

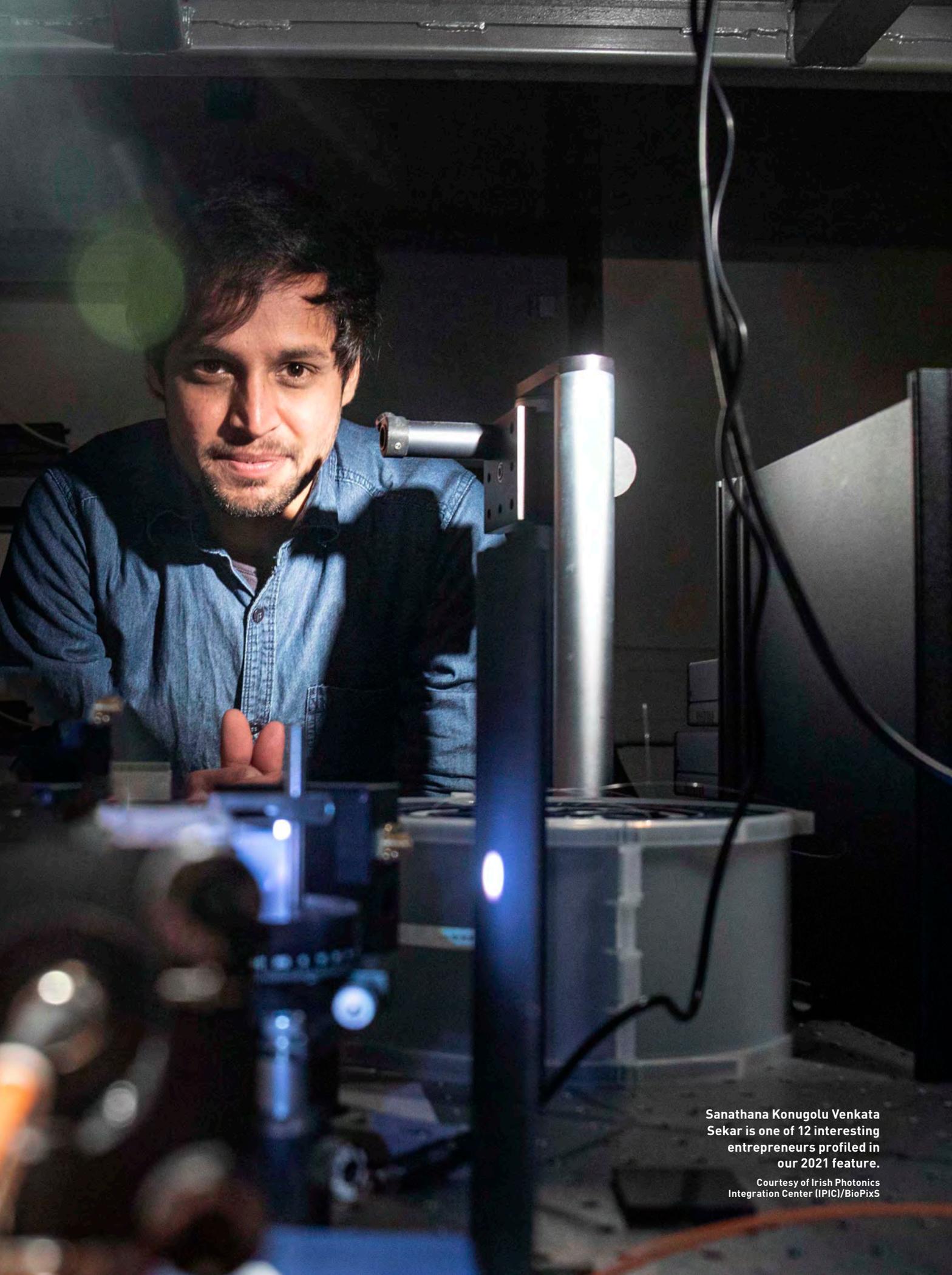
Entrepreneurs to Watch

In a new feature, OPN throws the spotlight on a selection of creative scientists and engineers—and the enterprises they're building.

In this issue, *Optics & Photonics News* begins a new periodic feature, in which we talk with a number of entrepreneurs who have used their optics and photonics background as a springboard for building intriguing new businesses and organizations.

The 12 scientists and engineers profiled in the following pages are leading companies in areas ranging from quantum technology to 3D imaging to photonic computing to vision, biomedicine and other areas. There are also a few stories of social entrepreneurship—efforts aimed at building human capital for the future.

While each of them highlights a single individual, one thing these stories make clear is that innovation is a team effort, involving the support of dedicated co-founders, mentors, funding partners and others.



Sanathana Konugolu Venkata Sekar is one of 12 interesting entrepreneurs profiled in our 2021 feature.

Courtesy of Irish Photonics Integration Center (IPIC)/BioPixS



Courtesy of Nu Quantum

Carmen Palacios-Berraquero

Quantum photonic technology—in computing, in sensors, in communications—is hot news. But to build such technology, you need a way to generate and detect single photons on demand. And the single-photon sources and detectors routinely used in the quantum physics lab are too unreliable, inefficient or awkward for robust commercial applications.

Carmen Palacios-Berraquero saw a business opportunity lurking in single photons while a grad student at the Cavendish Lab, University of Cambridge, UK. There, she developed a novel source, involving the atomically thin, 2D material hexagonal boron nitride, that had the potential to fire off high-quality single photons at room temperature, almost at the proverbial push of a button.

She began to discuss the commercial possibilities with Yuri Andersson, an experienced technology entrepreneur. The key turning point for the enterprise, according to Palacios-Berraquero, came when they joined forces with Matthew Applegate, a fellow Cambridge researcher who had invented a single-photon detection technology. With both a source and detector, she says, “the story became much more complete.”

In 2018, the trio, along with Cambridge professor Mete Atatüre, co-founded Nu Quantum, a new company working to commercialize single-photon components to enable quantum technology. The firm completed a £2.1 million seed funding round with venture-capital partners in September 2020, and has also successfully plugged into funding networks and projects of the UK government’s active effort to support quantum tech. The team has expanded from the original four founders to a current staff of 17.

Nu Quantum hopes to have its first products on the market next year, according to Palacios-Berraquero. And in the longer term, she says, “we’re going for Nu Quantum to have a key role in enabling quantum photonic applications, from computing to networks to interconnects.”

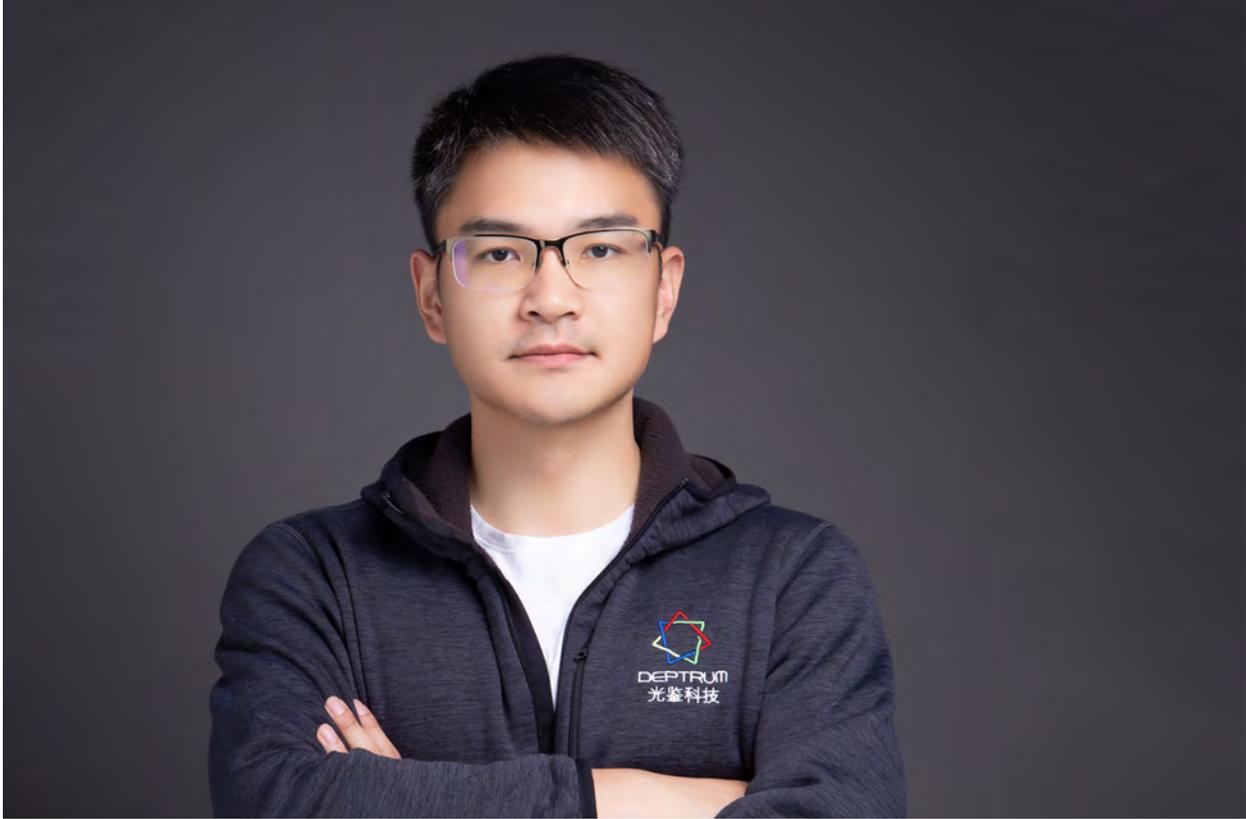
COMPANY

Nu Quantum

FOCUS

Single-photon sources and detectors for quantum tech

<https://nu-quantum.com>



Courtesy of Deptrum

Li Zhu

“The camera has a history of 200 years, and it’s always been two-dimensional—on paper or on screen,” says Li Zhu. “We really want it to be 3D.” To pursue that goal, in 2018, Zhu, along with co-founders Bo Wang and Fanglu Lu, started up Deptrum, a China-based developer of 3D-vision systems and the algorithms to run them.

Zhu—whose father is a physics teacher—showed an early aptitude for the subject, winning gold medals in the International and Asian Physics Olympiads. After wrapping up a Ph.D. in optoelectronics at the University of California, Berkeley, USA, he did a stint of several years with a top Silicon Valley tech firm, working to move 3D cameras into smartphones. When a family issue required his return to China, he took it as an opportunity to pursue the long-held goal of starting a company of his own.

Deptrum’s sweet spot is structured-light and time-of-flight cameras for 3D vision—harnessing nanophotonics and AI to solve some long-standing performance and safety issues in laser-projection depth cameras. By early 2018, the concept had attracted several million U.S. dollars worth of angel funding. An intense year of work followed building a prototype. “We got the chip to work with our first shot,” Zhu recalls. “That was pretty good, and a little bit lucky.”

On the strength of the prototype, the company was able to attract US\$50 million in additional series A, A+ and B funding. It now has a staff of around 140, more than 250 patents, and three products on the market. And Zhu sees tremendous opportunities in serving increasing demand for 3D vision for the Internet of Things—an addressable market amounting potentially to tens of billions of connected devices—as well as the mobile-payments and consumer spaces. “By the end of 2021 we’ll have hundreds of thousands of cameras shipped out,” he predicts. “Next year we’ll have millions.”

COMPANY

Deptrum

FOCUS

3D-vision solutions for the Internet of Things

www.deptrum.com



Courtesy of Y. Soudagar

Yasaman Soudagar

As a high-school pupil in Iran, Yasaman Soudagar faced a quandary. Science students could study either physics or biology, and Soudagar “fell in love with both.” She chose physics—but when her family emigrated to Canada and she entered the university system, her enthusiasm for biology reignited. The two tracks came together in the company she co-founded, Neurescence, which markets a microscopy platform geared for understanding the causes of neurological disorders.

Soudagar’s interest in neuroscience is partly personal; a family member suffered from schizophrenia and died from complications related to neurology drugs. Soudagar says her eyes were opened to how her optical research could make a meaningful contribution to understanding such diseases when she visited the lab of OSA 2009 President Thomas Baer, and was amazed at his team’s work in two-photon imaging of the brains of fruit flies.

She conceived an idea for a system that could image neural circuitry in multiple brain areas at once—crucial for studying disease mechanisms and potential therapies. Encouraged by several mentors from Optica (formerly OSA), she set about incorporating and building a prototype, with much of the work done in two-hour stints on a 3D printer at the Toronto Reference Library. The early effort also benefited from equipment donations by established firms. “It is really amazing,” she says, “how generous these companies are.”

The prototype attracted the interest of investors and others, including co-founders Taufik Valiante, a noted neurosurgeon and neuroscientist, and Sepideh Hashemi, a seasoned medical-device executive. Neurescence is now generating revenue from a hardware/software imaging product for preclinical (non-human) research on neurological diseases, and has signed a distribution partnership with Plexon, an established firm in the neuroscience space. Soudagar says that Neurescence is looking forward to its first big capital raise next year, to move the company toward human clinical trials for its technology.

COMPANY

Neurescence

FOCUS

Multi-region functional neuroimaging

www.neurescence.com



Courtesy of Luminare

Felix Kim

Even as a kid in Seoul, South Korea—where he teamed up with friends to write and publish poems, and then sold them in front of subway stations—Felix Kim was driven by an entrepreneurial spirit. When he came to the United States for his university education, he says, he sought “a unique major and technology” around which he could build his own business.

He found such an opportunity at the University of Rochester’s Institute of Optics. There, as an undergrad, he worked with the research team of Geunyoung Yoon on wavefront-sensing technology, and on miniaturizing and adapting it for complete measurements of high-order aberrations of the human eye. That ultra-precise measurement—coupled with techniques to translate such measurements into exquisitely tuned custom contact lenses—forms the basis of Ovitz, the company Kim founded with fellow students and advisers in 2014.

A key to launching the enterprise, according to Kim, was entering—and winning—“a lot of business competitions.” Those experiences both built confidence in the concept and attracted angel investors. Another milestone was a million-dollar prize from the Rochester-based Luminare business accelerator, which Kim says “really accelerated our market entry and growth.”

A big promotional push to the eye-care community in early 2020 ran into a snag, as pandemic lockdowns closed many optometry practices. Since then, Ovitz has focused on reputation-building with a small community of optometrists “to create a great story,” with a bigger rollout planned for next year.

Initially, the company is targeting the relatively small market of patients with highly irregular corneas, for whom the Ovitz technology can be life-changing. Longer term, Kim also sees opportunities in “sports vision”—potentially, he says, a market of more than US\$40 billion—and in the value of patient eye data for scientists studying causes and correction of complex vision problems.

COMPANY
Ovitz Inc.

FOCUS
Custom wavefront
guided lenses for vision
correction

www.ovitz.us



Courtesy of LIGENTEC

Michael Geiselmann

LIGENTEC makes photonic integrated circuits built on silicon nitride—a photonics-friendly material that’s also a natural fit for the semiconductor industry’s CMOS infrastructure. The company was spun off in 2016 from the lab of Tobias Kippenberg at the Federal Institute of Technology (EPFL) in Lausanne, Switzerland, where co-founder Michael Geiselmann was working as a Marie-Curie Fellow.

At the time, Geiselmann was focused on building integrated frequency combs based on high-Q ring resonators. It was, he says, “a logical step” to roll that work into a startup in photonic integration. To do so, Geiselmann, with expertise on the optics side, teamed up with co-founder Michael Zervas, whose roots were in the CMOS manufacturing world.

To get things started, the pair took advantage of Switzerland’s well-developed system of early-stage funding and business incubators. They also benefited from a “minimum viable product”—the high-Q ring resonator—that, as a building block for other devices, saw immediate demand. “From day one,” Geiselmann says, “we had something to offer that was worth paying money for to the customer.”

Since then the company has seen growing demand in quantum, lidar and sensing applications—as well as in the data-intensive “Industry 4.0,” area, where silicon nitride photonics can enable greater bandwidth and energy savings both on Earth and in space communications. Geiselmann says LIGENTEC is now “well established and growing rapidly.” Looking ahead, it’s working to expand the platform to other materials and to scale its offering to volume fabrication. On that note, it very recently announced that its processes are now available for mass production on a 200-mm CMOS line.

Such scaling, Geiselmann believes, could finally realize the long-promised potential of silicon photonics—possibly in the very near future. “Everybody’s speaking about photonic integration, but the numbers are still very low compared with CMOS,” he points out. “In five years, I believe these numbers will increase dramatically,” with customers “taping out millions of devices.”

COMPANY

LIGENTEC

FOCUS

Silicon nitride photonic integrated circuits

www.ligentec.com



Courtesy of Phutung Research Institute

Ashim Dhakal

Entrepreneurial journeys often start with a flash of insight on a new technology or an unmet market need. For the Phutung Research Institute, the nonprofit enterprise co-founded by Ashim Dhakal in October 2016, the journey began with an earthquake.

In April 2015, a magnitude 7.8 quake struck Dhakal's home country of Nepal, killing some 9,000 persons and damaging almost 800,000 homes. At the time, Dhakal was wrapping up a Ph.D. in Europe, where he had worked with Roel Baets, University of Ghent, Belgium. Dhakal might have gone on to build a comfortable career in Europe or the U.S. But his family's difficulties—and Nepal's—after the earthquake convinced him that he needed to return to his homeland to help build a scientific ecosystem there.

Using money from his own pocket, Dhakal registered the institute as a nonprofit under Nepalese law. He also leveraged his personal and professional network, attracting small contributions from local contacts, partnering with European scientists on grants, and receiving generous equipment donations from firms like Thorlabs, Lumerical and Luceda Photonics. The institute now includes 14 staff scientists, and has begun seeing its name on papers in journals such as *Optics Express* and *ACS Photonics*.

At present the institute focuses mainly on photonics, though its vision encompasses other areas such as biotech, engineering and environmental science. It emphasizes research “useful for humanity,” says Dhakal, such as a system for real-time water testing that's under development. In the near term, he hopes that the institute will be able to spin some of its research off into companies

that can contribute to the national economy. In the longer term, he believes that if successful in Nepal, it could expand with similar ventures in other countries in Asia and Africa, to help build the research ecosystems there.

COMPANY

Phutung Research Institute

FOCUS

Advancing scientific research in Nepal

<https://pinstitute.org>



Courtesy of S. Gaspard

Sanna Gaspard

Bedsores, or pressure injuries—painful lesions related to prolonged pressure on the skin—are a huge health care problem that’s hiding in plain sight. In the U.S. alone, they afflict well over two million hospital and nursing-home patients and lead to 60,000 deaths a year. And the difficulty of detecting them early means they disproportionately affect people of color.

The battle against this scourge captured the imagination of Sanna Gaspard, who learned about bedsores from a professor while pursuing a Ph.D. in biomedical engineering at Carnegie Mellon University, USA. “I realized,” she says, “that this was a health care problem that technology could solve.” That prospect led her in 2010 to found Rubitection, a startup focused on optical tools for skin health assessment and care management.

Gaspard gained initial funding by winning several business plan competitions, which financed the company’s incorporation, and via NIH and NSF grants that supported prototype development and initial patient testing. Last year Rubitection also garnered a US\$300,000 award from the Luminare accelerator. Such competitions and accelerators, Gaspard notes, have helped to raise the company’s visibility and to forge connections with potential corporate and medical partners. “I’m a huge proponent of business plan competitions,” she says. “It’s good exposure to investors and it’s great press.”

Gaspard says Rubitection is “networking with investors to close its first official capital raise by October,” to complete early product tech development. It’s focusing initially on the market for detecting bedsores and diabetic foot ulcers. But the ultimate vision is much larger.

“I want Rubitection to be the go-to, standard tool for skin health assessment and care management,” Gaspard says, not just for bed sores but for general wound care, chronic conditions and skin cancer risk assessment. In the long term, she’s looking to take the solution global. “We really hope to democratize skin health assessment—to make it easy for anybody, and applicable to all skin tones.”

COMPANY

Rubitection

FOCUS

Optical tools for skin-health assessment and care management

<https://rubitection.com>



Courtesy of B. Buades

Bárbara Buades

As a student in the ultrafast-photonics lab at Spain's ICFO, Bárbara Buades was accustomed to thinking in timescales of femtoseconds (10^{-15} sec). But obtaining optical components to drive those ultrafast experiments could be painfully slow—sometimes involving weeks of product comparisons, research on the offerings of different companies, and back-and-forth on price quotations and delivery times.

The opportunity for a better way struck her when she was arranging travel using the online booking tool Skyscanner. The tool enabled quick sorting and comparison of flights, prices and schedules from numerous different carriers. "I was like, 'Okay, this technology exists—why does it not exist for us?' And I got annoyed."

Out of that frustration, Buades—along with co-founder James Douglas from the University of Oxford, UK—started MeetOptics in October 2018. After querying engineers and researchers on their needs and pain points, the pair built and iterated on an online platform that would let users search for and compare optical components with something like the ease of online flight booking. Three years later, the platform includes some 40,000 products from 14 major vendors (who pay an annual fee to be included), and the MeetOptics staff has grown to 10 persons.

Looking ahead, Buades says the company will focus on expanding its universe of products and vendors, moving into the Asian market, and boosting its service offering to include advice to users on specific components. "We want to make the platform," she says "the place to search for all products related to photonics technology."

COMPANY

MeetOptics

FOCUS

Specialized search for optical/photonic components

www.meetoptics.com



Courtesy of Lightmatter

Nicholas Harris

During his Ph.D. studies at the Massachusetts Institute of Technology (MIT) in the early 2010s, Nick Harris invented and developed programmable photonic systems, eyeing applications in quantum computing. But he wanted a way to put the technology to work in an area that might have more immediate impact—and on which he could build a company. The explosion of AI and machine learning showed the way and, in 2017, led to his co-founding of Lightmatter, a developer of photonic chips for next-gen computing.

Harris says the AI boom meshed well with his interest in silicon photonics and in “building amazing technology.” But he wasn’t completely convinced until he and co-founder Darius Bunandar won several prestigious business competitions at MIT and Harvard. Those wins attracted investor interest, and, says Harris, “it became pretty clear that this might be a good idea.” Series A funding of US\$33 million followed in 2019, with another US\$80 million in a series B round in 2021.

Lightmatter has put that money to work developing a production-ready suite of products—including an AI accelerator chip, an accompanying software stack and a wafer-scale interconnect offering—that it plans to roll out to early adopters in the coming year. It has also boosted its staff to more than 75 persons, including top sales, marketing and product-launch talent recruited from Silicon Valley firms. The journey from early academic R&D to the cusp of a commercial product launch has, Harris says, been “a huge learning experience.”

While Lightmatter is a play on computing’s AI future, Harris and his team also seek to reduce that future’s potential environmental footprint. The company’s photonic chip, he points out, draws just over one-quarter of the power of the electronics-based chip of a leading competitor. “The U.S. Department of Energy has estimated that about 10% of the planet’s energy consumption will go to compute and interconnect by 2030,” Harris says. “We want to take a chunk out of that.”

COMPANY

Lightmatter

FOCUS

Silicon photonic chips for AI

<https://lightmatter.co>



Courtesy of T. Mhlanga

Thandeka Mhlanga

Thandeka Mhlanga says she began to see education as “the tool that will get me from point A to point B” at age eight, after the untimely death of her mother. Her commitment to education’s role in creating economic value eventually led her to co-found Nka’Thuto Edu Propeller, a nonprofit enterprise working to fill the pipeline of STEM entrepreneurs in South Africa.

Mhlanga studied physics at the University of Johannesburg, and gained experience with lasers and Bessel beams in vacation work in the lab of Andrew Forbes. She later joined South Africa’s CSIR for master’s research in photonics. But after that she switched to business school, where she “got quite excited” studying business cases—and became convinced that an entrepreneurial spirit should “be introduced much earlier in the career development of a scientist.”

With that in mind, she reached out to CSIR colleague Thulile Khanyile, and the two co-founded the Nka’Thuto nonprofit in mid-2016. Nka’Thuto works to foster entrepreneurial thinking early, through a skills-development program for elementary and secondary school students that combines hands-on technology R&D training with a business boot camp (including a pitch competition) on taking technology ideas to market. The organization currently works with a network of 35 partner schools, and has interacted with more than 6,000 learners over the past five years.

Mhlanga admits that COVID-19 has raised considerable challenges for the young Nka’Thuto project—both in the loss of a major sponsor and in the difficulty of organizing live events. The nonprofit has shifted to hybrid digital–live approach, which she notes has been “a bit tricky,” because not all of the program’s learners have access to data and devices. The team is also working to attract new sponsors, she says, to deliver on its long-term vision: building sustainable communities in South Africa by instilling “an entrepreneurial mindset” at an early age.

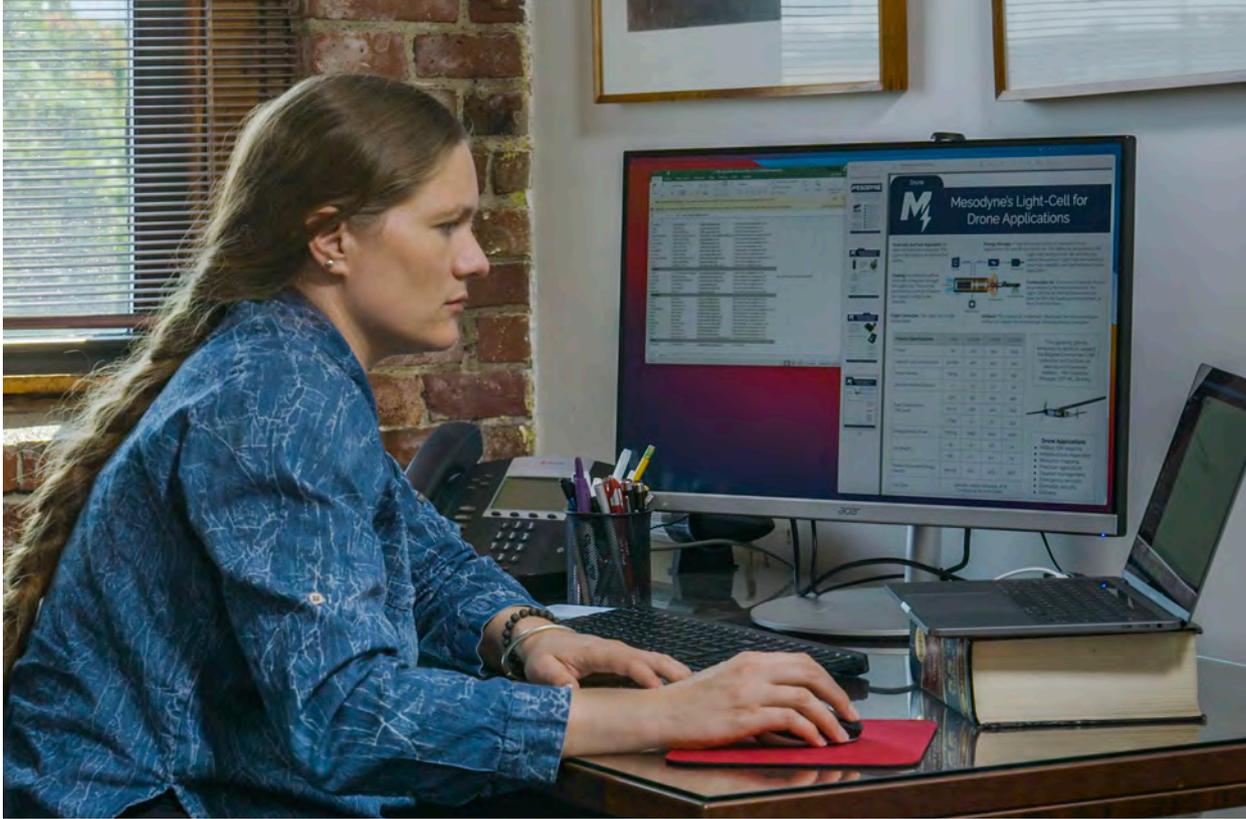
COMPANY

Nka’Thuto Edu
Propeller

FOCUS

STEM entrepreneurship
in South Africa

www.nkathutoedu.org.za



Courtesy of Luminare

Veronika Stelmakh

Mesodyne, according to its co-founder Veronika Stelmakh, is building “a new kind of power generator—one that enables reliable, compact, quiet, efficient power generation from any fuel, anywhere, any time.” That enterprise rests on an innovative nanophotonics-based system for harvesting photovoltaic electricity from heat. The system was co-developed and demonstrated by Stelmakh and co-founder Walker Chan during Ph.D. studies at MIT’s Institute for Soldier Nanotechnologies.

Mesodyne’s LightCell power generator consists of a microcombustor, which burns small amounts of fuel to create heat; a metallic nanophotonic crystal, which tunes the infrared radiation to an ideal set of wavelengths; and photovoltaic cells that convert those wavelengths to electricity. In 2017, a prototype built by Stelmakh and Chan set what was then an efficiency record for thermophotovoltaic energy conversion. “We decided, okay, there’s really something here,” says Stelmakh.

Going from the lab to building a company was, says Stelmakh, “the most exciting thing I’ve ever done, but it was definitely challenging.” Smoothing the transition were entrepreneurship programs at MIT and support from the NSF Innovation Corps (I-Corps), Chain Reaction at Argonne National Labs, Techstars, and other programs such as the Luminare accelerator, as well as numerous government grants. She also credits the team that she and Chan are building. “There’s a lot of people behind Mesodyne who are making this possible,” she says.

Mesodyne is now finishing prototypes for two initial contracts, both in defense—one to power drones, and the other for stationary power. The focus in both cases is semi-autonomous or remote applications for which batteries don’t provide sufficient endurance time. As the company works on scaling the technology and bringing costs down, Stelmakh hopes that it will be able to move into more general markets, such as reliable, clean, energy-efficient backup power generation and waste-heat recovery.

COMPANY

Mesodyne Inc.

FOCUS

Compact thermophotovoltaic energy systems

www.mesodyne.com



Courtesy of Irish Photonics Integration Center (IPIIC)/BioPixS

Sanathana Konugolu Venkata Sekar

Sanathana Konugolu Venkata Sekar showed an early knack for optics—and for building things. As a boy in India, he took apart binoculars and experimented with lenses to prove to himself that a lens really could invert an image. Much later, while working as a researcher in Ireland, he co-founded BioPixS, which creates standardized tissue “phantoms” for biophotonics research.

Phantoms are materials that mimic the optical properties of human tissues. Konugolu Venkata Sekar became passionate about their potential while a Ph.D. student at Politecnico di Milano in Italy. There, he learned that while tissue phantoms are widely used, they are poorly standardized across labs. A more uniform approach, he realized, could solve “one of the big bottlenecks” in biophotonics, getting new technologies to the clinic far faster. It would also, he saw, reduce the number of animals exploited in preclinical research.

After taking a research post at the Tyndall National Institute, University College Cork, Ireland, he co-founded BioPixS as a spinoff in mid-2020, with Stefan Andersson-Engels and David McGovern. The signing of new customers after only a few months vindicated the initial idea, and BioPixS has since been able to attract €1 million in funding from additional sources.

Starting up in a pandemic year created challenges—and opportunities. For a time, with access to labs and facilities curtailed by COVID, Konugolu Venkata Sekar was making phantoms “of the highest quality”

in his apartment building’s garage to fulfill customer orders. Yet BioPixS is also supplying phantoms for VASCOVID, an EU-funded project for monitoring microvascular health in COVID-19 patients.

Longer term, Konugolu Venkata Sekar is convinced that better tissue phantoms will accelerate biophotonics, from research through clinical translation and day-to-day use. “I strongly believe,” he says, “that it’s going to change the success rate of biophotonics devices at every possible level.”

COMPANY
BioPixS

FOCUS
Standardized tissue phantoms for biophotonics applications

www.biopixstandards.com