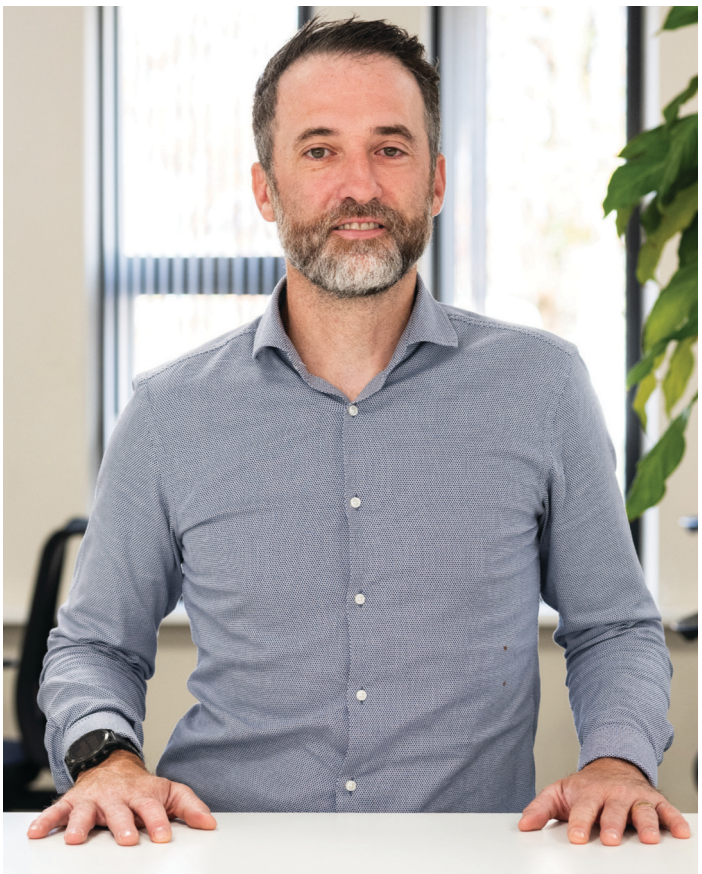
Large-area roll-to-plate(R2P) 'offers design freedom and a cost advantage'

Morphotonics' CEO, Hugo da Silva, and Head of Global Business Development, Erhan Ercan, tell **James Wormald** how the company's nano imprint lithography technology helps scale up electronics manufacturing



Morphotonics

Hugo da Silva, the CEO of Morphotonics, left, and Erhan Ercan, its Head of Global Business Development, above

'All displays require a light management layer, either in front of or behind the display panel, to optimise light performance'

EO: How did Morphotonics start off?

Hugo da Silva: Morphotonics was founded by former colleagues who used to work on Blu-Ray disc manufacturing technology at Philips. Nano-replication is one of the optical disc production steps, and this technology was further developed and integrated into larger solar panels. Recognising the absence of large-area replication equipment, the founders leveraged Roll-to-Plate (R2P) nano-imprint lithography (NIL) technology to form the foundation of the company.

The name 'Morphotonics' was inspired by the Morpho butterfly, whose stunning iridescent blue wings are a result of microscopic light-reflecting scales. As a company, we are passionate about enhancing lives visually, striving to make innovations like 3D displays and smart eyewear both high-quality and affordable.

EO: What early challenges did Morphotonics face?

Erhan Ercan: When the company was formed in 2014, there were only a handful of people, so there were challenges. But the company obtained some early contracts and was able to get off the ground quickly.

Hugo da Silva: Inspired by the replication knowledge they had from their work at Philips, they wanted to apply it to larger applications. Obviously, the CD was dying, so they left Philips and started to look for other groundbreaking applications in printing technology. That started with the solar panels, but then there was the exploration of other potential optical applications.

They moved into displays with 3D functionality and anti-glare, but also AR smart glasses on the other side. That's normal for companies like ourselves to be in different markets until finding ones that give the kind of growth expected by investors.

EO: Explain roll-to-plate(R2P) production technology and how it advances the production of display products

Hugo da Silva: Regardless of the display technology used – whether it's LCD, OLED or MicroLED – all displays require a 'light management layer' either in front of or behind the display panel to optimise light performance, but the role of the layer can vary. It might be used to collimate or trap light, to improve efficiency and reduce power consumption, for example, or it could serve specific functions such as guiding, magnifying or reshaping the photons produced by the display panel. This means the large-area nano-imprint technology can be used to create such light management layers, regardless of the display technology used.

R2P allows the processing of 'large' substrates of up to 1.1x1.3m. Microns and nano structures of all different shapes and types – from 500 microns down to 50nm – can be replicated on those large surfaces using Morphotonics' R2P technology and equipment to improve displays of consumer electronics such as smartphones, laptops and car screens.

Two major advantages of R2P technology include design freedom: allowing designers the freedom of choice to select more complicated micron and nano textures that otherwise wouldn't be manufacturable, and a cost advantage: the per-unit production cost of micron and nano textures can be made significantly cheaper due to the use of larger substrates, making them more commercially feasible.

EO: What are the main technology advances that have led to this point?

Hugo da Silva: Advances in 2D display resolutions (1080p, 4K, 8K) with increasingly smaller pixel sizes have significantly enhanced viewing experiences. However, this progress has also introduced challenges in managing the cost-effective yet high-quality manufacturing of optics to control light output. In response, display manufacturers have intensified their efforts to develop, and patent, nano-and micro-

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Morphotonics

> structured designs for displays.

To address the growing complexity of optical textures, while remaining cost-competitive, innovative and economical manufacturing solutions are essential. Morphotonics' R2P technology provides a breakthrough, unlocking new possibilities for enhanced visual experiences and display innovations.

EO: How will R2P advance display applications? Will it advance other sectors?

Hugo da Silva: Large-area nano-imprint technology enables the commercial feasibility and use of more complicated optical components inside a variety of products, with a special focus on displays. Some of those display optic examples are lenticular lenses, which are used in 3D displays, binary/blazed/slanted gratings as waveguides inside augmented reality (AR) smart glasses and anti-reflection/anti-glare surfaces for mobile device screens. Other examples include light-trapping structures for solar panels, micro needles for biosensor devices, hydrophobic structures for anti-folding boats, and many more.

[Beyond this,] we foresee semiconductor applications, especially panel-level advanced backend solutions, as a natural evolution of our work in displays. As our capability to replicate features shrinks to the nanoscale and evolves to more complex structures, such as slanted nano gratings for AR waveguides, the potential for manufacturing such products at the panel level becomes highly relevant to semiconductor applications.

EO: What does Morphotonics do differently to competitors?

Hugo da Silva: One of our key strengths is our holistic approach, considering the system-level ecosystem, rather than focusing solely from a manufacturing equipment provider perspective. We've developed extensive know-how and IP around processes and materials [that] enable us to address customer needs more effectively and efficiently. Combined with the inherent scalability of our R2P manufacturing, this positions us ahead of the competition in terms of unit economics and delivering high-quality output.

EO: What challenges do you see ahead?

Hugo da Silva: As a scale-up company, we continually refine our technology and offerings to achieve optimal product-market fit and drive widespread adoption. Our technology is commercially proven and delivers significant technical and economic benefits to customers. The key challenge ahead is expanding our customer base and strengthening relationships with existing clients to ensure our solutions become an integral part of everyday life, ultimately aiming to have a product with Morphotonics inside every pocket.

Morphotonics

The Morphotonics cleanroom: the company says quality control is crucial to mass market applications such as AR

[Before that,] we have plans to develop equipment that can replicate structures with even greater precision where the lenses are located – adding lenses with precise position accuracy on display pixels, for example – while maintaining large substrate sizes. With these two advancements, we will expand our focus beyond displays and target products in the semiconductor packaging and biotechnology sectors.

[In the future,] we see 3D display applications, followed by AR smart glasses and eventually semiconductor applications as the major market opportunities for our R2P technology.

EO: How long is the R&D journey from idea to shelf? And how do you keep up to date with advances?

Hugo da Silva: We prioritise continuous innovation and investment in R&D to maximise our impact. Having just celebrated our 10-year anniversary last summer, we've made remarkable progress from the original concept to where we are today. This success stems from constant iteration, innovation and listening closely to customer feedback. As we prepare for our next phase of growth with recent funding, we remain committed to evolving and staying ahead of technological advancements.

EO: Is new technology you're working on ever obsolete by the time it's been through development? How do you make sure you win the development race?

Hugo da Silva: The first step in bringing technology to market is to develop a platform, and that takes a really long time. Morphotonics is developing this R2P, nano-imprinting lithography platform, but there are many groundbreaking technologies that will come from it, for example.

Sometimes these new platforms come from research institutes or university spin-offs, there are several ways they can start, but when the platform is developed you can find applications for it. Obviously, some applications might fail because it involves pivoting the company or the technology into a different direction, but that doesn't mean the platform will fail, [as long as you] develop it to be robust enough with groundbreaking technology, you just innovate through the platform to get [alternative] applications.

Part of speeding up that process is about how you apply the platform technology, and how you can improve it, and that's what we've been doing. We started in solar panel technology, then we moved to displays; displays is a neighbour of AR, but to get there we need to add the precision to get from micro to nano. So we're increasing the precision of our platform as we move into more critical applications.

The first iPhone was launched as a platform, but it evolved. A lot of the parts and pieces evolved in different directions, but the initial platform, the soul of the technology – which was a user-friendly mobile phone with apps – is still there. Similarly, Morphotonics will evolve the applications of the [R2P] platform, but the soul will always be there.

EO: Tell me about the recent $10minvestment you received. Where will it go?

Hugo da Silva: A portion will be dedicated to finalising the development and commercialisation of fully automated versions of our large-area nano imprint machines. In fact, we are currently building the first unit for a customer, with delivery expected in 2025.

EO: When do you make that decision to secure further funding?

Hugo da Silva: Always. As CEO, I'll always be talking with investors or potential investors and potential partners. We have a structured, strategic business plan where we can see how much money we need to come in over the next year or two. We are in round B. Most likely, we won't need a round C until a year-and-a half or two years from now. From there, we need to end up being a profitable company.

What we really need to do

Morphotonics says R2P allows the processing of 'large' substrates of up to 1.1x1.3m

is advance the technology. So we are in need of development engineers, mechanical engineers, electrical engineers, application engineers in the field, a system architect and sales people. We're using this investment to hire people, generate demand, grow the business and advance the technology, then we go to the next round, and that's our plan.

EO: How important would you say automation is?

Hugo da Silva: If you're moving from a semi-automated line to a fully automated line, manufacturing can be scaled up and have the same precision as it used to, especially in mass manufacturing environments. Display would benefit greatly from that because, if you think about the target applications for display, they are extremely high volume.

We're going to ship our first fully automated tool to the market soon, allowing manufacturers to reach much higher yields with faster productivity, enabling them to scale up their product at the lowest possible cost and at maximum speeds. Then, if they move to even larger production numbers with more devices, they can simply add more production lines as they go.

We're always targeting mass market applications. So, if you think about other future applications such as AR smartglasses or the billions of other devices that need to be manufactured – if market predictions are true – you can imagine that requires speed, quality control and cost control, and fully automated lines give a lot more than semi-automated lines.

EO: So manufacturers need to plan automation into their lines from the start, if they're assuming it will turn into a mass volume product?

Hugo da Silva: Yes, they do. One of our recurring customers in particular started with a small line, moved to a larger semi-automated line and has now moved through to a fully-automated line, and they have clearly seen the benefit, step by step. For most of our customers, however, it depends on their volume requirements and the size of the displays (or the lenses for AR). It makes sense not to move to fully automated lines until you can clearly see the benefits.

For injection moulding, for example, if you have fully automated robots working one or two injection moulds, it's a large investment. We only do it if there is enough volume to justify it. And that's what we do, we help our customers to understand their curve. Most of the time, we start off with a semi-automated line and ramp up to a point where they need a fully-automated line.

EO: What are the key success milestones for the company?

Hugo da Silva: The 3D display market is more mature [now than it was], and we've made great progress. We have manufacturing tools installed now, and that's a very important milestone for us, proving ourselves in high-volume manufacturing. Now we're busy expanding that, getting more customers to do the same.

In AR, we have grants from the EIC for $2.4m and we have products that we are about to launch. We have customers of machines in both markets, we are expanding our base of customers in 3D and we are validating our applications. These are all important milestones that our investors have witnessed, that prove we are on the right track, and will help us gain more investment.

As more of our customers introduce their products into the marketplace and start selling them, that will generate more demand, more demand will mean they need more capacity and more capacity means they will need to buy more machines. And we'll support them on this path.

Once upon a time, a 50-inch LCD TV would cost $10,000 to $20,000 and you'd only see them in luxury hotel lobbies, whereas today they're more like $500 and everyone has one at home. Meta announced Smart Glass recently for $10,000, for example. They're not expecting massive adoption, but it's more like a starting point that will end up somewhere in the hundreds of dollars and mainstream adoption.

EO: How important is sustainability during the design and development phase?

Erhan Ercan: We have large panel scalability in our DNA, and that allows the more efficient use of materials as opposed to doing things on round wafers where you can't fit as many parts. So we have an inherent advantage with our scalability factor, to have a better use of resources.

As machine makers a long way down the supply chain, however, we don't have a lot of influence on the design aspects. Of course, we're trying to change that. One other area we are active in, for example, is anti-glare for AR products. Our approach could actually result in better and more efficient mobile displays, where the battery usage could be reduced by increasing functionality.

Hugo da Silva: To give another example, our tools can be used for mass manufacturing. With a different method, you might need three or four times as many machines to achieve the same yield. That means three or four times as much electricity and three or four times as much space required. EO