Wednesday, February 5, 2013

SPIE

Photonics West® Show Daily

In association with: optics.org

Lasers pull crowds into Moscone exhibition


Photo: Joey Cobbs.

Nearly 1300 exhibitors welcomed an anticipated 20,000 visitors to the Moscone Center yesterday morning as doors opened at the 2013 Photonics West industry exhibition. Products and technology demonstrations on show included a raft of new lasers from the likes of Newport Spectra-Physics, Coherent and IPG Photonics, as well as a new real-time CMOS hyperspectral imaging system from imec. Turn to page 04 for our round-up of product announcements.

Quantum optomechanics: a new toolbox

Tuesday's OPTO plenary kicked off with Markus Aspelmeyer of the University of Vienna describing recent developments in quantum optomechanics, where quantum effects are being put to use driving macro systems. "Sensing based on purely classical mechanical oscillators has now become amazingly accurate, able to sense displacements of attometers and masses measured in yoctograms [10^{-24}g]," he told the audience.

The approach potentially provides a new toolbox of techniques for engineers to use, in applications where the manipulation of photons feeds through into action on the nano-, micro- or macro-scale. In some cases a single universal coupling system might be feasible, exploiting the effects across the full breadth of this size range.

This could allow engineers to make good use of quantum phenomena previously thought to be undesirable, and turn them to advantage. "The inherent quantum-mechanical noise in a laser signal has always been a potential problem for some applications," said Aspelmeyer. "But recent experiments have shown that we might be able to produce mechanical action from the native shot noise of laser itself."

Other possibilities include the development of non-volatile memory cells, in which bistable mechanical components are set and flipped exclusively by incident photons. Another could be optomechanically-induced transparency, a quantum interference effect that could deliver "on-chip mechanical storage of light," according to Aspelmeyer.

continued on p.30

DON'T MISS EVENTS

LASE PLENARY SESSION
10:20am to 12:30pm

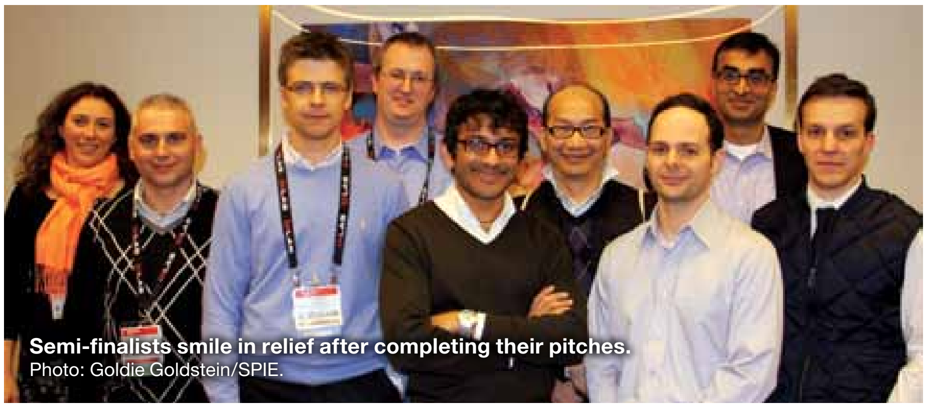
- **Three-dimensional Metamaterials Made By Direct Laser Writing**; Martin Wegener, Karlruhe Institute of Technology
- **Laser-based Particle Acceleration and the Path to TeV Physics and compact X-Ray and Gamma Ray Sources**; Wim Leemans, Lawrence Berkeley National Lab.
- **Remote Laser Welding for Automotive Seat Production;** Geert Verhaeghe, Faurecia Autositze GmbH

INDUSTRY EVENT

- **Executive Perspectives on the World of Optics and Photonics**
  2:00 to 3:00pm; *Open to all attendees*

See Technical Program and Exhibition Guide for details. Registration fee applies for Plenary Session.

INSIDE



Semi-finalists smile in relief after completing their pitches.
Photo: Goldie Goldstein/SPIE.

Ten make start-up challenge finals

Nineteen semi-finalists gathered for the Jenoptik-sponsored 2013 SPIE Startup Challenge, with ten making their way into today's final (3:30-6:00pm in Moscone 101, open to the public). A diverse group of researchers has three minutes to pitch their new photonics startup concept. All ten will win a sponsorship to attend the Entrepreneurship Academies organized by UC Davis, while the winner will walk away with a $10,000 prize.

Javid Khan kicked off proceedings with his company Holoxica's holographic display technology. His business plan starts with running a joint R&D program with a large player in the automotive industry, to create lower-cost displays for cars. Khan wants to further expand into medical display and computer gaming markets.

Finalist Arun Chhabra from 8tree presented the fastCHECK system, designed for the rapid inspection of rivets for aircraft. He explained: "It is imperative for structural integrity that external rivets sit perfectly flush with the surface." 8tree's product is specifically designed for quick inspection of rivets to speed manufacturing and maintain the longevity of the aircraft. Chhabra says that the 3D scanner is both less expensive and more multi-functional than current devices on the market.

A new imaging modality for breast cancer care was introduced by Alexander Oraevsky, the CEO/CTO of TomoWave Laboratories in Houston, TX, namely the Laser Optoacoustic Ultrasound Imaging System. Oraevsky said: "With one instrument, we can revolutionize and simplify breast cancer care." The company is looking for $2M to supplement an existing $3M of capital already obtained, to help achieve FDA approval. "The money we are looking for will allow us to build a clinical system and complete a 100 patient study," added the entrepreneur.

Judge Mark Wippich, a partner at consulting firm Lightwave Advisors, said of the challenge: "All of their business plans need some work but they're all on the right path. I have a lot of respect for people who are willing to get up there for three minutes and pitch their idea and take our questions. It takes a lot to do that."

GOLDIE GOLDSTEIN AND CHRISTINA C.C. WILLIS

The ten finalists for the 2013 SPIE Startup Challenge

Arun Chhabra, 8tree; fastCHECK: a revolutionary 3D surface inspection system.

Jeppe Dam, DTU Fotonik; IRSee: an add-on for a camera visualizing chemicals in infrared spectrum.

Sanjee Abeytung, Memorial Sloan-Kettering Cancer Center; Rapid Pathology at the Bedside.

Swapnajit Chakravarty, Omega Optics Inc.; Silicon chip integrated, high-throughput, highly sensitive and specific diagnostic microarrays for the detection of cancers, allergies and infectious diseases.

Frank Palmer, ColdSteel Laser, Inc.; Remote image-guided endoscopic surgery (RIGES) platform.

Ryan Denomme, Nicoya Lifesciences Inc.; Compact, low-cost, high-performance optical biosensors for point-of-care diagnostics.

Christopher Glazowski, Memorial Sloan-Kettering Cancer Center; A low-cost ($5000 retail) device for non-invasive screening of oral cancers worldwide.

Alexander Oraevsky, TomoWave Laboratories, Inc.; "LOUIS-3D" laser optoacoustic ultrasonic imaging system.

Rafael Piestun, Double Helix LLC; Double Helix optics: See More, See Clearer.

Michael Engelmann, MACH8 Lasers Acoustically tunable DFB laser for mass-market applications.

Gu illuminates China's rapid laser progress

China's industrial sector may have slowed in the past year but laser-related activities are booming. That was the message from industry consultant and LASE symposium co-chair Bo Gu at publisher Pennwell's 25th *Lasers and Photonics Marketplace Seminar*.

Gu said that both the Chinese laser industry and its domestic market will continue to grow at a rapid pace over the coming decade; and predicted that China's share of the world laser market will grow from its current 15% to more than 25% over the next 20 years.

"To date there have been around 15,000 high-power laser systems installed across China and typically each year more than 20,000 low-power laser systems are sold," he said. "By 2012, there were more than 25 Chinese companies making fiber lasers."

Gu added that high-power laser welding was supporting China's industrial progress, saying: "This includes the recent use of 15kW fiber lasers for welding 18mm stainless steel in the fabrication of components for nuclear power plants; laser additive manufacturing of the titanium alloy for the new C919 Chinese commercial airplane; and the recently opened first tailored blank laser welding line."

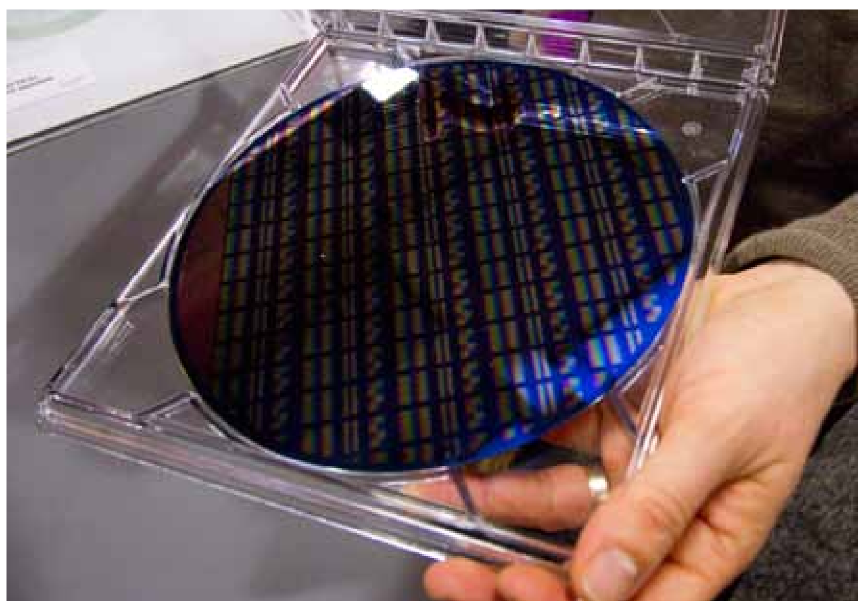
The market for high-power laser welding equipment in the country should grow from $80 million in 2008 to $420 million by 2015, he added. The Chinese government has supported market development by establishing the National Laser Technology Alliance in Wuhan last April, followed by the National Laser Industrial Cluster Zone in Wenzhou.

Photonics consultant Bo Gu.
Photo: Matthew Peach.

Gu predicted increasing penetration of lasers into all types of manufacturing; domestic fiber laser manufacturing to grow and become vertically-integrated; domestic kilowatt lasers to compete with established US and German manufacturers, and price pressure to spread from low to higher power sources.

The consultant concluded that increasingly successful domestic laser developers would inevitably start to compete more in export markets, while the Chinese marketplace would undergo significant consolidation.

MATTHEW PEACH



Belgian microelectronics institute imec showed off its prototype CMOS hyperspectral imager in the Moscone North Hall — said to be the first hyperspectral camera to operate in real time. A line scan-version is currently sampling. Photo: Joey Cobbs.

Ultraviolet fiber sources debut at multicolored laser exhibition

As doors opened Tuesday morning and the crowds streamed in, they were met with a host of new product launches at the Photonics West main exhibition. Responding to customer demand for more power, higher efficiency, wider tunability and smaller footprints, exhibitors once again raised their game. Here's our first round-up of the innovations on show at the Moscone this year:

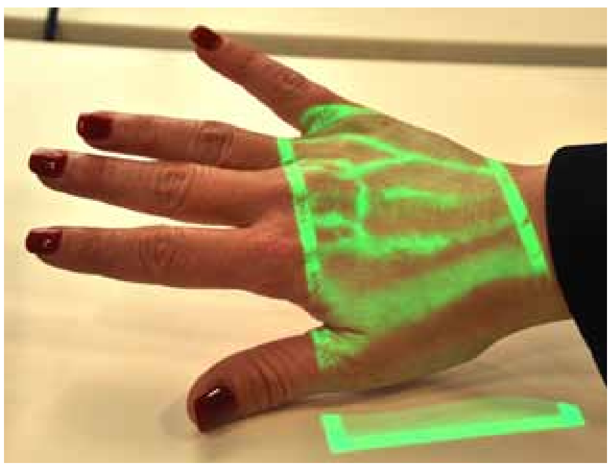
A new ultraviolet fiber laser from Coherent offers the precision processing capabilities of a short-pulse, picosecond laser, combined with high throughput speed characteristic of a Q-switched, diode-pumped, solid-state laser. The Daytona 355-20, using a photonic crystal fiber from NKT Photonics, delivers more than 20W in 1 ns pulses, at repetition rates above 1 MHz (at 355nm). It produces a TEM_{00} (M^2 <1.3) output beam, making it ideal for precision micromachining.

Newport's **Spectra-Physics** was another to launch a fiber-based ultraviolet source. Its Quasar, actually a "hybrid" fiber and solid-state laser, delivers high-power UV and green outputs at high repetition rates. It produces an average UV power of more than 40W, while the Quasar 532-70 puts out above 70 W of green output power at more than a 200 kHz pulse repetition frequency. Both models operate over a wide repetition rate range, from 1–500 kHz for ultra-high speed micromachining and output excellent beam characteristics (M^2 <1.3) with low noise.

Trumpf introduced the latest generation of its Programmable Focusing Optics, the PFO 3D, for scanner welding, cutting and drilling. The PFO 3D features a larger work area, higher maximum laser power, and enhanced electronics for increased accuracy with remote welding — now a key technology in automotive manufacturing.

The German company also launched a UV laser, its TruMark 6350, offering improvements in design and performance for marking applications. Increased average power with the same high beam quality leads to an increase in repetition rates and, therefore, higher processing speeds. The higher pulse peak power and pulse energy allow the laser to achieve better mark contrast across a wide range of materials, in applications such as color change on plastics and glass marking.

Trumpf's TruDiode 903 direct diode laser also made its debut. The lasers are available with output powers of up to 3 kW for welding, brazing, hardening, and heat treatment, and are said to possess a beam quality comparable to that of lamp-pumped lasers — even at high output power — at significantly lower operating costs.



You're so vein: Texas Instruments' DLP, illuminating veins as shown here at Photonics West, is finding its way into operating and examination rooms worldwide. Clinicians are partnering with medical design companies to take this versatile MEMS technology to the medical community.
Photo: Matthew Peach.

IPG Photonics extended its range of ytterbium fiber sources with the new YLS-Y13 fiber laser. This CW low-mode fiber laser system represents a new generation of kilowatt-class industrial fiber lasers designed to enhance the company's high-power industrial laser range.

Notable improvements on IPG's previous ytterbium laser models include: increased wall-plug efficiency from 30% to 33%; beam parameter product vs. output power doubled; a new fiber block damage threshold also doubled; and the mean time of uninterrupted laser operation increased to more than three years.

The YLS-Y13 comes in compact and standard formats. Both forms offer a randomly polarized, 1070nm output, from the ytterbium-doped laser featuring a red aiming diode. The compact version delivers between 1kW to 4kW and the larger format between 1kW and a remarkable 100kW for a wide range of material processing applications.

High visibility: Coherent's Sapphire low-power lasers suit life science applications.
Photo: Joey Cobbs.

Edmund Optics was demonstrating its "reversible" Techspec compact instrumentation imaging lenses. These streamlined versions of fixed focal length imaging lenses are designed for instrumentation integration. The innovative design means that the Techspecs can operate as economical conventional lenses in one orientation or as a microscope lens when the optics are simply reversed.

An adjustable, lockable focus enables setting the best focus position prior to integrating into instrumentation, avoiding future adjustments. The wide range of fixed aperture options ensures maximum flexibility of resolution, throughput, and depth of field.

For modifying resolution, throughput, and depth of field, each focal length of these compact lenses is offered in a range of f/# options. Choosing a higher, slower f/# increases the depth of field. Different aperture stop versions are offered.

These compact lenses are designed specifically for volume integration into applications such as analytical medical devices, including benchtop-based blood analyzers. Customized f/# versions are available to suit diverse instrumentation application needs.

Jenoptik presented a wide range of new products embracing optics, lasers and infrared technology. For laser materials processing, Jenoptik showed its updated femtosecond laser, the JenLas D2.fs. While maintaining its stable beam quality, output power and pulse repetition rate have been increased to allow for faster material processing in industry and medical technology applications.

The company also showcased its new ultra-precision optics, processed using ion beam figuring. The F-Theta lens series Silverline complements Jenoptik's portfolio of full fused-silica lenses intended for micro-processing with high-power fiber and picosecond lasers.

And in the field of sensor systems, Jenoptik was showing its latest high-definition thermography camera, the IR-TCM HD 1024, to the US market for the first time. The handheld camera allows for the detailed and precise analysis of temperature distributions, in particular in the case of large objects or large focusing distances.

MATTHEW PEACH

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Photonics: enabling; disruptive; transformational

SPIE's industry and market strategist Stephen G. Anderson on three photonics applications with the potential to make a profound impact on society.

Photonics is regularly described as an enabling technology and has been identified by many governments as essential to future economic growth. But it can also be transformative. By disrupting the *status quo* it can bring about technological changes that have a profound impact on society. Here are three examples of technologies that I believe have that potential — though you can find many others in the sessions and exhibits at Photonics West.

Additive manufacturing

Last year Pipeline Orthopedics (Cedar Knolls, NJ) was granted 510(k) clearance by the US Food & Drug Administration (FDA) for a total hip replacement system. It was a "first", insofar as the prosthetic incorporates a novel biocompatible porous metal structure fabricated using laser sintering.

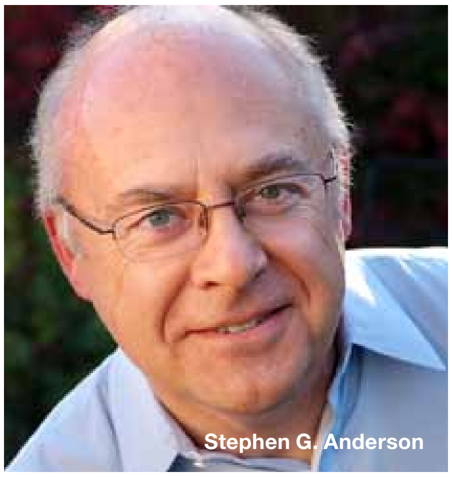
Over the next few years we will hear much more about 3-D additive manufacturing, also known as 3-D printing, not least because — as in the example above — it enables production of materials and parts that simply cannot be fabricated otherwise. 3-D printing also means that the cost of a part is independent of its production volume; it lends itself to automation (reduced labor costs); and the 3-D designs are easily updated in standardized CAD files.

The many variants of 3-D printing include stereo lithography (SLA) and laser additive manufacturing (LAM), which are already being used by auto makers to make or prototype parts, and LAM could be approved this year to fabricate an F-35 Joint Strike Fighter part.

This is just the tip of the iceberg. Last August, the US National Academies noted that 3-D manufacturing is vital for the economic well-being of the US, while both the US and the UK governments among many others are funding programs to speed its advance to commercialization. It's not only governments that are taking 3-D manufacturing seriously ... the technology has attracted the attention of major companies like GE Aviation and Lockheed Martin as well as the investment community. Additive manufacturing is set to profoundly disrupt our global manufacturing infrastructure.

Optogenetics

At a much earlier stage of development but with no less disruptive potential is the emerging field of optogenetics. By combining genetics with optics, researchers are able to control brain activity in specific cells responsible for a movement, a mood, or disease. Inserting light-sensitive proteins into specific neurons enables light to stimulate and "turn on" the neuron, with precise behavioral results. The hope is that by understanding neural circuits, brain function can ultimately be controlled or modified to mitigate the effects of conditions such as depression, epilepsy, or Parkinson's disease.


Stephen G. Anderson

Laboratory results show promise, though experiments are currently limited to laboratory animals and there's no guarantee that the techniques will transfer to humans. Nonetheless, it's an exciting field that could transform neurology. One of its pioneers, Karl Deisseroth of Stanford University, opened a brand new BiOS conference on the topic with a keynote presentation on Saturday morning (conference 8586).

Cell phone diagnostics

Another BiOS presentation highlights the benefits of adapting a mass-produced, widely available device to niche applications, an idea that has seen past successes (Ocean Optics, for instance, created its first mini spectrometers based on a fax machine sensor) and which now holds promise for future portable medical diagnostic devices.

In fact, smart-phone apps to assess skin lesions for cancer are already available, but at UCLA Aydogan Ozcan's research group is pioneering lensless (on-chip) imaging for a cost-effective and portable cell monitoring platform using a mobile phone. At this year's BiOS, the team describes a cellphone attachment for reading and digitizing rapid diagnostic test (RDT) results allowing real-time global mapping of infectious diseases.

We can anticipate further developments in portable diagnostics as researchers accelerate their efforts, motivated partly by the Qualcomm Tricorder X PRIZE—a $10 million competition to develop a palm-sized wireless device that monitors and diagnoses health conditions. Many readers will recognize the Tricorder name, which originated with the Star Trek TV series in 1966 and refers to a portable diagnostic device. Just imagine how personal healthcare would be transformed if people could accurately diagnose themselves from their home, before they contact a doctor. That's what photonics can do.

BiOS: optics meets biology and healthcare

Optogenetics, brain control with light and cancer detection with photoacoustic imaging: just some of the highlights of this year's BiOS, says symposium co-chair R. Rox Anderson.

The BiOS Hot Topics session is always one of the most eagerly anticipated parts of the meeting. What is its appeal?

I find this session to be incredibly stimulating and a constant source of surprise. It is a chance for some very good speakers in areas that are rapidly moving to give a talk that is not constrained by the usual format. Their results are scientifically accurate while at the same time forward-looking. I always find that the conference hall is buzzing after those Saturday night talks, and I like that. It really sets the tone for the whole meeting.

What emerging technologies and techniques are you looking forward to hearing about this year?

We have introduced four new BiOS conferences this year: Optogenetics and Hybrid-Optical Control of Cells; Bioinspired, Biointegrated, Bioengineered Photonic Devices; Optical Methods in Developmental Biology; and Terahertz and Ultrashort Electromagnetic Pulses for Biomedical Applications.

Personally, I'm drawn towards the bioinspired devices conference, as well as optogenetics. Even though these bioinspired devices are obviously some way off in terms of becoming products, I feel this conference is going to have some traction. The use of biological materials in the design of optical systems may sound bizarre — but why not?

Think of an endoscope, for example. What if it was the diameter of a human hair and made of biological materials that could be reabsorbed by the body? You could use the endoscope, and then just leave it inside the body. I feel this conference will be a wellspring of where you see things first, and then later you'll see them as products. I am very excited to hear about ideas that are at the fuzzy interface between optical and biological materials.

> "I feel that photoacoustic detection of deep structures is going to make it in medicine for applications such as detecting breast cancer."

What is optogenetics? What can it do?

Optogenetics is a relatively new technique that has already spurred a tremendous amount of neuroscience research. One starting point is to extract the genetic code from bacteria that is responsible for the production of the light-sensitive molecule rhodopsin. We can then introduce this into a complex organ such as the mammalian brain, and use light to activate the rhodopsin in different cell types. It is a wonderful combination of capabilities.

When you consider that we also have a fantastic suite of *in vivo* microscopy techniques, you can capture detailed structural information while at the same time use light to trigger responses in the brain. We still don't have a wiring diagram for the brain, so I find developments like this incredibly interesting.

Which new optical technologies are emerging for mainstream healthcare?

Optical coherence tomography (OCT), which has been a strong part of the BiOS meeting for 20 years now, has certainly made the transition into clinical practice for some organs. Now, as the capability of OCT gets better and better, so it will be applied more broadly. Researchers today are working to drive the speed, and particularly the depth and resolution, of OCT.

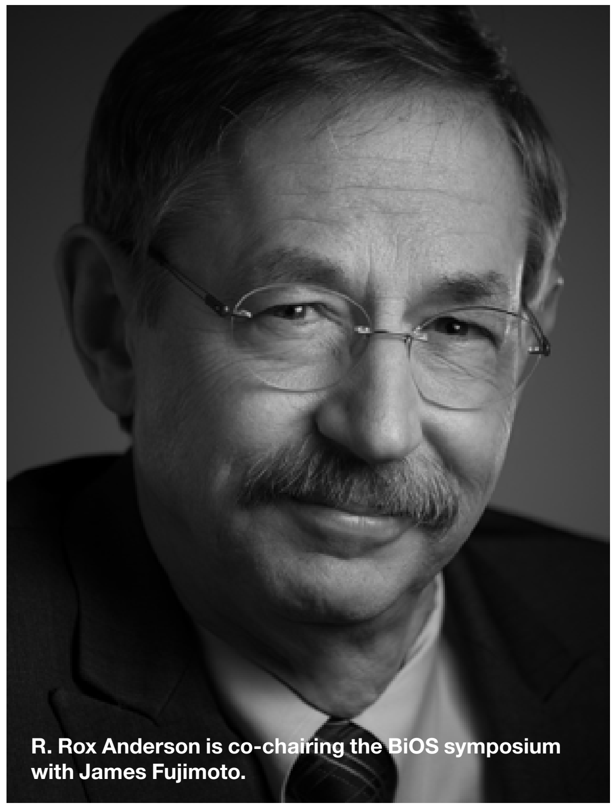
One new variant is micro-OCT, which gives you images of individual cells *in vivo* that can be acquired through a catheter to study heart disease in humans, for example. I am always blown away by the results presented in this conference, and I know I will be blown away this year to see these cellular resolution images.

One technique that I feel is set to make the transition in the future is photoacoustic imaging. Here, laser pulses are absorbed by the target tissue, generating ultrasound waves that are detected at the surface of the target using an ultrasound transducer. There are a lot of papers being presented that concentrate on ways to increase the depth and resolution of this type of imaging. I feel that photoacoustic detection of deep structures is going to make it in medicine for applications such as detecting breast cancer.

What are your personal research interests?

Several years ago, I decided to tackle treating acne, and that is what I am actively working on today. We are pursuing two strategies, the first is to use photodynamic therapy (PDT) and the second is to use lasers that are selectively absorbed by lipids, which in turn have a photothermal action on the sebaceous glands. We haven't used surgical lasers that are specifically absorbed by lipids before, and that is a strong personal interest of mine.

The lasers we use emit at 1726nm. At this wavelength, several lipid overtone vibrational modes have



R. Rox Anderson is co-chairing the BiOS symposium with James Fujimoto.

a sufficiently strong absorption that you can get a selective heating of the sebaceous glands. It is hard to get a high-power source at that wavelength. To date, we have used a free-electron laser and a high-power diode source specifically designed for the project.

What is the current state of PDT in general?

I would say that every year that goes by, PDT takes another step up in terms of being a preferred therapy. There is a tremendous barrier to the adoption of new technologies, and that is what PDT has to overcome. It takes a long time for technologies to be proven, and that is the process that PDT is going through. PDT is not a first line therapy for any cancer that I am aware, but it is number two in many settings.

PDT will be a strong part of BiOS program again this year, where no doubt there will be steady and interesting progress. We will see presentations on spectroscopy, imaging and the basic understanding of the PDT process as well as discussions regarding new targeted drugs and treatment strategies.

JACQUELINE HEWETT

BiOS SYMPOSIUM HIGHLIGHTS:

- More than 2000 presentations
- 235-company BiOS Expo
- Final poster session (with OPTO) takes place: 6-8pm Wednesday, Room 103

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Interview: Photonics21 president and Jenoptik Group CEO Michael Mertin

Jenoptik CEO Michael Mertin became the head of the "Photonics21" European member association in late 2012. Matthew Peach caught up with him shortly before Photonics West.

What are you expecting from the Photonics21 role?
It is a challenge. I would like to try to influence the European community to push the optical industries as a means for wealth and growth. And for the industry to help overcome the economic crisis we are in, not just for now but for the longer term by supporting further development of optical technologies.

I am convinced that optical and related industries are key to our future and this is what I want to develop with the different stakeholders. In the next generation of Photonics21 we have to come to a point of collaboration between the different stakeholders, whether scientists, universities, industries of different sizes, and of course politicians.

My role is more like being an ambassador. Part of my role is to explain the European photonics position and the business model, the technologies and how governmental structures can enforce cooperation between industry and science. I would also like to encourage industrial companies to use public funding and leverage as a way to cover risks, so that they are willing to co-invest.

What will be your agenda for Photonics21?
It's a bit early but an important point will be to establish an R&D funding structure for the growing photonics industry in Europe. To implement a co-funding structure as a dynamo for growth, to get the commitment from the European Commission (EC) for photonics funding until 2020; if this is achieved then Photonics21 will be successful. This will not be my personal success but the achievement of the whole organisation and for the whole of Europe.

What are some of the early tasks in your in-tray?
First I need to finish the Strategic Research Agenda and then, based on that, finalize the agreement on the financing of Photonics21 and the related upcoming projects along the value chain: research, small innovative companies, larger players, and then set up a structure to determine the objectives for all of these related projects. Then we will be having our next annual meeting in April 2013, at which we will discuss whatever Photonics21 is to be focusing on thereafter.

How will you balance your work between Jenoptik and Photonics21?
First of all the Photonics21 President's role is more or less a representative function. I am not really leading the organisation in a formal sense. Most of all it is an ambassadorial role based on a few trips per year. This includes Photonics West which I already attend for Jenoptik.

Photonics21 is based on a membership of individuals and there is a lot of capacity in this organisation. This capacity is bundled in the Strategic Research Agenda. A lot of work is being done in the work groups

Mertin (standing second from left) at the recent opening of Jenoptik's new laser diode manufacturing facility in Berlin-Adlershof. Photo: Klaus-Dietmar Gabbert; copyright Jenoptik.

and the real leading heads are the work group leaders and of course the stakeholders.

Can you describe the relationship between Photonics21 and the EC?
In my view the European Commission — especially under vice president Neelie Kroes, who is responsible for leading Europe's digital agenda — understands these photonics industry development mechanisms. They are looking for effective instruments and processes; and how to leverage these philosophies to achieve a flying start.

I would also like to bring my experience with politics and institutions in Germany to the European level.

Do you aim to transfer Jenoptik's successful business culture to the European photonics sector?
The role I have is not to transfer the Jenoptik culture to the European photonics community level. But perhaps we can learn something from Jenoptik as a high-tech company with lots of subsidiaries and smaller entities worldwide. The photonics market, on both the customer and supplier sides, is highly fragmented.

Is that a problem? Yes in certain parts due to economies of scale. But it's also a big advantage because the applications on the photonics side are very high-tech but very specialised to certain solutions, whether it's in life sciences, machine building, manufacturing or automotive sectors.

How can Europe make the most of its photonics potential?
The point now is to find synergies and levels of co-operation between different partners. That is what I have had to do in the past and what I still have to do in a company like Jenoptik.

What is also important is to bring together the three big groups of stakeholders: from the scientific, the industrial and political groupings. This is exactly what the European Commission wants to achieve by establishing Public Private Partnerships (PPP).

How will the PPP work?
The EC wants to have a reliable and a committed organisation to manage and secure the project funding between these three stakeholders. Furthermore they want to have a clear commitment from industry to co-invest.

From my point of view it's fair that if political bodies are providing public money then they want to have a clear understanding about how it is spent: how we can leverage this money and how can we secure the future of work, wealth and employment in Europe.

Just giving this public funding to certain companies or institutes does not really guarantee these synergy effects. So the EC is asking for help from Photonics21 to organise these kinds of commitments. In principle, this is not a bad idea but the devil is in the details, so we have to develop the ideas, agree and implement them.

Michael Mertin: Jenoptik CEO and now president of Photonics21 too. Credit: Jenoptik.

How can you balance creating a plan for European manufacturers while allowing a free market?
We are not talking about making a political plan and with this plan to somehow make Europe happier. It's the other way around. The plan should come from the industry: they have to supply additional funding [to the EC projects] and that planning has to be developed in consensus with the scientific community, universities, institutes and other stakeholders. A project will only make sense if it is economically beneficial.

Can companies maintain employment in high-tech manufacturing in Europe, especially in the photonics industries?
Firstly, I think photonics is like other high-tech manufacturing industries. We have to be innovative. The photonics industry and its business model is mainly about developing enabling technologies, such as helping to improve production in other industries.

The development of enabling technologies is something that fits perfectly with the European business models in a very mature industry region with high wages. I think that the intention to have all kinds of mass manufacturing as well in Europe is a misunderstanding of this region's enabling character.

For example, we are delivering core components for next generations of cell phones, computer chips, and displays from within Europe. We may buy some of these products back from Asia. But often we have already contributed to the development of those technologies.

What are the major challenges facing the public funding of R&D?
I appreciate that there are mixed feelings on public funding in the European Union. We need to unambig-

continued on p.14

Michael Mertin

continued from p.13

uously distinguish between funding and subsidising development. For example, if funding is not dedicated to growth, then it is really a subsidy.

In my view, the best method of funding is the mechanism that encourages further private money for even bigger co-investment. This is exactly what we want to achieve with the expertise of the Photonics21 members. This means bringing stakeholder groups together, constructively.

Considering the problem of taking new developments to market — well, with classical funding you just give money to research institutes and get back research that may not necessarily be connected to market developments. But if you involve private money then there is the incentive for a financial return.

So if you are able to bring big companies with an international footprint together with smaller entrepreneurial companies with scientific institutions, you will have the best of all worlds together, including the spending on the research. The idea is not to fund these three parties separately but to bring them together under the umbrella of PPP to fund the projects working together. This is my dream.

Can Europe work effectively as a coherent photonics continent?

Consider what is going on in Jenoptik: total sales in Europe are decreasing slightly, but worldwide our total sales are increasing. At the same time, we are creating jobs in Europe. My point is that products coming out of Europe's photonics sector are not necessarily used in Europe but they may be in demand elsewhere. This situation enables us to create new, well-paid jobs in Europe.

Look, for example, where the big computer chip manufacturing machines come from: ASML in The Netherlands is a good example, even though the main markets are usually outside of Europe. This kind of business model is something we should expand in Europe.

In the photonics industry in particular we have so many different niches, which address all of the key trends in the world, there is so much space for many photonics companies in Europe united under the umbrella of Photonics21 to find their place in the world market.

Do you have the job of making Photonics21 more popular across Europe?

It's a difficult question. But Photonics21 is not an organisation of countries: we are an organisation of members. Photonics21's Working Groups can talk to industrial and political leaders about the importance of innovation. We cannot live in old structures; we need innovation and we need revolution. What we hopefully can give to all of these countries and parties who are not yet looking at high technology industries is economic growth to develop trust in this industry.

Mertin and Mayor of Berlin Klaus Wowereit, outside the new Jenoptik laser diode facility. Photo: Klaus-Dietmar Gabbert; copyright Jenoptik.

If we can impart this kind of understanding across Europe, especially to political and industrial leaders, then we will be doing a good job.

Do you plan to make many changes to Working Group objectives, personnel, or major agendas?

The hand on the steering wheel is managed through a decision making process by the Photonics21 Board of Stakeholders. My role is more strategic — thinking about the basic principles of cooperation between the relevant parties in the value chain and seeing how we can have effective communication with politicians.

An interesting second aspect from my perspective would be if we can really implement the PPP strategy with the co-funding and with the broader spectrum of participating partners along the value chain. This will give a certain objective and target-setting to the entire industry.

Would you like to see the German model of adapting technical research into industrial success replicated across Europe?

I strongly believe that instead of subsidising certain innovations and institutions, the big success factor is definitely "project funding of innovation", as it is called in Germany. This is something that the European Commissioner wants to implement at the European level, which I think is what should be done with the PPP plan.

If you think about this model then the role of the governmental institutions can be described just in two points. The first is to create an environment in which the different parties can work together — and they take some risk there, the funding from the governmental side. Secondly, you can address very basic trends, so you can say this is the direction, which we as a country or a union should take. Thus we can build mechanisms of how people can work together instead of working individually.

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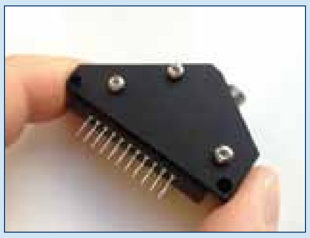

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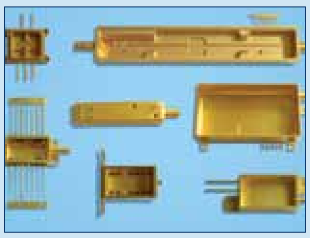

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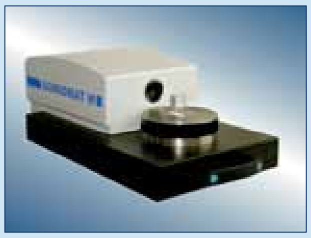

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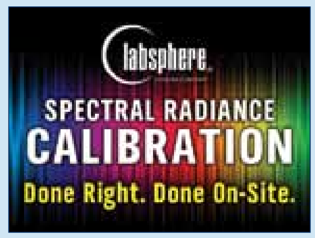

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Uncovering a dark secret: the mystery of LED "droop"

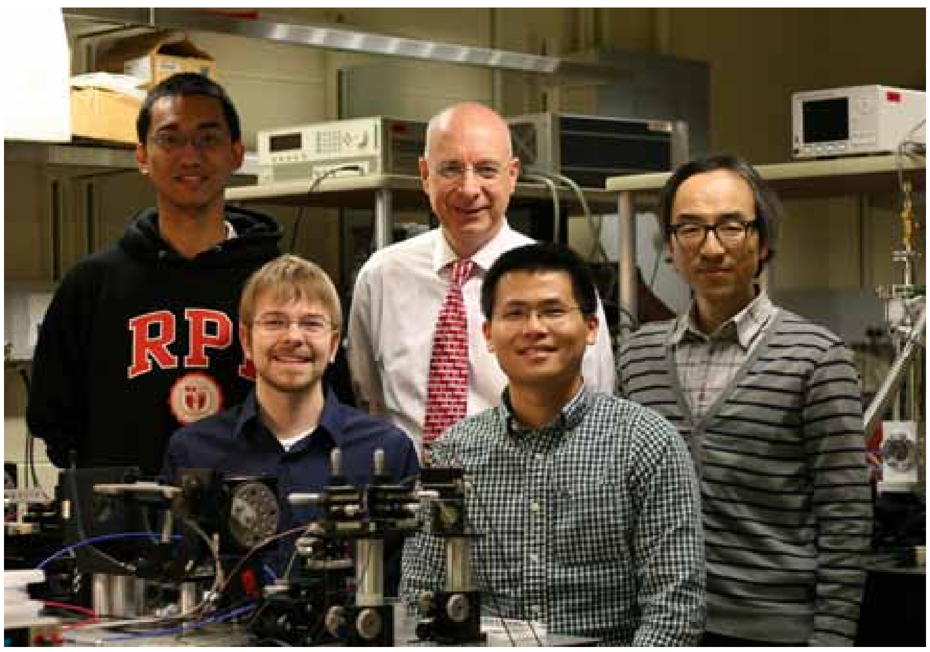
Researchers refine their theories to explain LED droop, a controversial, mysterious malady that threatens the advance of affordable solid-state lighting. Richard Stevenson reports.

LED light bulbs have many attributes: they are efficient; they can last for 15 years; they are free from mercury; and they reach full brightness in an instant. However, the technology remains very expensive.

That will slowly change as prices will fall, with significant uptake of solid-state lighting possibly beginning with a hike in sales of LED replacements for 50W halogen lamps. Even at today's prices, this LED bulb makes a competitive economic case for itself. Although it retails for three times the price of the halogen, it lasts ten times longer and draws only one-tenth of the power.

But the makers of LED light bulbs could find it far harder to displace the 60W incandescent and its compact fluorescent (CFL) equivalent. Solid-state light sources are more efficient than CFLs, but the performance gap is small, and LED bulbs have a price tag that will make many potential customers wince.

Early adopters insisting on the best are currently forking out about $30 for the Philips light bulb that won the US Department of Energy's $10 million Bright Tomorrow Lighting Prize. Purchasing a bulb with inferior efficiency and color quality trims outlay, but not by much, with prices still tending to be above $20.



Fred Schubert's team from Rensselaer Polytechnic Institute have developed an analytical model that is claimed to replicate real LEDs operating at various temperatures. Credit: RPI

Solid-state bulbs will need to sell for less than half that figure if they are to thoroughly displace the incumbents. And to do that the cost of the LEDs in the bulb must plummet because, according to a report published in August 2012 by the US Department of Energy, about half the cost of a 60W-equivalent light bulb comes from the packaged LEDs.

The most elegant way to slash the cost of these LEDs is to drive them at higher currents, so fewer are needed. But cranking the current up really high is not an option with today's LEDs, because it leads to a significant reduction in the light output efficiency that prevents the solid-state bulb from delivering lower running costs than CFLs.

The most promising route to eliminating this reduction in efficiency, which goes by the name of "droop", is to understand its origins and address them. However, despite much effort by both the academic and industrial community into fathoming its origins — this topic is the subject of two dedicated Photonics West 2013 conference sessions (8641; sessions 1 and 12) — the cause of droop is far from clear. Many theories have been put forward, but none has widespread backing, and this has led to a heated debate.

Droop origin: the arguments

To follow the arguments over the origin of droop, you must first understand how the LED works. To operate it, you apply a few volts across its two terminals, so that electrons are forced into the middle of the device from one side, while their positive counterparts, holes, are injected from the other. If the LED were perfect, electrons and holes would then accumulate in the middle of the device in narrow trenches, known as quantum wells, where they would interact to yield photons that exit the chip.

In practice, devices are never perfect, with weaknesses that include droop. Efforts to explain this mysterious malady have multiplied since late 2007, when two popular, very different theories were proposed. Back then researchers at LED chipmaker Philips Lumileds claimed that some electrons and holes don't recombine to emit light, but interact in a non-radiative manner known as Auger recombination, and that this was the cause of droop. Auger recombination involves the

continued on p.20

LED "droop"

continued from p.19

interaction of three carriers — either two electrons and one hole, or two holes and one electron — so that one carrier is promoted into a higher energy state.

Within a month of that explanation being published, Fred Schubert's group at Rensselaer Polytechnic Institute proposed an alternative: that electrons were passing through the quantum wells, so that instead of interacting with holes, they leak into the region supplying these positive charge carriers.

This team has spent the last five years refining its ideas on the origin of droop, and at Photonics West 2013 Schubert will detail its latest efforts, including a recent breakthrough that has come from reassessing equations describing the injection of carriers into an LED. These formulae were first proposed in 1950 by the Nobel laureate William Shockley, and Schubert's team has amended them so that they include the mobilities of electrons and holes.

These new insights into the behavior of the LED have been applied to an analytical model, known as the "drift-leakage model", that can accurately replicate the behavior of real LEDs. This model shows that droop is multifaceted, and its magnitude depends on polarization fields, temperature, and the speeds electrons and holes travel through the material.

Schubert claims that this model offers insights into how to combat droop: "Decreasing the carrier concentration in the quantum well is always helpful, and we find that *p*-type doping and electron leakage are factors that we need to tune and modify." Droop is also influenced by polarization fields, which occur in piezoelectric materials, such as the nitrides that are used to make blue LEDs.

The model does not include Auger recombination, which is known to be stronger in semiconductors emitting at longer wavelengths. According to Schubert, if droop was prevalent in the blue LEDs used to make solid-state light bulbs, it would prevent efficient operation of their red and infrared cousins. This is not the case.

It's a convincing argument, and one that a supporter of Auger recombination as the cause of droop — theorist Chris Van de Walle from the University of California, Santa Barbara — has given much thought to. Van de Walle, who is also giving a paper (8641-54) at Photonics West 2013, agrees with Schubert that droop is not an issue in red and infrared LEDs. But, in his opinion, that is due to tremendous differences in the active region of these devices, where the light-generation process occurs.

Supercomputer calculations

The active region of a blue LED has a handful of quantum wells, each with a width of typically 3nm. This suggests that the total thickness of the light-generating region is no more than 20nm, and in practice it is much less than this. "Careful studies have indicated that many of those quantum wells don't even light up," says Van de Walle, "because of problems of distributing carriers over quantum wells. So only one or two wells contribute to the majority of device output." In comparison, the active region in infrared and red LEDs is far larger. The absence of polarization fields allows the wells to be much wider, and there are typically up to 40 of them.

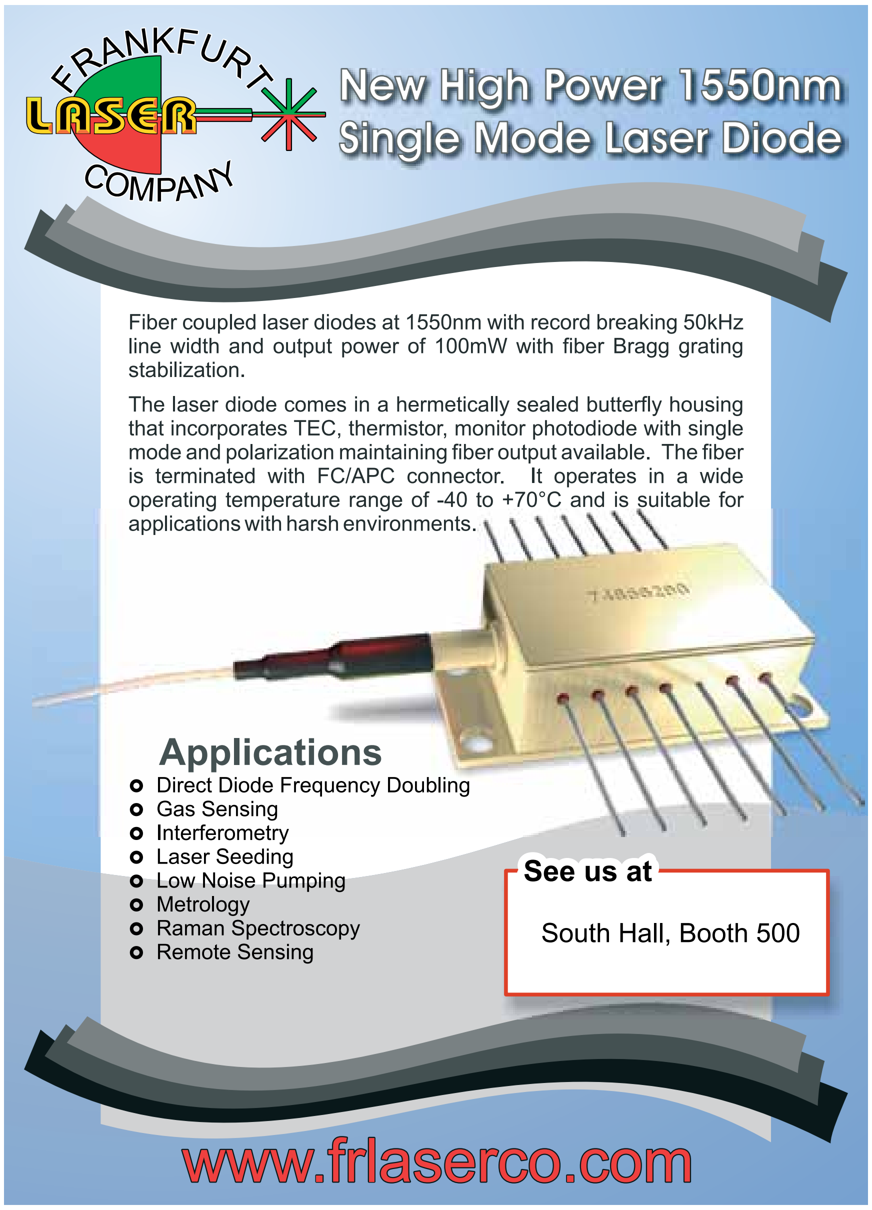
In both types of LED, similar currents are injected, but in the nitride LEDs the carriers are spread over a light-generating volume of material that is at least an order of magnitude smaller than that of infrared and red LEDs. "And since the Auger process goes as the cube of the carrier density, lowering the carrier density makes it seemingly go away," says Van de Walle. "That doesn't mean that the Auger process isn't there intrinsically — it just doesn't kick in at the low carrier concentrations that are achieved in traditional [red and infrared] LEDs."

The Philips bulb that won the US Department of Energy's Lighting Prize draws less than 10 Watts while delivering an output equivalent to a 60W incandescent. It typically retails for about $30, but costs could fall if the bulb could contain fewer LEDs. Understanding the origins of droop could help, because it could allow the deployment of devices driven at far higher currents than those used today, without compromising efficiency. Credit: Philips

Van de Walle says that he and his co-workers are the only theorists to carry out "truly first-principles calculations" of Auger-based processes in nitride materials. "It's a lot of work to write the code, and it takes many hours of supercomputer time to actually do the calculation, but then you get an accurate result."

Simulations by this West-coast team suggest that

continued on p.23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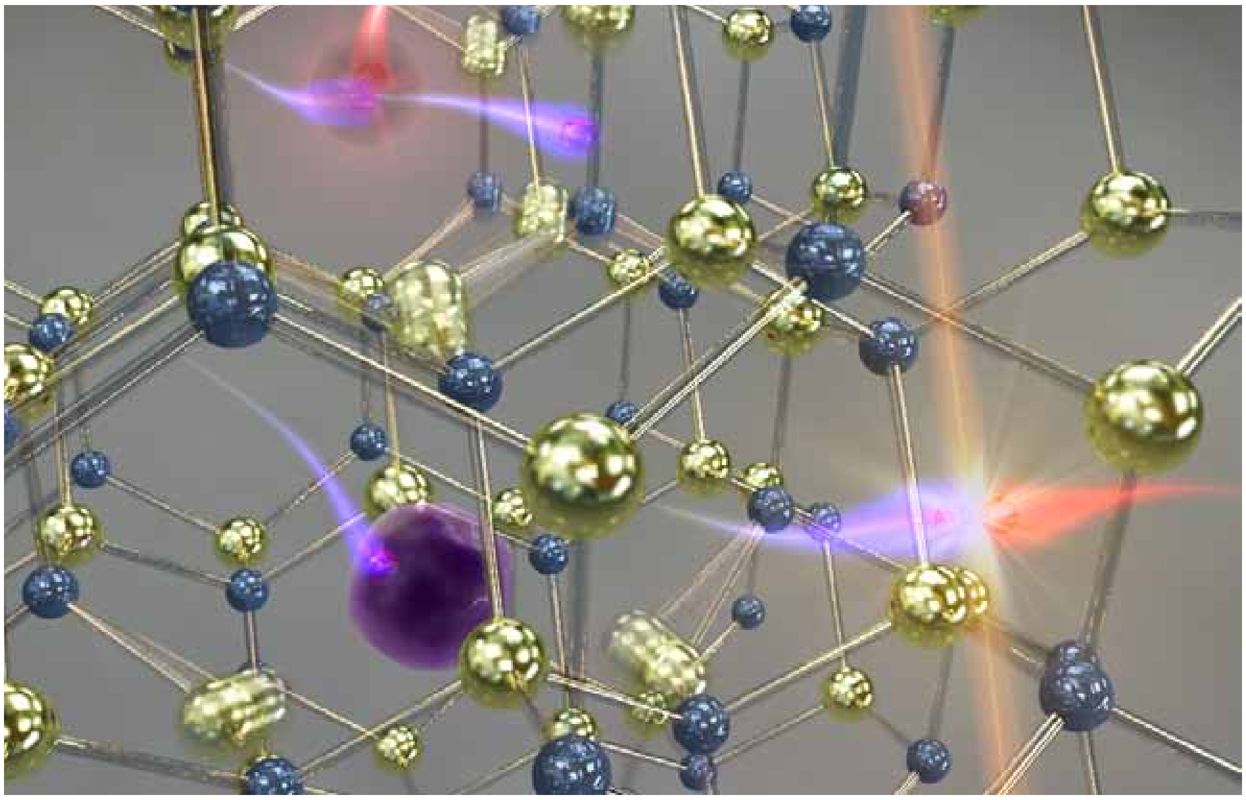
LED "droop"

continued from p.20

droop in nitride LEDs is not caused by the standard, direct Auger process, but by Auger-based processes involving alloy disorder and phonons (lattice vibrations). These calculations have been performed for bulk indium gallium nitride, the material used in the quantum well, because it is not feasible to model a real device structure.

More recently, the insights gained from these calculations have been used to perform simulations on simple LED structures using the SimuLED package produced by STR Group of St. Petersburg, Russia. This effort compared the performance of conventional LEDs with identical structures grown on a different material plane, known as a non-polar plane. Switching to this plane eliminates intrinsic internal electric fields.

Experiments from other groups show that the non-polar LEDs have far less droop. Prior to performing calculations, Van de Walle suspected that this superiority stemmed from a higher quantum efficiency. But that's not the case, according to his calculations, and he now offers a new explanation for the gains that can result from switching from polar to non-polar LEDs: "The light output is higher because the rate of the radiative recombination is greater in the non-polar wells." In addition, he says that it is possible to have wider wells, leading to lower carrier concentrations that reduce the impact of the Auger process.



Various processes take place in LEDs, with droop resulting from a non-radiative mechanism that is stronger at higher current densities. Chris Van de Walle's team from UCSB argue that this decline in efficiency is caused by an electron and hole recombination process that is assisted by lattice vibrations (top left). The energy associated with this process is imparted to a third carrier, which is excited to a higher-energy state. Carriers can also recombine in LEDs to emit light (right), or interact with defects, a process that prevents light emission. An example of the latter is the trapping of an electron by a nitrogen vacancy (bottom left). Credit: Qimin Yan, UCSB.

Theoretical argument

Not all theorists agree with the claim that Auger-based processes are by far the biggest contributor to droop. Calculations by a team from Boston University and the Politecnico di Torino, Italy, suggest that these non-radiative mechanisms are just one of several factors that impact device behavior at high currents.

Van de Walle questions the work, saying: "They are still calculating everything as if it's just a direct Auger process. They introduce some kind of broadening into the curves because of electron-phonon coupling, but that doesn't describe the process accurately. It's an approximation, and they get a different result."

In response, the US-Italian team argues that Van de Walle and co-workers use a broadening parameter that could have a dramatic impact on the results. "This broadening parameter is just a mathematical trick to deal with the singularity, and this approach is not consistent with the underlying theory," says Francesco Bertazzi from the Politecnico di Torino. "In our work, the broadening is computed self-consistently from realistic electronic structures and phonon dispersions."

Another theorist who doubts that Auger processes provide a full explanation for droop is Jörg Hader from the University of Arizona. Working in collaboration with former colleagues from the Philipp University of Marburg and LED manufacturer Osram Opto Semiconductors, Hader and his co-workers initially calculated the strength of the direct Auger process, before adding phonons into the mix. "We get numbers like the [US-Italian] team get, which are on the very, very low end of explaining anything related to droop."

Hader and his co-workers model real devices by calculating the radiative recombination rate with a great deal of accuracy. This is particularly challenging with nitride materials, because pairs of electrons and holes bind together tightly to form excitons that interact with each other. Hader says that complex interactions between excitons are often overlooked, which is an oversight, because they are a very strong source of radiative loss in nitride materials.

One major contribution to droop, according to Hader, is a process known as density-activated defect recombination (DADR). He believes that as more carriers are injected into the quantum well, they fill higher energy states, and an increasing number of them can then reach defects that are surrounded by potential barriers. These defects contribute to droop by trapping carriers, so that they can't emit light.

This conjecture forms part of Hader's explanation for droop. At low currents and low temperatures, he suspects that droop stems from carrier delocalization — as more carriers are injected into the device, there is a reduction in the localization of electrons and holes, which can be restricted in movement by variations in either the thickness of the quantum well or its composition. "When you get to room temperature and higher currents, the onset of droop is driven by density-activated defect recombination, and at high currents the current overflow becomes more important." At really high currents, he thinks that it is just possible that Auger plays a role.

Hader is not alone in drawing on several conjectures for droop to explain this phenomenon. In 2011 Weng Chow from Sandia National Laboratories, Albuquerque, put forward a model that included contributions to droop from defects, carrier overflow and Auger recombination. Although this model drew several theories together, it did not have the backing of many researchers, who are still defending and strengthening their own ideas.

And so the debate over the cause of LED droop rages on. While the LED community appears to be getting closer to understanding this mysterious malady, it still has a long way to go to uncover a watertight, universally accepted explanation.

LED bulbs may be improving in quality and getting cheaper, but truly taking over the lighting industry will remain a challenge until a better understanding is reached. At Photonics West 2013, the debate over LED droop is set to continue.

ABOUT THE AUTHOR

Richard Stevenson is a freelance science and technology journalist, and the editor of Compound Semiconductor magazine.

PHOTONICS WEST LINKS:

- Monday February 4: OPTO conference 8641 Session 1 "High Current Performance and Droop Effect in LEDs I"
- Thursday February 7:OPTO conference 8641 Session 12 "High Current Performance and Droop Effect in LEDs II"

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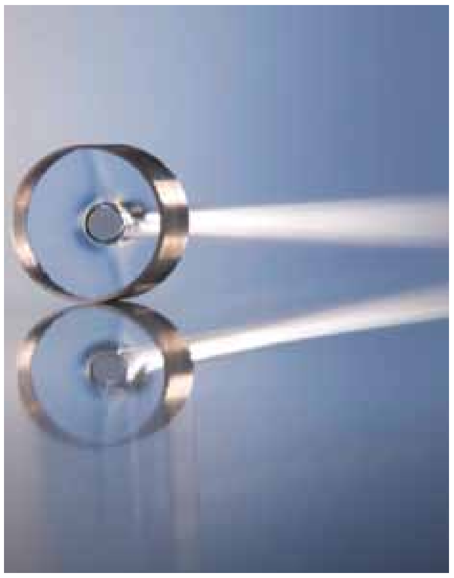

The aeroGAIN-ROD is available in a PM55 and a PM85 version with 55 and 85 µm polarization-maintaining cores, respectively. Each model is available in a Standard and a Power version designed for different power levels so that you can chose exactly the fiber you need.

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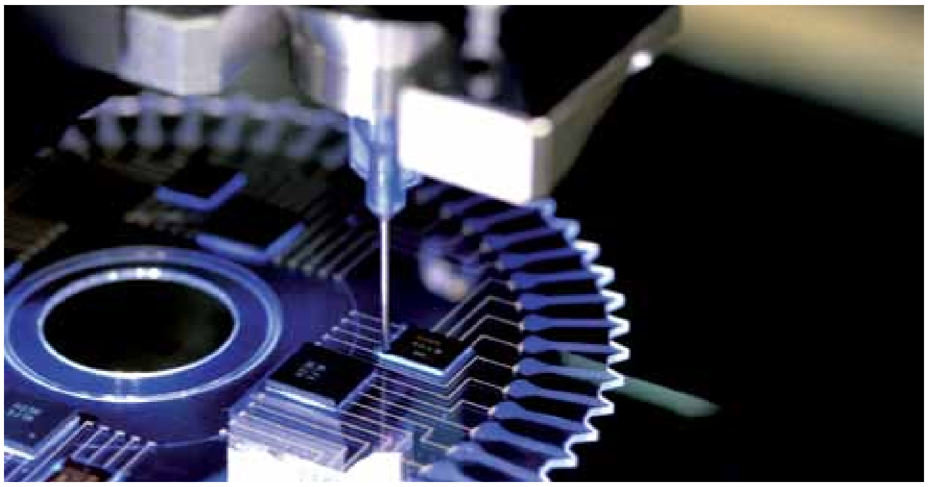
Photonics-based components and multi-μ-functional devices

Optical device manufacture requires command of interdisciplinary microfabrication.



CDA GmbH (Suhl, Germany) is a specialist manufacturer of optical components and solutions in plastic for photonics-based applications. CDA also provides their customers with access to several high-end technologies for the development and manufacture of complex miniature devices incorporating printable electronics components and microfluidic channels.

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The primary intended uses for these components are for general illumination tasks, for example as diffusors or for improving efficiency in light emission from (3D) displays and OLED panels. Further applications include imaging systems for multi-channel cameras or for improving the effective fill factor of CMOS image sensors, or as projection optics for LED, VCSEL and fiber arrays.

While silicon and glass remain important material options, the vast majority of applications are served exceptionally well by various types of plastics, such as polycarbonate, PMMA and cyclo-olefin-copolymers. These materials provide all of the performance aspects required in most applications, but are lighter, lend themselves to high volume replication via injection molding, and are more cost efficient.

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CDA is additionally a champion of more complex devices that integrate several functions on a single chip. So-called ›lab-on-a-chip‹ and other compact but sophisticated and sensitive devices are becoming increasingly important, for example, where physical chemistry, electrical and/or optical properties need to be tested on a small scale. Appropriate devices lend themselves well to high levels of parallelization, bringing cost reductions into a design but their manufacture does require a fully integrated process chain and command of several cutting-edge microfabrication technologies.

The manufacture in plastic means producing highly complex and functional microstructures with extreme precision, and doing so very cost efficiently under mass production conditions. The CDA approach is so attractive because of the number of available process steps and due to the nature of the functionalities – optical, electronic, microfluidic – that can be combined freely so as to optimize the performance of a device for the intended application. Finally, coatings can enhance specific optical performance or induce other specific physical properties, such as hydrophilic or hydrophobic behaviour.

According to Pia Harju, Business Development Manager at CDA, "We believe the market for both micro-optical elements and for integrated devices is absolutely global and we are targeting a range of industries including machine vision, lighting, medical devices, environmental applications and food production."

Contact

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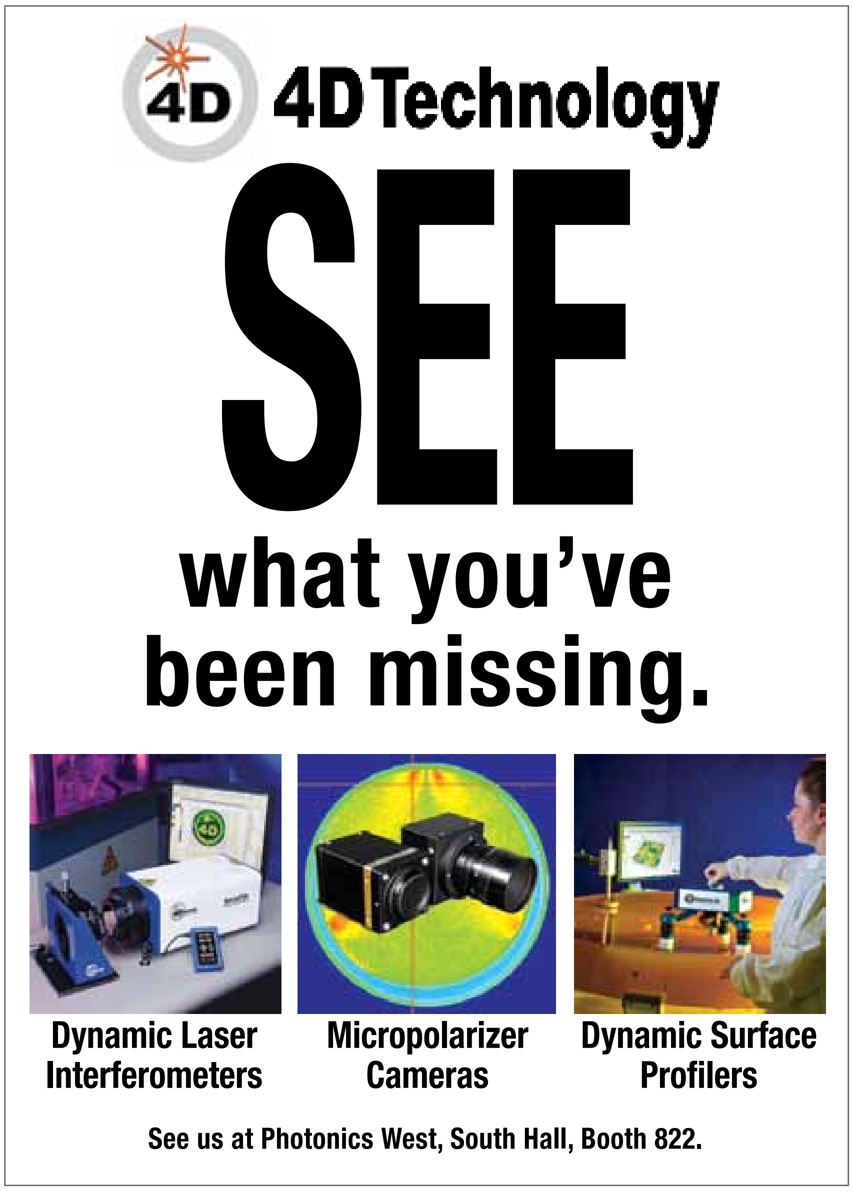
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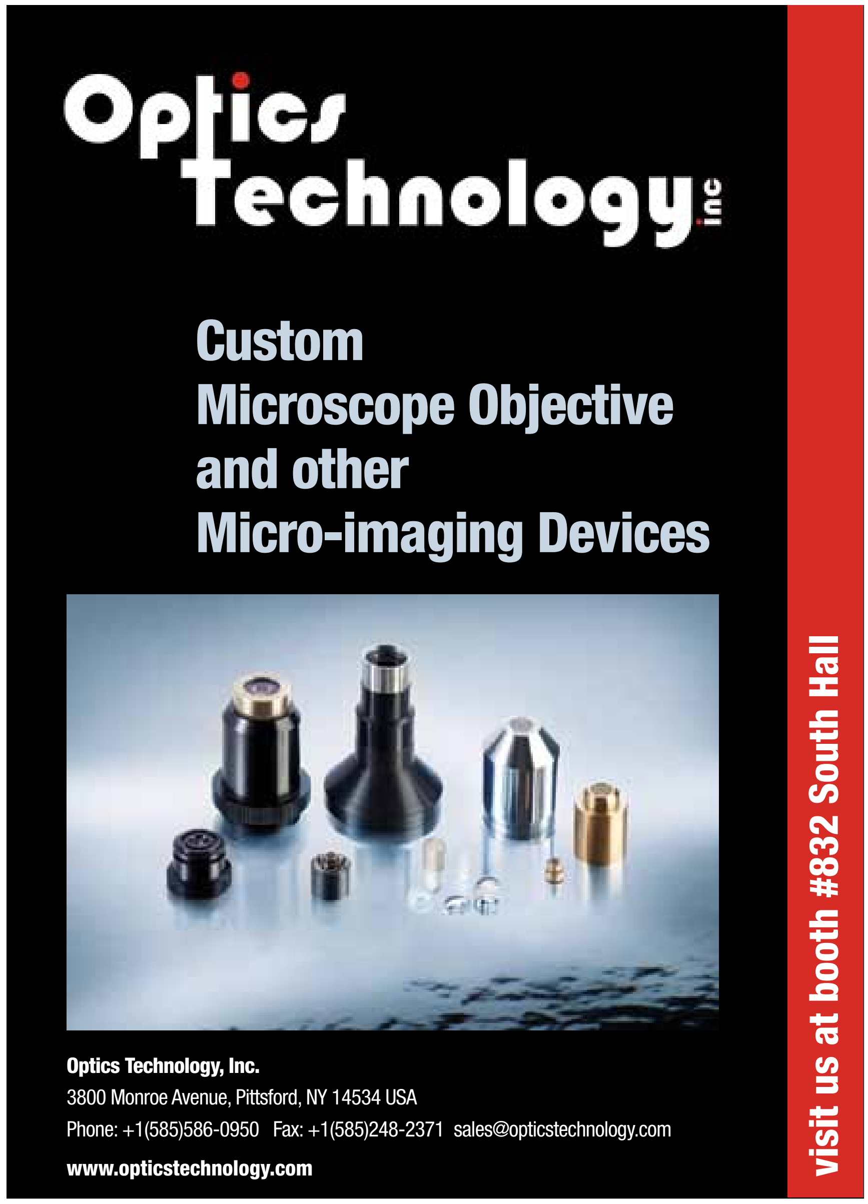
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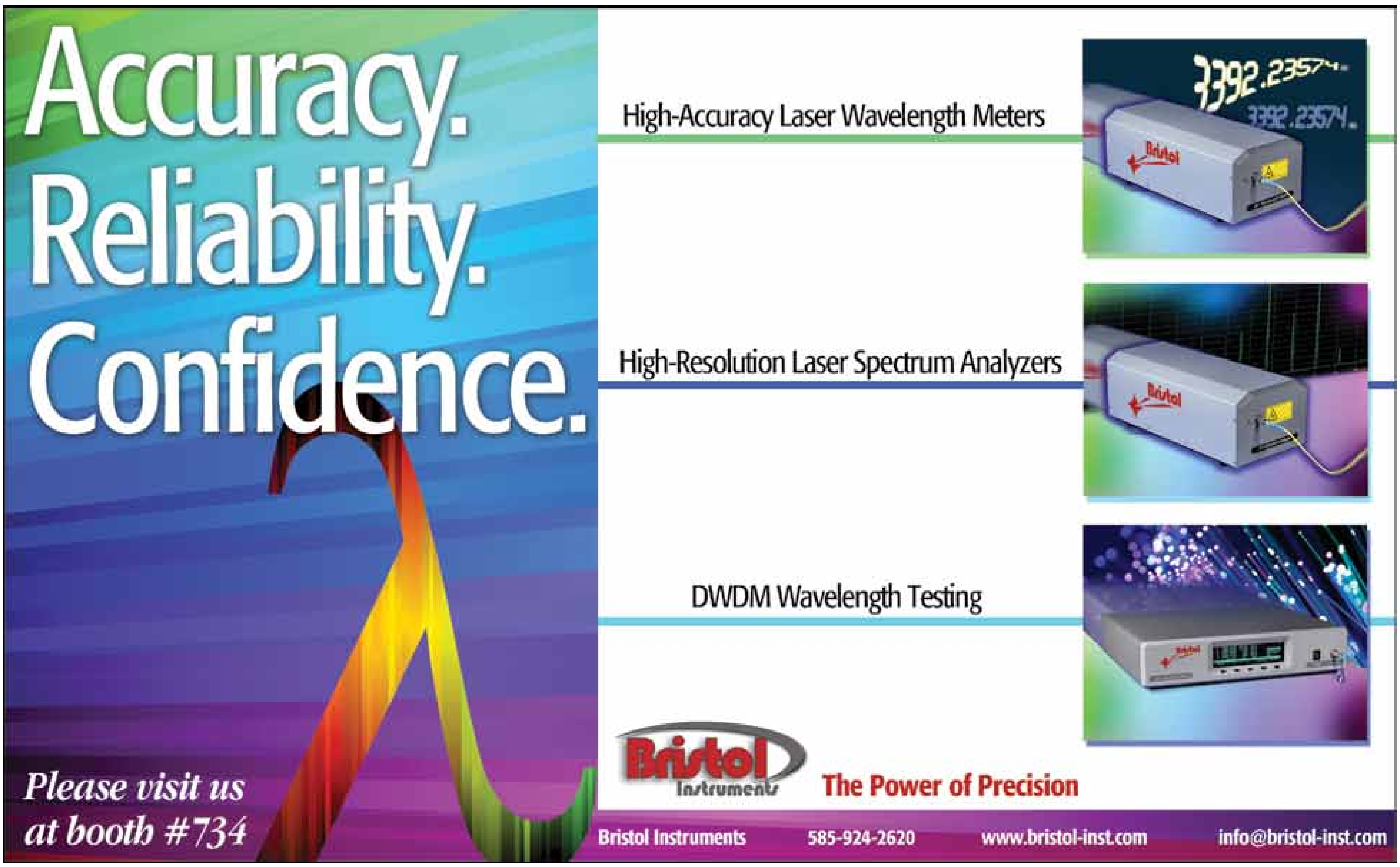
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Flexible waveguides meet "Big Data" challenge

In an effort to end copper's long domination of circuit connections between silicon boards, Dow Corning and IBM have unveiled a system that they say can replace copper links with new low-loss polymer waveguides based on high-performance silicone.

A high-energy announcement from the team came during the "Fiber and Waveguides" session of the *Organic Photonic Materials and Devices* conference, part of the Photonics West OPTO symposium.

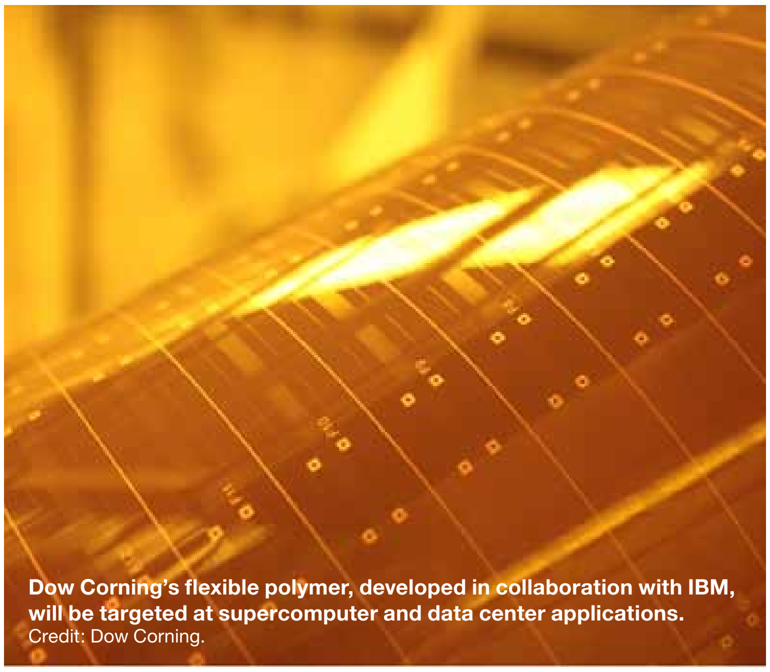
Dow Corning experts said their board-level photonics will solve mounting data flow problems for "Big Data," for example data centers strained by the popularity of smart phones that are connected non-stop to the internet and social media networks.

They predicted it will lead to low-cost integration of photonics in more energy-efficient supercomputers and data centers. The polymer offers higher speed, lower power use and lower cost than copper at very high data rates, they said, and can withstand extreme operating heat and humidity. It proved stable in 2,000 hours of tests at 85 percent humidity and 85° C.

Dow Corning's Brandon W. Swatowski, an optical materials engineer and physicist, has been working in the technology area for five years, most recently at Dow Corning's labs in Midland, Michigan.

"To me this means taking it out of the lab and into feasibility for manufacturers," Swatowski said. "It is the next step toward adopting a new way for the Big Data industry to solve this key issue."

Another presenter at the session, Robert Norwood of the University of Arizona, commented, "I've been waiting 20 years for this. Now to see IBM pulling this along toward the market, that's promising." He added, "Dow Corning couldn't make this market by themselves. The electronic circuit boards market is way too complex."


Dow Corning's flexible polymer, developed in collaboration with IBM, will be targeted at supercomputer and data center applications.
Credit: Dow Corning.

Simon Jones, a Dow Corning executive in the United Kingdom, said here that he expects polymer waveguides to take hold with circuit boards at high data-rate applications, and in turn could replace copper in consumer products. "We have a low-loss product that is highly reliable and processable," he said. "Big Data users are facing more and more challenges in moving data from one silicon chip to another. Our system will accomplish that with lower power usage and costs."

The board-level waveguides, a joint venture of Dow Corning and IBM's Photonics Research Group, can be fabricated using conventional manufacturing techniques already available, Jones said.

Swatowski said the products can be completed in less than 45 minutes, and that the silicone polymer, applied as a liquid, will process more quickly than other waveguide materials.

"With everybody connected by smart phones all the time, even on the road, we can't just make more of what we are doing today," Jones said. "For high-end computing systems, copper has hit the limit. We need revolutionary breakthroughs to support Big Data in moving data from silicon chip to silicon chip in the rack. Copper becomes increasingly difficult to use as data rates move from 25 gigabits per second toward 100 gigabits per second. We are stretching the boundary of performance — at first for board-level optical interconnects. Then over time this will work down to everyday applications."

FORD BURKHART

Northwestern tunes mid-infrared QCLs

The ongoing challenges of developing short-wavelength QCLs were described by Neelanjan Bandyopadhyay of Northwestern University in an OPTO session on the topic. "Wavelengths of 3 to 3.5 microns are important for several different spectroscopy applications, because it coincides with many hydrocarbon absorption bands," he said. Of the candidate semiconductor systems, InGaAs-InAlAs on InP is the best choice on balance for short-wavelength QCLs, according to Northwestern's research. Using it has allowed the development of the first room-temperature continuous wave QCLs in the target wavelength band, although the same system can additionally cover the entire 3-16 micron range under appropriate conditions.

Daylight Solutions has demonstrated a broadly-tunable high-resolution CW laser based on its QC devices. "Broad tuning capability allows the identification of multiple chemical species in spectroscopy applications, while narrow linewidth facilitates the high spectral resolution that spectroscopy requires," commented Leigh Bromely. The company's external-cavity system, called ECqcl, uses a grating to tune the QCL output and control the tuning performance, and a unique cavity geometry that enforces one mode during operation.

TIM HAYES

Shining light on pulmonary medicine

"It has been 20 years since optical coherence tomography was developed, so why has it made only limited penetration into pulmonary medicine? And will it ever?" Matthew Brenner of the University of California, Irvine, posed the questions during a BIOS panel session discussing the barriers hindering the adoption of optical technologies in the pulmonary field.

The numbers hold clues to the difficulties faced by developers interested in pulmonary optics. Human lungs contain up to 500 million alveoli, equivalent to an area of $70m^2$, but optical access to specific regions through each lung's millions of branches can be difficult. Many lung nodules are in fact benign, and large differences in refractive index between lung tissue and air complicate many imaging modalities. "In essence, it is like trying to find truffles in a forest, but from a satellite," said Brenner.

Even so, several photonics-based techniques hold promise, especially ones targeting some of the commonest pulmonary conditions. Bradford Diephuis from Massachusetts General Hospital described a new imaging platform, christened OCT, intended to measure the increased mucous viscosity that is associated with cystic fibrosis. It uses a supercontinuum laser source producing 600-1000nm irradiation, and tracks the movement of particles in the mucus to arrive at a mean square displacement. From this, a viscosity can be readily calculated. This improves on the use of bulk rheometers, which are difficult to use on small volumes of mucus, and on fluorescence particle tracking methods, which are not feasible *in vivo*," said Diephuis.

Kam Chow of Canada's BC Cancer Agency discussed a breakthrough that might help Raman spectroscopy take its place in pulmonary medicine. "We used a hollow-core photonic crystal fiber as the Raman cell, with a 785 nm source," he explained. "In such a tiny space, the interactions between laser and molecule that produce the Raman signal are promoted and the efficiency of the process is increased.

TIM HAYES

Little labs; very big future

"I shouldn't be talking about football today," Sharon Weiss, of Vanderbilt University, said on Monday at the session on lab-on-a-chip technology (with no mention of the 49ers loss Sunday). But she spoke of a football field anyway, to illustrate her research.

First, she showed a golf ball — representing the surface area of a sensor cube without pores. And that size sensor with many nanoscale pores would, she said, have the surface area of a football field, greatly multiplying the chip's sensitivity. Her planar sensors have up to 60 nm pores, increasing the assay surface by more than three orders of magnitude.

Weiss and others showed that, after two decades, the search for ways to manipulate photons, electrons and fluids in a silicon lab-on-a-chip is picking up steam. "Potentially revolutionizing" is how session chair Andrew W. Poon described the papers.

"The future of finding such advanced silicon-based biosensing chips in hospital labs and clinics for accurate, targeted, fast and potentially low-cost biomedical diagnostics and health monitoring certainly seems bright," he said.

FORD BURKHART

Lightweight mirror blank readied for space missions

Schott unveiled its latest "Zerodur" astronomical mirror blank, which at only 45kg is said to be 88% lighter than its predecessor, in the Moscone South Hall. This version is 1.2 meters in diameter, with a parallel face sheet of 8 mm and a rib thickness down to 2 mm. Schott said that it would be possible to make a 3 meter diameter version, something that could be used in the tilting "M5" mirror at the European Southern Observatory's Extremely Large Telescope. Photo: Joey Cobbs.

Retinal prosthesis reaches final stages of FDA trial

A retinal prosthesis to return sight to people with moderate to severe *pigmentosa* is in the final stages of FDA clinical trials, as reported by Lyndon Da Cruz *et al* in a BiOS session Sunday (paper 8615-6). The Argus II by Second Sight assists patients blinded by retinal damage that prevents the conversion of incident photons into electrical signals for processing in the brain.

Argus II comprises an implant that attaches directly to the eye, and a modified set of eyewear which works in tandem with the implant. The implant features an electronics case and antenna mounted to the outside of the eye, and an array of electrodes attached directly to the retina. The electrodes artificially stimulate the retina and can be switched individually like pixels in a screen. The brain then processes the "image" electrically projected onto the retina.

Already available in Europe, Argus II is being FDA-tested for improving patients' ability to perform visual tasks, and the effect it has on their quality of life. It has been able to improve tasks such as locating a door in a room by almost a factor of two, and has even enabled patients to perform otherwise impossible everyday tasks, such as sorting dark and light colored socks.

In a remarkable video, one subject was able to walk down the street and halt when another pedestrian crossed his path, demonstrating the real-world utility of the device. Other possibilities that are being explored include face detection and text finding for conversion to visual brail.

Of 26 subjects in the study, 20 showed an improved quality of life, with the remaining six having a neutral response to the implant.

CHRISTINA C.C. WILLIS

Neurophotonics probes animal brains

Neuroscientists using infrared light to probe inside animal brains and nerve systems could help open pathways to advances like a bionic eye, to motorized prostheses controlled by a patient's brain, or to improved cochlear implants to restore hearing.

At Monday's BiOS session on infrared stimulation in neurophotonics, E. Duco Jansen of Vanderbilt University, the session chair, said these steps are still in the experimental stage but could one day help treat Parkinson's disease, epilepsy and perhaps even depression.

"We are trying to figure out, at an experimental level in the lab, what cells to target, what lasers to use, what color, and how much energy to use," Jansen said.

"These studies of non-human primates, the closest animal model to humans, will help in understanding the neurocircuitry of the human brain," said Jonathan Cayce, a member of the Vanderbilt team.

The Vanderbilt researchers reported that they had even produced signals in human spinal roots, pointing to new diagnostic and therapeutic applications. And that is the first venture into translating this technology from the lab to human patients, Jansen said.

Early in their research, the team had to identify cells that respond to irradiation with pulsed infrared light. They placed optical fibers on top of the brain for surface stimulation, and for subsurface stimulation used a fiber optic insert.

Both neurons and cells called astrocytes (support cells) gave off calcium signals in response to stimulation that the team detected with calcium dye optical imaging. Two-photon imaging let them view calcium signaling on the cellular level.

Other papers at the session described ways to use laser stimulation for cochlear implants to restore hearing, including a cat stimulated through optical fibers implanted in the cochlea. At first, the cat behaves playfully, but when the signal is "on," it twists about, looking left or right, depending on the signal.

"The behavior of the cat is the evidence of success in creating auditory signals — and that is a step toward being able to create auditory stimulation in deaf humans," Jansen concluded. "But there's still a question about what exactly the cat is hearing."

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Quantum

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One intriguing avenue of exploration came out of the blue. Optical coatings on the cavity mirrors in laser systems have an inherent thermal noise, caused by Brownian motion of the coating molecules. It might now be possible to remove or reduce this extraneous effect by engineering free-standing optical coatings in which the motion is effectively quashed through the action of light. Early experiments suggest that this approach could yield a ten-fold reduction in thermal noise, through what Aspelmeyer described as monocrystalline optomechanics. "Coupling quantum information to other physical systems is a new playground, and a promising one," he concluded. "This is just the start."

TIM HAYES