Researchers investigated agave plants to understand how they store water.

J. Simpson / CINVESTAV

HORTICULTURE

THz Study on Agave's Drought Resistance

Terahertz spectroscopy and imaging reveal how the desert plant is able to retain water.

Scientists in Mexico used terahertz spectroscopy and imaging to probe agave's ability to retain water in drought conditions (Appl. Opt., doi: 10.1364/AO.547952). They studied a plant called *Agave striata*, which contains fructans—polymer chains of fructose molecules.

The team removed individual leaves from greenhouse-grown plants, rinsed them with deionized water and imaged them with a spectrometer in transmission configuration. To study the hydration dynamics of the fructans, the scientists switched the spectrometer to attenuated total reflection mode and inserted a prism between the aqueous fructan solution samples and the terahertz emitter and receiver. A femtosecond fiber laser with a frequency range of 0.1 to 2 THz powered the spectrometer in both scenarios.

The imaging revealed two regions inside each leaf: an outer layer of tissue containing 30 to 40% water by weight, and an inner core made of more than 70% water. The outer layer of the leaf contains chloroplasts for photosynthesis and protects the inner water-storage system.

The absorption spectroscopy of the fructan solution showed that each fructan chain bonds to roughly 320 water molecules—a water-retention capacity two to four times greater than other types of carbohydrates such as maltodextrin. —*Patricia Daukantas*

optica-opn.org/news/0525-agave

DISPLAYS

Eco-Friendly Quantum Dot LEDs

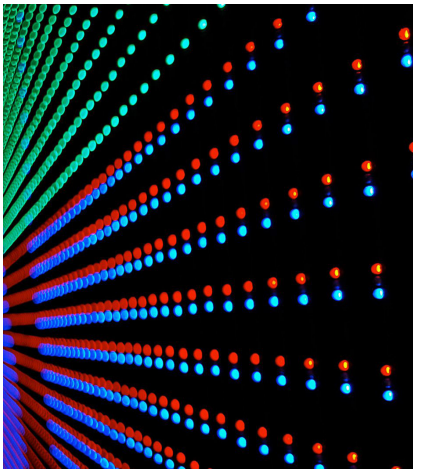
A new type of heavy-metal-free LED offers pure-blue emissions and near-unity photoluminescence quantum yield.

Quantum dot light-emitting diodes (QLEDs) have several advantages as a display technology. But most quantum dots are made of heavy metal ions like cadmium, which are toxic to humans and the environment. Now, researchers in China and Australia have created a new type of heavy-metal-free quantum dot with pure-blue emissions and near-unity photoluminescence quantum yield (Nature, doi: 10.1038/s41586-025-08645-4).

Quantum dots made with an alloy of zinc selenide and tellurium (ZnSeTe) have shown promise as a safer alternative to conventional metal-based quantum dots. But increasing the tellurium content to shift the emission peak toward the pure-blue region leads to aggregation of tellurium atoms, resulting in color impurity and structural instability.

The team discovered a strategy that incorporates sulfur, in complex with the organophosphorus molecule triphenyl phosphite, into the precursors of ZnSeTe quantum dots. The sulfur atoms inhibit the formation of tellurium aggregates by redistributing the placement of charge carriers around the tellurium atoms, promoting the formation of evenly alloyed ZnSeTeS quantum dots.

"Our research team has developed a new type of quantum dot that matches or even outperforms traditional cadmium-based QLEDs, but in a safer and more sustainable way," said study author Guohua Jia, Curtin University, Australia, in a press release accompanying the research. "Our quantum dots emit a pure and vibrant blue light with an impressive 24.7% efficiency, which is among the highest recorded for blue QLEDs."



Researchers developed quantum dot light-emitting diodes that are free of heavy metals.
Curtin University

The resulting homogeneously alloyed ZnSeTeS quantum dots also show a narrow spread of emitted wavelengths (17 nm centered at 460 nm) and a long operational half-lifetime close to 30,000 hours with a luminance of 100 candelas per square meter. Their performance rivals state-of-the-art, commercially available cadmium-based blue QLEDs, with the added benefit of being safe for the environment. —*Meeri Kim*

optica-opn.org/news/0525-qleds

The global market for quantum dots is expected to reach **US$24.24 billion** by 2032.

RapidEye / Getty Images

Patient undergoing photodynamic therapy for basal cell carcinoma.

BIOMEDICAL

Better Light Therapy

Photodynamic therapy (PDT) involves injecting light-sensitive molecules into the body that, when illuminated, generate highly reactive oxygen species that kill diseased cells while leaving healthy tissue unharmed. But current PDT agents are activated by red light, which only penetrates a few millimeters into the body, and the response is too weak for effective treatment. Now, cyanine–carborane salts may offer a solution. Cyanine dyes can be tuned to absorb near-IR light, strengthening the photoactivation further into the body, and the carborane cluster has been found to reduce unwanted toxicity.

In this work, the team optimized the composition of the carborane cluster to enable more precise and effective targeting of breast cancer cells (Angew. Chem. Int. Ed., doi: 10.1002/anie.202419759). Initial investigations showed that two of the candidate compounds have the right molecular energy structure to enable efficient absorption of light at 850 nm. *In vitro* tests showed that illuminating these molecules with near-IR light can suppress the proliferation and migration of metastatic cancer cells. When the compounds were injected into mice, PDT treatment eliminated primary breast tumors without apparent side effects. —*Susan Curtis*

optica-opn.org/news/0525-pdt

OPTICS

The Key to Negative Refraction

Negative refraction is an exotic optical phenomenon in which light propagating from one medium to another bends not toward but beyond the normal. It has been observed at optical frequencies, but losses have so far hindered the realization of a number of proposed applications, like optical invisibility cloaks. Part of the problem lies in precisely fabricating resonators on nanometer scales.

Now, scientists have carried out detailed atomic simulations and found that the much-sought-after effect should arise as an emergent phenomenon as atoms undergo collective scattering when held in an optical lattice (Nat. Commun., doi: 10.1038/s41467-025-56250-w). They simulated an infinite series of 2D planes of atoms, in which atoms are separated by distances smaller than the wavelength of light. They modeled two kinds of electronic transition that are characteristic of certain metals—a two-level transition and a four-level process.

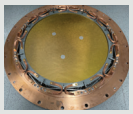
Working out the effect of the atoms on an incoming optical laser beam, they found that the scatterings experienced by the light induce a collective behavior, which they term transverse Bloch band resonances—an analogy of electron conduction bands in crystal solids. These collective excitations travel in the direction determined by light-mediated interactions between the atoms, which can be inverted compared with the normal propagation path, resulting in the signature of negative refraction. —*Edwin Cartlidge*

Lancaster University

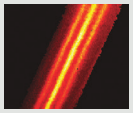
optica-opn.org/news/0525-atoms

In the Spotlight ...

Here is some interesting research recently highlighted in Optica Publishing Group's *Spotlight on Optics*:



Johann Toudert summarizes an *Applied Optics* paper that reports on **a measurement system that was developed for the ground testing of focus in SPHEREx infrared space telescope optics**.



Galan Moody covers an *Optics Express* study on an advance **toward harnessing sound to control light at the quantum level by embedding gated InAs quantum dots in surface acoustic wave cavities.**

For more on this and other research in the spotlight, visit opg.optica.org/spotlight.

Concentric rings of microscopic structures enable a flat lens to focus light at wavelengths across the visible range.

Menon Lab, University of Utah

DEVICES

Picture-Perfect Flat Lens

Researchers at the University of Utah, USA, have engineered a flat lens that delivers the optical performance needed to capture full-color pictures of distant astronomical objects (Appl. Phys. Lett., doi: 10.1063/5.0242208).

The lens is based on the idea of a Fresnel zone plate, in which a series of concentric rings etched on a flat surface diffracts the incoming light so that it converges at the desired focus. While some large-aperture versions of these flat lenses have been designed for space applications, strong chromatic dispersion has restricted their use to single-wavelength imaging. The researchers believe that a modified design, called a multilevel diffractive lens, could overcome that limitation. In these lenses, the concentric rings are formed from micrometer-scale surface structures, which enable more precise and efficient manipulation of the incoming light.

By using computer simulations to analyze the optical performance produced by microstructures with different geometries, the team designed a pattern of rings that could effectively focus light at wavelengths ranging from 400 to 800 nm. The optimized configuration, which requires 10,000 concentric rings with a fixed width of 5 μm and heights varying between 0 and 2.4 μm, yields a lens with a diameter of 100 mm, a focal length of 200 mm and a numerical aperture of 0.24.

Tests showed that the fabricated lens could produce focused spots at 17 separate wavelengths within the target range. The researchers then incorporated the lens into a telephoto camera, producing a color image of the moon that resolved various geological features, such as titanium-rich volcanic flows, that cannot be seen with standard systems.

The team also assembled a hybrid telescope that combines the microstructured lens as the primary focusing element with a refractive lens as the eyepiece. This hybrid instrument was used to image terrestrial objects as well as the lunar surface, while measurements confirmed that the telescope could accurately focus light across the visible range. —*Susan Curtis*

optica-opn.org/news/0525-flat-lens

The fruit-sucking moth, *Eudocima aurantia*.
J. Kelley

BIOLOGY

Optical Illusions Hide Moth in Plain Sight

Nanostructures on the flat wings of the insect give it the appearance of a leaf with 3D features.

New work looks at how the fruit-sucking *Eudocima aurantia* moth mimics a leaf—not only in coloration but in appearance of shape. The flat wing features surface highlights that make it look like it has the 3D midrip (large vein down the center of a leaf), veins and curvature of a crumpled leaf.

The researchers photographed specimens from overhead while altering the illumination angle to investigate the angle-dependent reflection properties of the wings (Curr. Biol., doi: 10.1016/j.cub.2025.01.029). Using stereo microscopy, they observed that all of the scales were oriented in the same direction. This means that angle-dependent changes from reflection were caused by differences in scale shape.

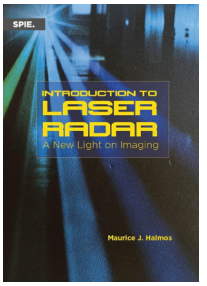
The team found that the crumpled-leaf look of the moth is achieved with a combination of structural and pigmentary coloration. Specialized scales with morphology similar to that of a thin-film reflector combined with structural coloration undergo scattering and color mixing—creating a "shiny" brown appearance in the regions of the wing generating directional reflections. In contrast, the nonspecialized scales look brown because of their pigmentation.

The reflective nanostructures are only found on the parts of the wing surface that would be convex on a leaf. The team says the directional reflections show an evolved "3D shape mimicry" adaption. *—Rachel Sender*

optica-opn.org/news/0525-moth

BOOK REVIEWS

Introduction to Laser Radar: A New Light on Imaging



Maurice J. Halmos, SPIE Press, 2024

This book is an outgrowth of the lecture notes provided by the author to his students at the Raytheon corporation, where he developed lidars. Originating as laser rangefinders for long-distance measurements, lidar has evolved as the ideal technology for a number of applications in disparate fields like industrial and topographic telemeters, remote sensing and mapping, autonomous vehicles and archaeology. This agile volume offers a well-balanced introduction to the related principles and technologies. It starts with three chapters on the laser transmitter, the receiver and the lidar constitutive equations, followed by three shorter in-depth chapters on detection statistics, resolution and light waveforms. Then, we find an extensive chapter on modern coherent detection lidars, with two short complementary chapters on the choice of waveforms and the use of single-photon detectors. A final chapter about present and future applications summarizes the state-of-the-art technologies and products.

Review by Silvano Donati, University of Pavia, Italy.

Simulating Speckle with Python

Joseph W. Goodman, SPIE Press, 2024

The latest book by Joseph Goodman contains careful discussions of a large number of topics dealing with the multifaceted aspects of speckle phenomena analyzed with the Python programming language. Within this context, the author succeeds in presenting a comprehensive analysis of physics-based and statistics-based methods dedicated to the simulation of speckle in a variety of situations ranging from propagation to phase vortices to polarization. A set of illustrating examples covers a wide range of difficulty. The content of Goodman's book makes it suitable for a large audience ranging from undergraduate students in optics and photonics to researchers who want to learn more about speckle phenomena.

Review by by Christian Brosseau, Optica Fellow and professor of physics, Université de Bretagne Occidentale, Brest, France.

The opinions expressed in the book review section are those of the reviewer and do not necessarily reflect those of OPN or its publisher, Optica. Read the full reviews at ***optica-opn.org/books****.*

FUNDING

RPO Snags Funding

Optical solutions company Rochester Precision Optics (RPO), USA, announced in early March that it had secured a US$50 million financial commitment.

According to the company, the funding comes from a combination of private investors and customer promises based on contracts that RPO has won for future projects. RPO says the funding will be used to expand all of its operations, including "scaling production capacity, advancing optical technology innovation and expanding its highly skilled workforce."

The vertically integrated company offers customers support from design to manufacturing with high-volume production capabilities in expertise such as polymer optics, precision glass molding, electro-optical systems assembly and diamond turning. With the investment, RPO says it plans to compete with international groups across the medical, security, industrial and critical product fields.

—Rachel Sender

optica-opn.org/news/0525-rpo

RPO's night vision lens.

RPO

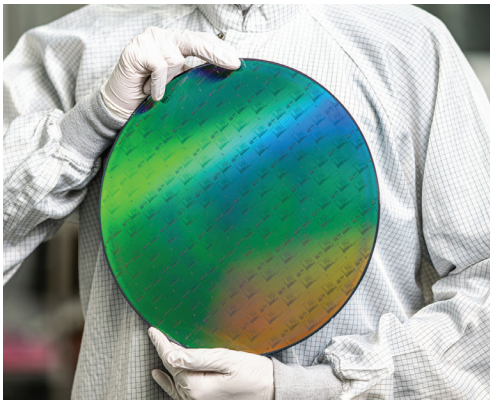
TECHNOLOGY

PsiQuantum Chipset

The US-based quantum computing company PsiQuantum in late February announced the release of Omega—a quantum photonic chipset built for utility-scale quantum computing (Nature, doi: 10.1038/s41586-025-08820-7).

A significant obstacle to practical quantum computing is the ability to manufacture quantum chips in the volumes required to build a commercially viable machine. Producing a quantum computer with fault tolerance and full error correction, which PsiQuantum says are essential characteristics for a useful device, requires a very large-scale system with qubits in the millions. The company says that a photon-based approach to quantum computing can solve these scalability problems by leveraging existing semiconductor manufacturing processes and cryogenic technologies.

PsiQuantum says that the Omega chipset integrates high-performance single-photon sources, superconducting single-photon detectors and a next-generation optical switch into a silicon-based chip that can be produced with a high-volume manufacturing process. To achieve this integration, the company introduced a superconducting thin film, low-loss silicon nitride waveguides and an electro-optic phase switcher made of barium titanate. The team evaluated the performance of the system using a series of benchmarking circuits to test quantum operations.



A silicon disc containing PsiQuantum computing chips. PsiQuantum

The circuits yielded a single-qubit state preparation and measurement fidelity (qubit initialization and readout) of 99.98%, a chip-to-chip qubit interconnect fidelity (qubit transmission over optical fiber) of 99.72%, a quantum interference visibility (showing indistinguishability of photons from independent sources) of 99.5%, and a two-qubit fusion gate fidelity (entangling operations) of 99.22%.

The company is already producing the chips in partnership with semiconductor manufacturing giant GlobalFoundries at the latter's fab in Albany, NY, USA. The method uses industry-standard foot-wide wafers on GlobalFoundries' 45-nm process to achieve yields that match those of standard semiconductors, according to the companies. PsiQuantum says it has characterized millions of devices on thousands of wafers and currently performs around half a million measurements each month. It plans to break ground this year on two data-center-sized "Quantum Compute Centers" in Brisbane, Australia, and Chicago, USA.

—Hannah Lanford

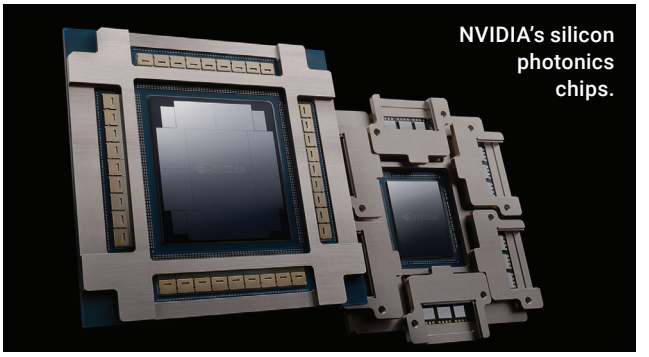
optica-opn.org/news/0525-chipset

Edwin Cartlidge, Susan Curtis, Patricia Daukantas and Meeri Kim are freelance science writers. Bibiana Campos Seijo, Alessia Kirkland, Hannah Lanford and Rachel Sender are OPN staff contributors.

TECHNOLOGY

NVIDIA Looks to Silicon Photonics and CPO

NVIDIA



NVIDIA's silicon photonics chips.

The artificial intelligence (AI) computing multinational NVIDIA has announced its plan to leverage silicon photonics and co-packaged optics (CPO) to connect millions of GPUs in so-called AI factories. At the company's GTC 2025 event in San Jose, CA, USA, CEO Jensen Huang introduced two new silicon photonics network switch platforms, Spectrum-X and Quantum-X, that he said would enable this leap while also reducing power consumption.

"AI factories are a new class of data centers with extreme scale, and networking infrastructure must be reinvented to keep pace," said Huang. "By integrating silicon photonics directly into switches, NVIDIA is shattering the old limitations of hyperscale and enterprise networks and opening the gate to million-GPU AI factories." To meet the million-GPU goal while using less energy, the platforms use 1.6 Tb/s port switches, and they leverage CPO for short-range connections to improve overall electrical efficiency. The company says that the switches "deliver 3.5× more power efficiency, 63× greater signal integrity, 10× better network resiliency at scale and 1.3× faster deployment compared with traditional methods." The CPO is based on a new micro ring modulator technology.

NVIDIA has teamed up with a number of partners in its silicon photonics efforts. Photonics firm Lumentum is providing the lasers for Spectrum-X, while Coherent is collaborating on CPO. The company's "silicon photonics ecosystem" also includes Browave, Corning, Fabrinet, Foxconn, Senko, SPIL, Sumitomo Electric, TFC and TSMC.

—Hannah Lanford

optica-opn.org/news/0525-nvidia