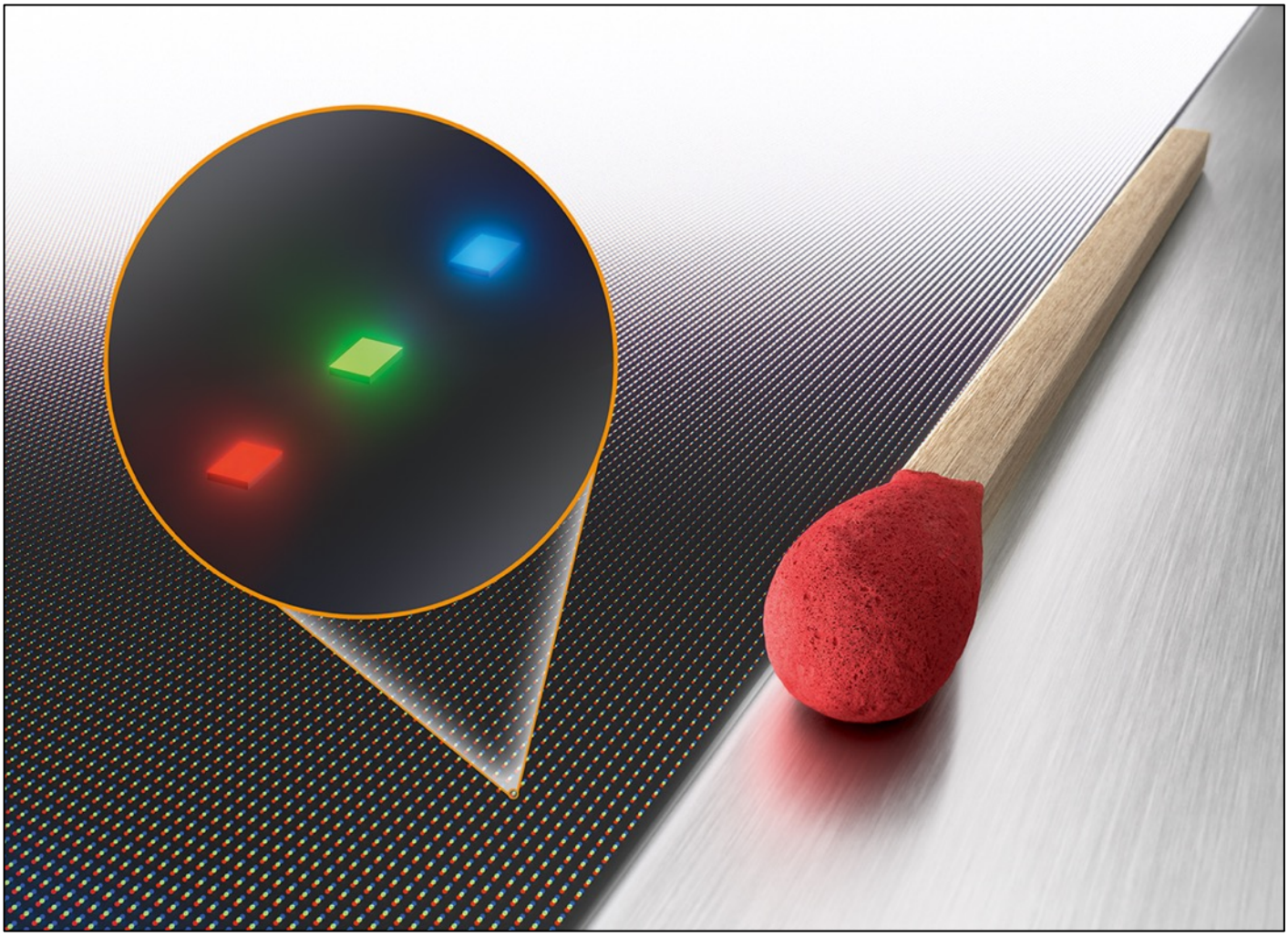


Canadian Start-Up VueReal's Solution To Mass Transferring MicroLEDs To Make Displays? Print Them

By Dave Haynes

One of the biggest hurdles slowing the development of true microLED displays has been maturing a process to accurately transfer and place what could be millions of tiny light pixels on a surface.

A Canadian start-up says it has a solution: print them.

Working out of one of many former Blackberry office buildings in Waterloo, Ontario, south of Toronto, VueReal has developed a method and equipment to mass transfer and place LED lights the size of bacteria on target backplanes (surfaces).

At the heart of the process are what VueReal calls cartridges, microchip-like electronics that are smaller and much thinner than a mobile phone micro SIM card. The cartridges, belying their size, can hold thousands of LEDs so small they need to be viewed under a microscope.

One of those tiny cartridges, seen on a table during a visit to VueReal's main office, had a depth of just six microns, and was populated by some 50,000 LEDs.

VueReal is developing enabling technology - mass transfer capability to build displays much more rapidly than conventional methods. Critical to that is doing so with 99.999% accuracy, a so-called yield rate needed to minimize flaws and hedge against products being unmarketable.

VueReal's MicroSolid Printing technology enables mass parallel transfer of micro devices – not just LEDs but equally small devices like sensors. In lay terms, printing involves passing the cartridge over backplanes and depositing LEDs.

Premium TVs, and by extension commercial displays, are touted as potential uses for microLED, but VueReal CEO Reza Chaji says the more feasible first applications are for automotive - expansive dashboard displays that improve on the current LCD versions, and lightweight, tiny footprint alternatives to conventional lighting inside and outside of cars, SUVs and trucks.

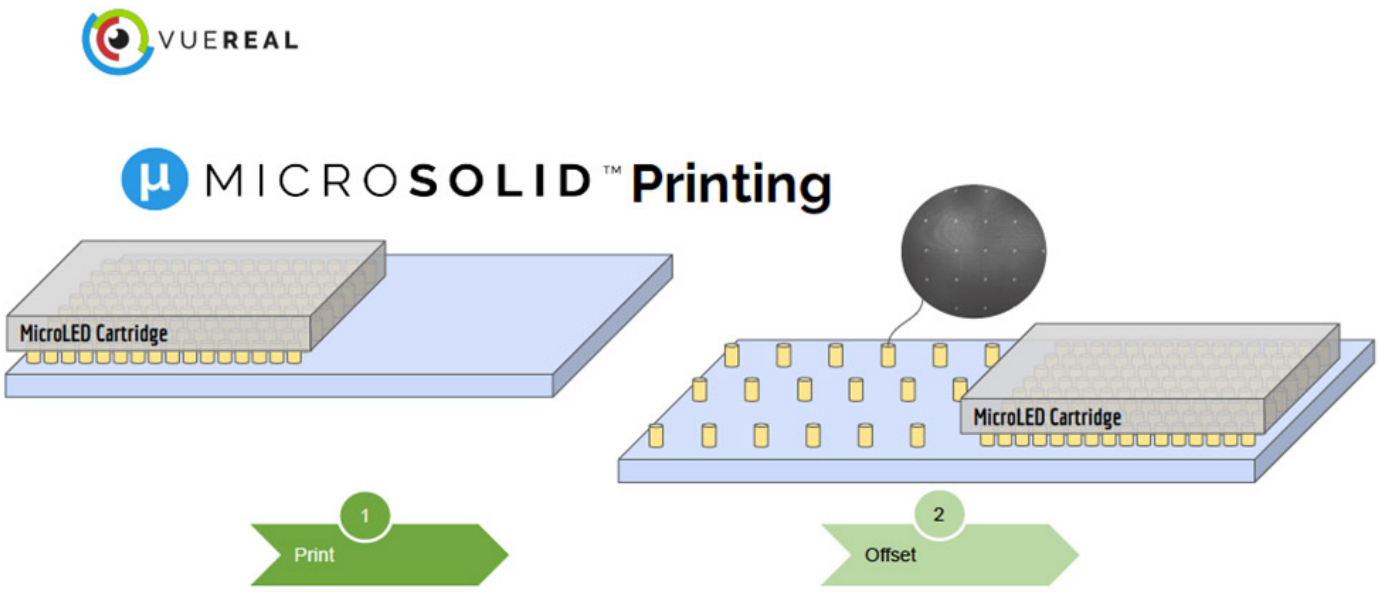
Wearables were also seen as an early microLED application, but development slowed in 2024 when Apple – a huge investor in microLED development and intellectual property – effectively stopped internal R&D work on microLEDs that were likely to be used for wearables, from watches to AR/VR tech.

Chaji says Apple's moves slowed overall microLED activity for the consumer market, but he and his team always saw more critical applications, at least in the early adopter years, for automotive. Long to mid-term, he sees plenty of potential for microLED in consumer good. He believes the VueReal MicroSolid Printing platform will pave the way for mass adoption of microLEDs in the consumer market by addressing key limitations.

Transferring Technology

VueReal has been spinning up for the past decade – the evolution of founder Chaji's work in CPUs and later in OLED. Originally from Iran, Chaji has been in Canada for more than 20 years and earned his PhD from the one of the world's top computer science and electrical engineering schools, the University of Waterloo (which is just down the road from the VueReal offices).

One of his early jobs in Waterloo was working on OLED manufacturing processes, and that



technology is now used in LG's OLED TVs. What he learned there has influenced development for what, by 2014, looked like the next OLED – the then-nascent microLED technology.

OLED and microLED have some similarities, and Chaji and his early team looked at OLED's manufacturing process as a baseline for addressing the big challenge with microLED – transferring millions of microscopic LEDs at once, and accurately.

The first iteration was termed Assisted Transfer. "We modified the back plane that can help the transfer," explains Chaji. "So instead of picking the LED and then transferring it on the backplane, we designed the backplane so that it could selectively take the LEDs. That helped a lot."

The backplane effectively pulls the LEDs into place and bonds them through an electrical arc connection.

That process was later dubbed cartridge-based transfer, and it is at the core of VueReal's platform. The company stays away from specifying microLED because the same process can "print" other microscopic electronics, such as MicroSensors, MicroChiplets, and MicroSolar devices.

"We call it printing because it has all the attributes of a printing process," says Chaji. "So if you look at printing versus typewriting, you pick the ink for every single letter, like picking and placing those letters and numbers. This is similar to the sort of pick and place that we call printing, because the cartridge has millions of LEDs, depending on what size, and what resolution LED you have on the cartridge."

The microLED cartridge populates the backplane based on parameters, such as the LED size, pixel pitch and type of LED. "So it has all the attributes of a printing method, and that's why we call it MicroSolid Printing, because it's not liquid, it's solid."

Clearing Barriers To Adoption

As with most technology, microLED has been evolving, with R&D focused on addressing several barriers to broad adoption.

The big one, as always, is cost, and the quest to leverage existing tools and processes to minimize capital investments.

Yield is another way of saying accuracy and quality control – with a goal of being able to manufacture microLED displays with few or ideally no flaws. Throughput is closely related – the effort to quickly transfer millions of micro-pixels, in a display industry that sees LED displays built one pixel at a time (albeit dizzyingly fast) using "pick and place" machines.

The others are the somewhat nerdy challenges of uniformity and maximizing what's used from the semi-conductor wafers that contain LEDs "grown" in high pressure, high temperature chambers. Higher utilization means less waste, and by extension, lower materials costs.

VueReal suggests it has addressed and cleared those barriers, with a near flawless five nines (99.999%) yield, as much as five times higher throughput and 80% wafer utilization, versus less than 50% for other solutions that try to address microLED manufacturing.

There are other technologies also being applied to address mass transfer, such as lasers, fluids, polymers and even magnets – but VueReal has settled on printing.

Enabling, Not Making

While VueReal does have some in-house production capacity and is doing early prototyping and proofs of concept work for clients in automotive and elsewhere, it regards itself as a company providing a process and tools to partners and end-users.

"Our business model is to work with companies who have different type of devices, LEDs, sensors, whatever they want to transfer into a surface," says Chaji. "We take those, we turn them into a cartridge, and then we have a set of partners that work on the tools. We offer the tools and those packaged LEDs to companies who want to make products, so that they can produce their applications."

"It's more for enabling them to get to the market, and then we pass it to the tier one suppliers," he adds.

"We are a transfer company, but in order to enable the market, we are actually doing a fully verified tool integration, or a dedicated machine with all the other tools that you need to make a product. And we're going to offer this turnkey platform as a full solution to our partners," Chaji continues.

He sees a market for helping existing display manufactures incorporate microLED – companies that know manufacturing and have capabilities, but don't have sufficient knowledge or experience with microLED.

"The other interesting market is, actually, with smaller, low to mid volume production by tier one suppliers, because with microLED, you don't need to produce high volume products to justify the initial cost. The initial setup cost is much lower. So you can do a lot of customization," says Chaji. "You can do a lot of low to mid-range kind of production volume, and that can enable a lot of new manufacturing, like tier one suppliers for automotive, who can actually produce their own displays."

While manufacturing LCDs and OLEDs requires billion dollar fabs (specialized factories), VueReal's processes and integrations with existing machinery mean a company can put the necessary equipment in their own facilities and do small volume, specialized manufacturing. The machines are larger, but the approach is akin to companies buying and running 3D printers to make prototypes or finished foods.

On a more industrial level, it is like metal fabrication shops making the investment in their own laser and water-jet cutting machines, to have rapid access and control over custom, precision work.

"This turnkey platform is essentially a printer that people can put in their office. We are looking to make it as simple as that, so people can use it and produce products," says Chaji. "The first product is a display. But if we successfully put that together now, people can use it to do other applications, as well … If they want to make medical devices. If they want to do sensor-based devices."

"We make the cartridge in partnership with companies who have different semiconductor devices. They have a turnkey platform. They buy the cartridge. They create different applications."

"So we think this setup and business model is going to have the same impact that smartphones had for the app market in 2007. When Apple launched the iPhone, nobody knew there was going to be an Uber, or an Airbnb. Now there are huge businesses out of that, and this is going to do the same thing for the manufacturing hardware."

How It Works

The MicroSolid Printing is done in passes, and by tiling cartridges, VueReal can enable a 13.5-inch sized display to be printed in one pass, and work is underway with partners to do a 65-inch display surface in a single run.

Mass transfer is at the core of production challenges. Analysts have suggested the few true microLED displays produced in larger formats like TVs and video walls (most are just miniLEDs dubbed micro by sales and marketing) would

have taken days, weeks and even months to produce using existing manufacturing processes.

Chaji suggests that using VueReal's MicroSolid Printing, properly equipped and with what he calls the right production recipe, a 55-inch microLED TV could have all of its pixels transferred in less than 10 minutes.

True MicroLED

The consumer and commercial display industries have long histories of truthiness, the term comedian and talk show host Stephen Colbert came up with to describe falsehoods portrayed as real.

Manufacturers have called video walls seamless and invisible when they weren't. They've marketed LED TVs that were really just LCDs with LED backlights. Quantum dots overlaying an LCD become, somehow, a QLED. And most recently, numerous manufacturers have loudly marketed display products as being microLED, when they do not meet the common technical definition of using LEDs less than 100 (or some analysts suggest 50) micrometers in size.

Most of what's marketed as microLED is really just miniLED.

But in the case of VueReal, it really is micro ... or what, because of all the misleading marketing, is sometimes referred to as "true" microLED. The company has worked with LEDs as small as two micrometers. That's the size of bacteria.

At display nerd trade shows and conferences such as the annual Society for Information Display's event, most microLED demonstrations are screens smaller than business cards, equipped with a photographer's magnifying loupe in front of them so that the pixels can even be seen by naked eyes.

Future Prospects For Pro AV

Between advances in OLED and fine pitch direct view LED, it is not at all clear that true microLED will ever be a big part of the mix for commercial pro AV and digital signage applications.

First, even as manufacturing processes improve and costs drop, it may always be positioned and priced as a premium product, and not deployed and used at scale.

Second, OLED R&D has continued to evolve and improve, and some of the barriers to commercial adoption like brightness and image retention have been addressed or at least made better.

Third, most people walking around major display trade shows, looking at sub 1mm pixel pitch video walls, would reasonably conclude that the current generation of product meets most customer needs for visual quality and scale. Simply put, the pro AV industry isn't waiting for microLED so that there are FINALLY great looking displays. That mountain has been climbed.

But, there will doubtless be efforts to market microLED TVs and specialty displays, and Chaji thinks there is a potential market. Already, he says, with the technology at hand, it is possible to manufacture TVs with microLED that would be cost-competitive with premium OLED.

"It actually has a path to beat OLED. If you purely look at material cost, you can actually beat OLED," says Chaji.

Is The Future Transparent?

More interesting, though, and probably offering greater possibilities, is leveraging the transparency and brightness of microLED. Because microLED pixels are so small, they make truly transparent displays feasible – with 85% or greater transparency.

It may explain why the true microLED at Samsung's mega-stands at the ISE and InfoComm trade shows in 2024 both featured transparent microLED. There are other ways to do transparent-ish displays, but LCD needs edge-lighting, OLEDs lose brightness when transparent and films and overlays are limiting and offer lower resolution.

Chaji says auto industry customers are already testing concepts. "So imagine the back, the rear glass, of an electric vehicle. It is perfectly transparent. You don't see anything. And then, when you want to charge your car, the back window shows some pattern that indicates how much your car is charged."

The same could be done with turn signal indicators, or other messaging. And if it can do that on car windows, it can also do that on shop windows or office building curtain glass. Chaji calls this public AR (the augmented reality-like experience of visuals on glass overlaying a view outside or into a different room).

Just as is done with more conventional LED technologies, display electronics can be sandwiched in sheets of building glass. But Chaji says VueReal's process enables printing on a polymer, and that can then be applied to other surfaces. That opens up the possibility of unexpected surfaces becoming displays – bringing Corning's famed Day Made Of Glass concept videos (that had everyday surfaces becoming active) closer to reality.

Another intriguing aspect of microLED is its size and how light emitters so small leave room for "real estate" on a display – so that other things like sensors can be intermingled without affecting visual quality.

VueReal's technology would make it possible to print a display that mixes microLEDs with microsensors in the same process – so a light sensor could be imperceptibly embedded right in the display face, instead of on the periphery of the screen surface.

Early On The Improvement Curve

MicroLED, Chaji emphasizes, is still at the beginning of its improvement curve, whereas mainstream display technologies are mature and subject more to tweaking than radical improvements or changes.

"So with OLED and LCD," he adds, "every improvement comes at a cost. When they want to do better backlights, they do backlight zoning. They increase the number of zones. That's adding more cost."

"If they want to do better OLED for reliability. They do two or three-stack OLED. That's what Apple did for iPad. It becomes a more expensive display."

Meanwhile, microLED is still evolving, and also leveraging earlier technologies, not only from displays, but also from the semiconductor industry. "I think microLED has much, much more potential," says Chaji, "and one of the things is that it has more future-proofing. If you want to do a new function, you don't need to change your entire manufacturing platform like you would with something like LCD."

Business Prospects

VueReal is not a pure R&D shop, and has customers, suppliers and people actively courting production deals and partnerships. They even have a sales presence in the auto manufacturing mecca of Detroit.

The company also has solid backing, including financial support from the venture wings of Samsung, LG and TDK, as well as venture capital firms. To date, the capital expenditure into VueReal is north of $60 million.

While most of what is true microLED is still in prototyping and trade show demos, Chaji says he expects the first microLED displays will be in cars within a couple of years.

It will take longer for larger displays like TVs and other flat panels, he says, but that's coming.

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