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Biotronics for defense

Prism Awards

New SPIE Fellows

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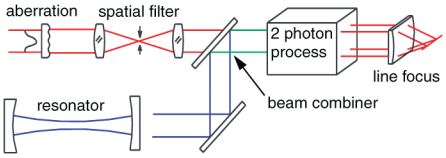

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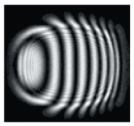

- Complex multiple laser systems
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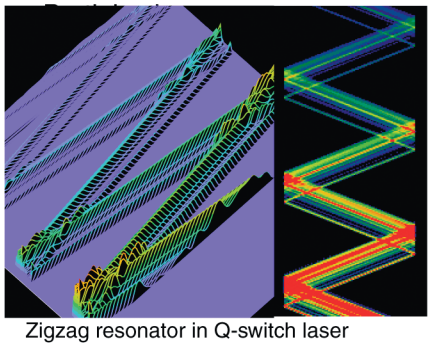
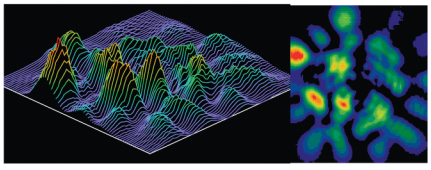
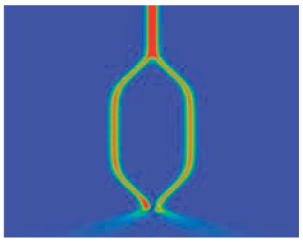


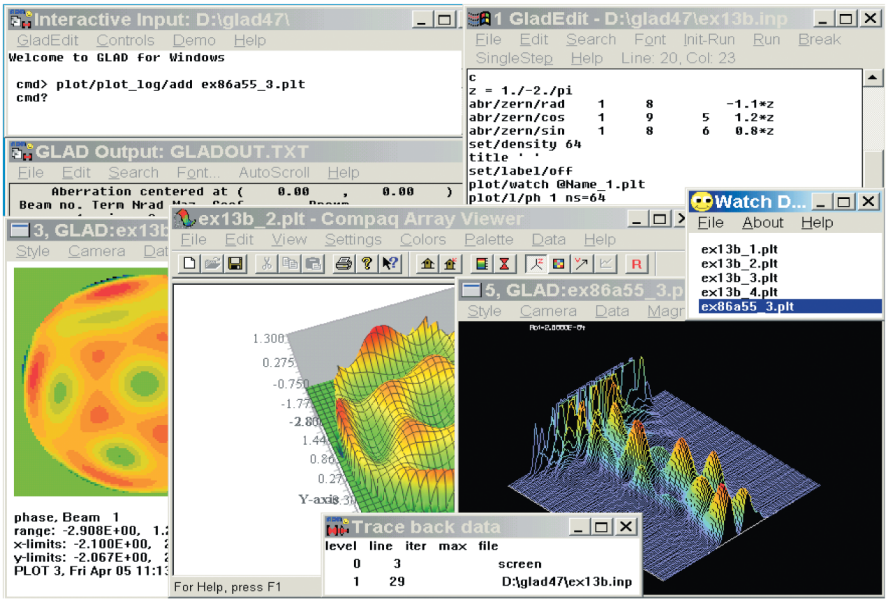
Zigzag resonator in Q-switch laser showing amplification from top to bottom and self-interference at side mirrors.



Transient Q-switch laser mode at 2ns



Photonic switch in the *off* position



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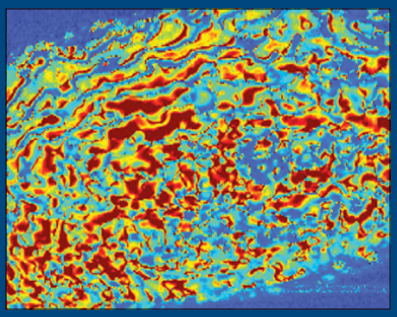

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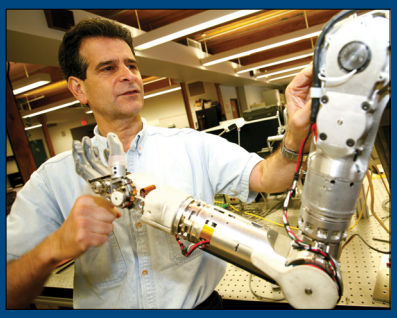

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25–29 April 2011

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Cover photo courtesy Connor Gleason

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SPIE

Shining light around the globe

As a professor and a clinician in a hospital, I have the privilege of interacting every day with physicians and researchers who are at the beginning of their careers. Teaching, mentoring, and even learning from these intelligent and compassionate scientists as they apply their training to meet our patients' health issues is one of the great joys of my career. I am continually inspired by their creativity, commitment, and idealism.

My involvement in the leadership of SPIE, including serving on committees, the Board of Directors, and this year as president, has introduced me to many more optics and photonics practitioners around the world. In my travels on behalf of SPIE, to Brussels, Lima, Beijing, Paris, Singapore, Riga, San Francisco, Trieste and elsewhere, I continually meet students and researchers who are just as motivated as those I know at home in Sweden.

They are mostly using the unique properties of light; some to diagnose and treat disease, like my students, and some to work towards a deeper understanding of biological processes. Others are working in the many areas of science and life where photons are key. They look across the cosmos for life or at single molecules, detecting muons in ice or looking for gravitational waves, studying our planet and trying to resolve our energy issues. I am inspired by the bright young (and not so young minds) across the world putting our cumulative knowledge of optics and photonics to good purpose.

Filling a need

While the dedication and creativity are shared throughout the world, I have also seen that opportunities are not the same everywhere. Laboratories with the latest equipment and opportunities for education and research are not readily available in every country.

In addition, in some regions it is extremely difficult to develop the infrastructure from scratch. We quickly forget the importance of "connecting minds," the local and international network that is so vital to advancing research and so important to furthering the work of individual scientists and engineers.

I am grateful to have the role of helping SPIE deliver such opportunities to researchers and students in regions where the need is great. Guided by the vision and desires of its members — you — the Society annually funds scholarships, grants, and other educational outreach programs around the world. Last year, SPIE contributed more than $2.3 million in support to such activities. The hard-working Scholarship Committee selects scholarship winners. We also support developing regions though the International Centre for Theoretical Physics (ICTP) in Trieste, the UNESCO Active Learning in Optics and Photonics (ALOP) program, and through the International Network for the Availability of Scientific Publications (INASP) to provide our publications at no charge.

Connecting minds

The importance of connections and networking cannot be overstated. From earliest times, the advance of science has been aided by collaboration. The contribution of any individual is amplified and often sparked through the input from colleagues, and by application of existing knowledge.

The face-to-face access to others working in one's field is priceless in establishing strong and useful networks. Many of the programs SPIE and its members support create those opportunities through travel grants and regional programs.

Working together, as a Society, we can do a great deal to increase opportunities in regions where relatively few exist. I encourage you to look at the list of projects and programs supported by SPIE (spie.org/global), and see where you may help make a difference through these activities that touch so many lives.

Each of us can help as an individual. We strongly encourage you to mentor a young scientist or engineer anywhere. We can help connect you to those in challenged regions of the world. There is likely also much young talent in your own neighborhood that can be inspired and encouraged.

I urge you to get involved, however you can, in supporting researchers who need resources or networks, and in communicating about how photonics can change lives.

I assure you that you will be inspired as a result.

Katarina Svanberg
2011 SPIE President

How do you promote science understanding?

At a meeting of the SPIE Engineering, Science, and Technology Policy Committee during Photonics West in San Francisco in January, 20 people were asked to share what they have done in the past year to advance the understanding of science in their communities.

Those 20 people reported around 60 different activities, many of them not associated with formal programs.

They provided opportunities for students to visit their labs, gave optics demonstrations for their children's classrooms, judged community science fairs, provided testimony to policy makers on the importance of funding for scientific research and education, and much more.

Have you done something similar?

Let us know. Write to governance@spie.org.

Photonics for a Better World

Priming the Biophotonics Pump

Biophotonics researchers get help with technology transfer.

Three aspiring biophotonics entrepreneurs working on potentially life-saving cancer and malaria detection techniques will get help advancing their ideas into full-scale business plans as winners in the Biophotonics Startup Challenge at SPIE Photonics West in January.

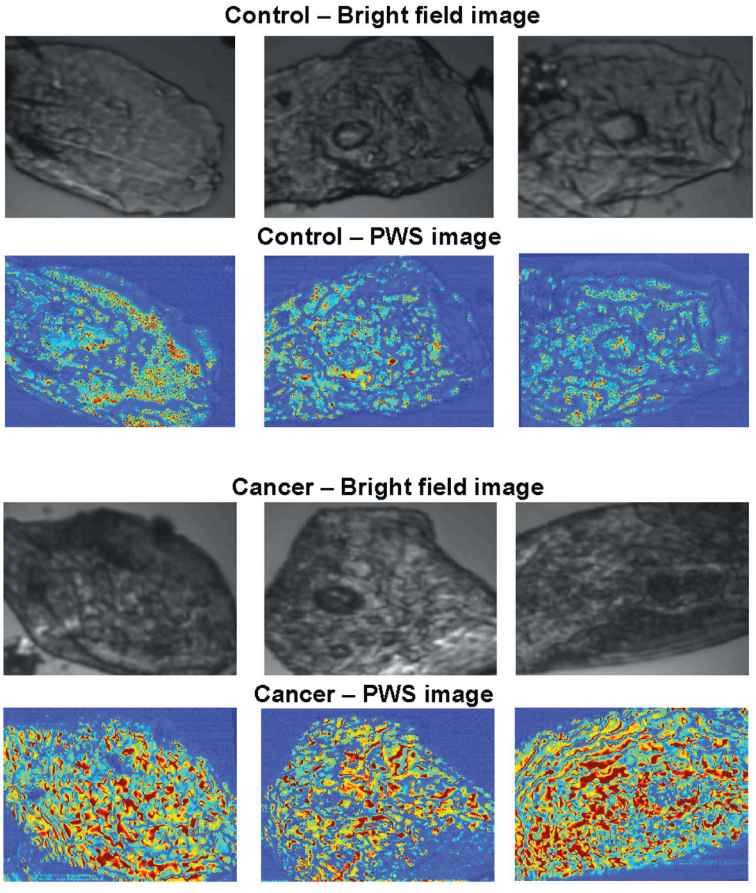
The three were among 16 biophotonics researchers vying for sponsorship from Newport Spectra-Physics to attend the University of California, Davis, Biomedical Engineering Entrepreneurship Academy. SPIE organized the event, in which the researchers pitched their ideas to a panel of judges, and is providing travel stipends for the three winners.

The five-day academy will help them construct a business case, analyze markets, develop a network of connections to drive their new ventures, and ultimately help improve our lives through photonics.

Indeed, all the proposed technologies at the Biophotonics Startup Challenge, ranging from optical drug-delivery systems to liquid-crystal pupils for prosthetic eyes to wearable muscle oxygenation sensors, are fresh evidence of the many ways that photonics can be applied to create a better world.

Disease detection from cheek cells

The volunteer judges selected Hariharan Subramanian's simple cheek swab for early screening for lung cancer — for which there is no existing screening method beyond a traditional biopsy — for first prize.



Images courtesy Hariharan Subramanian

The PWS technique for detecting lung cancer doesn't require the examination of the tumor itself. Top two rows are non-cancerous cheek cells from three different people. Mostly blue coloration in the PWS images (second row) indicates normal, or negative for lung cancer. The bottom two rows show cheek cells from three other patients. Red coloring in the bottom-row images is a marker for lung cancer.

Subramanian is a research associate at Northwestern University (USA). He and his Illinois colleagues, who include Hemant Roy of NorthShore University HealthSystem and Vadim Backman, director of the Biophotonics Lab at Northwestern, have developed the highly accurate test based on partial-wave spectroscopic (PWS) microscopy. The non-invasive test is sensitive enough to identify cancer cells well before normal histopathological methods can because it focuses on smaller-than-microscopic disturbances at the nano level.

Subramanian, who co-authored and presented "Optical screening for lung cancer using epithelial cells obtained from buccal mucosa" at Photonics West, says the test could be readily used within the primary care setting.

"PWS is a paradigm shift, in that we don't need to examine the tumor itself to determine the presence of cancer," Subramanian says.

"The potential for this approach to change detection of lung cancer, and thus save lives, is tremendous," adds Duke University's Adam Wax, one of the judges.

Subramanian notes that there is a huge need to screen for lung cancer, the leading cause of cancer-related death in the United States, with five million possible patients requiring diagnosis. The disease is already advanced by the time most lung-cancer patients develop symptoms. He points out that the market for such a screening method could be worth $5 billion — similar to the existing market for cervical cancer screening.

Backman and Roy have previously used PWS to assess the risk of colon and pancreatic cancers, also with promising results. And the researchers

have an exclusive license for the technology, which is based on two approved patents.

TACTILE IMAGING SYSTEM

The second- and third-place winners are also hopeful of learning how to further develop and fund their photonics innovations for a better world.

In second place, SPIE Member Chang Won of Temple University (USA) earned a place at the entrepreneurship academy to develop a business plan for a novel system for detecting malignant breast tumors using tactile imaging. The system is based on total internal reflection principles and can pick up signs of early-stage malignancies at a depth of 3 cm.

His target market is small clinics in China, India, and other countries where hospitals and imaging centers are sparsely located.

Judges for the Biophotonics Startup Challenge were (seated left to right): SPIE members Adam Wax (Duke University), Linda Smith (Ceres Technology), and Brandon Yee (Daylight Solutions), and Sergey Egorov (Del Mar Photonics and Tech Coast Angels). Aspiring biophotonics entrepreneurs (standing, left to right) are: Hariharan Subramanian, Chang Won, Natan Shaked, Babak Shadgan, Jerome Lapointe, Yann Cotte, Michelle Xu, and Yuan Luo.

INTERFEROMETRIC MICROSCOPE

The third place at the academy went to SPIE member Natan Shaked, a post-doc researcher at Duke University (USA) who has developed a small interferometric microscope that can be used to detect diseases such as malaria. The "InCH" microscope has an interferometric chamber and a compact and portable quantitative phase instrument for label-free cell imaging.

The microscope provides better imaging than either brightfield or fluorescence microscopy, Shaked says. The portable instrument, which costs less than $500, could ultimately be integrated in a cell-phone-sized handset.

OTHER PROMISING TECHNOLOGIES

Honorable mentions at the Biophotonics Startup Challenge went to five others, four from Canada. Fourth- to eight-place finishers in order, were:

- Jerome Lapointe of École Polytechnique de Montréal (Canada) for an artificial eye that uses LCDs to simulate pupil reactions
- SPIE member Michelle Xu of University of Toronto (Canada) for silicon-based cancer sensors
- SPIE member Behnam Molavi of University of British Columbia (UBC) (Canada) for a wearable blood-oxygenation sensor for exercise training
- SPIE member and D.J. Lovell scholarship recipient Babak Shadgan of UBC for early diagnosis of acute compartment syndrome using near-IR spectroscopy
- SPIE member Yuan Luo of MIT (USA) for a real-time, 4D holographic imaging system

ASPIRING BIOPHOTONICS ENTREPRENEURS

Other participants who pitched their ideas to the judges were:

- Myunghwan Choi of Korea Advanced Institute of Science and Technology (KAIST) for optical drug-delivery system
- Yann Cotte of École Polytechnique Fédérale de Lausanne (EPFL) (Switzerland) for optical device for systematic food inspection
- Amos Danielli of Washington University in St. Louis (USA) for magnetic modulation fluorescence biosensing for rapid detection of specific DNA and proteins at low concentrations
- Perry Edwards of Pennsylvania State University (USA) for nonscanning holographic coherent anti-Stokes Raman microscope
- Alexander Kalyanov of Saratov University (Russia) for a laser Doppler flowmeter
- Etienne Shaffer of EPFL for an optical device for early-stage cancer diagnostics
- Natlja Skrebova Eikje of MC Professional OÜ (Estonia) for skin applications development
- Jonghee Yoon of KAIST for optical control of urinary bladder contraction using femtosecond laser pulses ■

ENTREPRENEURSHIP FOR A BETTER WORLD

The Biomedical Engineering Entrepreneurship Academy at University of California, Davis, is a one-week, intensive program that brings grad students, postdocs, and faculty together with business leaders, financial analysts, intellectual property experts, and venture capitalists.

Attendees explore market opportunities surrounding their research, refine their presentation pitches, and receive feedback from biomedical industry experts about their plan to commercialize their work. A series of networking and mentoring sessions is included in the program.

"The network is the innovation" says Academy director Andrew Hargadon, the founding director for the Center for Entrepreneurship at UC Davis.

For more information: entrepreneurship.ucdavis.edu/bmea.php

More articles in SPIE Newsroom

Technical articles on the latest advances in biomedical optics and medical imaging are available in a free news feed from the SPIE Newsroom at spie.org/news-biomedical.

The SPIE Newsroom offers news feeds and monthly e-mail alerts on 12 other specific topics, along with video interviews of research innovators and entrepreneurs, industry technical reports, and updates on new optics and photonics products.

The SPIE Newsroom also publishes a list of the most-downloaded technical articles each month at spie.org/top10-news.

The SPIE Digital Library (SPIEDigitalLibrary.org) and SPIE Press (spie.org/press) also have numerous publications on microscopy, bioluminescence, and other biomedical optics topics.

Technology may improve devices for clogged arteries

Canadian researchers have proposed a new optical tool for angioplasty balloon manufacturers that could ultimately lead to better treatment of clogged arteries and better devices to treat cardiovascular problems.

Writing in a recent article for the SPIE Newsroom, Guy Lamouche, Sébastien Vergnole, and Hamed Azarnoush of the Industrial Materials Institute at the National Research Council say that intravascular optical coherence tomography (IVOCT) technology could provide powerful development information for manufacturers of angioplasty balloons.

Their NRC lab in Québec is involved in developing materials for the next generation of these and similar biomedical devices.

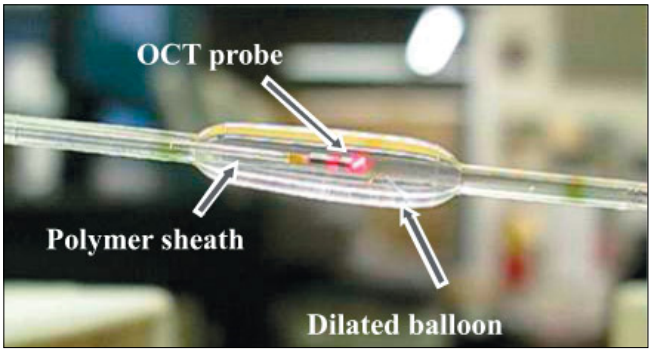


Image courtesy NRC.

OCT probe monitoring balloon inflation.

Balloons for angioplasty

The balloons used in an angioplasty procedure, where a balloon-tipped catheter is inserted into an artery and inflated, must be well designed and vigorously tested. A balloon rupture during the procedure could be fatal.

Manufacturers test the balloons through inflation under predetermined conditions, and this is traditionally done with an external laser scanner that provides measurements of the balloon's outer diameter at a given location. However, the NRC researchers note, these measurements are only obtained from a side view and from a particular orientation.

IVOCT allows a better testing method, they say, because it provides for full, 3D characterization of balloon diameter and wall thickness during the test inflation process and detailed cross-sectional imaging of the artery wall with a resolution of approximately 10 micrometers.

Images may be acquired during a 'pullback' (backward translation of the imaging probe, usually at a predetermined speed), so that pictures are obtained at different positions along the inside of the artery. IVOCT also allows realistic 3D reconstructions.

Based on OCT technology

The researchers' IVOCT probe is composed of a single-mode fiber laser, a gradient index lens, and a small prism to redirect light in a direction perpendicular to the probe axis. The whole assembly rotates and translates in a liquid within a polymer sheath.

The semi-compliant balloon is then connected at both ends to a tube. The OCT probe is introduced into the balloon through a T-connector that also connects the balloon to the high pressure line of the deployment tester. The scientists obtained the compliance and elastic modulus by measuring the average diameter of the balloon as a function of the pressure. They also compared the complete data to a 3D simulation of the balloon deformation to infer mechanical properties at all locations.

To monitor balloon inflation under more realistic conditions, they used the same setup and inserted the balloon inside an excised artery or an artery phantom (a silicone-based structure composed of three layers that provide the same optical signatures as the three artery layers).

The research group is investigating applications of the IVOCT technology in other percutaneous (through-the-skin) coronary intervention (PCI) devices as well, perhaps for new stent designs or new atherectomy devices that remove accumulated plaque on artery walls.

To read more in the SPIE Newsroom and to see a real-time imaging of a balloon deployment inside an artery phantom, go to spie.org/ivoct.

The authors also presented a paper on this technique at SPIE Medical Imaging in February. See: *Proceedings of SPIE* **7964**, 79641V (2011). ■

Better imaging for disease detection

Optics and photonics researchers have developed two new biomedical imaging technologies that improve brain scans and mammography in 3D.

• An international team of physicists and neuroscientists is making MRI brain scans more than seven times faster than currently possible by combining two technical improvements invented in the past decade that separately boosted scanning speeds two to four times over what was already the fastest MRI technique, echo planar imaging (EPI).

U.S. researchers from University of California, Berkeley, and University of Minnesota, along with colleagues at Oxford University (UK), reported that their technique allows for full 3D brain scans in less than half a second, compared to the typical two to three seconds. They describe their method in "Multiplexed Echo Planar Imaging for Sub-Second Whole Brain fMRI and Fast Diffusion Imaging," published in the journal *PLoS ONE* in December 2010.

In addition to broadly advancing the field of neural-imaging, the discovery will impact the Human Connectome Project, a National Institutes of Health-funded program designed to map the connections of the human brain through functional MRI and structural MRI scans of 1200 healthy adults.

• On the breast cancer screening front, the U.S. Food and Drug Administration approved in January the first x-ray mammography device that provides 3D images of the breast.

The Selenia Dimensions System, made by Hologic, is based on digital tomosynthesis, a technology that can see through overlapping tissue often obscured in traditional 2D scans. This allows radiologists to accurately differentiate abnormalities from normal tissue.

Clinical trials showed a 7% improvement in radiologists' confidence in ruling out cancer without recalling the patient for further study. Other benefits include improved lesion and margin visibility.

Read more about these advancements in the SPIE Newsroom (newsroom.spie.org), SPIE Digital Library (spieDigitalLibrary.org), and *SPIE Professional* online (spie.org/spieprofessional). ■

Blogging for a Better World

Articles in our Photonics for a Better World series and in a new blog highlight optics and photonics technologies that bring tangible gains to humanity.

Join the blog discussion celebrating the many ways that photonics are applied in creating a better world at PhotonicsforaBetterWorld.org.

Read more articles in the *SPIE Professional* series at spie.org/betterworld.

Do you have a story to tell about the work that you or colleagues do to make the world a better place? Write to us at spieprofessional@spie.org.

SPIE promotes 67 to Fellow

SPIE is promoting 67 members to the rank of Fellow of the Society this year to recognize the significant scientific and technical contributions of each in the interdisciplinary fields of optics, photonics, and imaging.

The new Fellows are from 17 countries across the globe, including 11 from Asia, eight from Europe, and 41 from the United States.

A large number, nearly 70%, are employed in academic institutions around the world conducting research and teaching a new generation of scientists. Several have won excellence in teaching awards at their universities. Three professors from Ben-Gurion University of the Negev (Israel) made the promotion list this year as did numerous SPIE members employed in industries or government labs that produce the latest lasers, medical imaging equipment, and other optical products, technologies, and research.

"The annual recognition of Fellows provides an opportunity for us to acknowledge members for their outstanding technical contributions and service to SPIE," says SPIE President Katarina Svanberg, who became an SPIE Fellow in 2005.

More than 900 SPIE members have become Fellows since the Society's inception in 1955.

Fellows are recognized at SPIE meetings of their choice throughout the year. This year, 26 new Fellows received their certificates at SPIE Photonics West, four each at SPIE Advanced Lithography and IS&T/SPIE Electronic Imaging, one at SPIE Medical Imaging, and two at SPIE Smart Structures. Others are scheduled to be inducted at SPIE Defense, Security, and Sensing, SPIE Optics and Photonics, and other SPIE meetings.

Five who will be recognized at SPIE Defense, Security, and Sensing in April are among a group of about 20 new Fellows featured on page 10 whose work in optics and photonics has brought them into the aerospace, remote-sensing, security, and defense communities. Their work is done in the service of imaging extrasolar planets, building better photodetectors, electronic displays, biosensors, lasers, and other equipment for soldiers, and conducting specialized research that can have unintended benefits for citizens across national boundaries.

For more information on SPIE Fellows and to learn about nomination criteria and deadlines, go to spie.org/fellows. ■

Three from BGU

Three professors from the same university in Israel, Ben-Gurion University of the Negev, are being promoted this year to the rank of SPIE Fellow.

Ibrahim Abdulhalim, associate professor of electro-optic engineering, created four new courses in biomedical optics at BGU and is recognized for liquid crystal devices and optical sensors. He serves as associate editor of the SPIE *Journal of Nanophotonics* and adviser to the BGU SPIE Student Chapter that was established recently.

Herzl Aharoni, professor emeritus in the Department of Electrical and Computer Engineering, is recognized for developing integrated silicon LEDs and contributions to the research and realization of ITO/InP photovoltaic structures and devices.

Shlomi Arnon, associate professor and a founding member of the Department of Electro-Optical Engineering, is honored for his work with laser satellite communication, optical wireless communication, and sensor networks.

See page 36 for information about the upcoming SPIE Defense, Security, and Sensing meeting 25-29 April.

For more information on SPIE Fellows and to learn about nomination criteria and deadlines, go to spie.org/fellows.

Ibrahim Abdulhalim
Ben-Gurion Univ. of the Negev, Israel

Samuel Achilefu
Washington Univ. School of Medicine in St. Louis, USA

Ali Adibi
Georgia Institute of Technology, USA

Lahsen Assoufid
Argonne National Lab, USA

Alexander Balandin
Univ. of California, Riverside, USA

John Ballato
Clemson Univ., USA

Irving Bigio
Boston Univ., USA

Mark Brongersma
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John Petersen
Petersen Advanced Lithography Inc., USA

Costas Grigoropoulos
Univ. of California, Berkeley, USA

Xuelong Li
Xi'an Institute of Optics and Precision Mechanics, China

Radislav Potyrailo
GE Global Research, USA

Khaled Habib
Kuwait Institute for Scientific Research, Kuwait

Rongguang (Ron) Liang
Carestream Health Inc., USA

Ileana Rau
Polytechnical Univ. of Bucharest, Romania

Ahmed Hassanein
Purdue Univ., USA

Lenny Lipton
Oculus3D, USA

Halina Rubinsztein-Dunlop
Univ. of Queensland, Australia

Naoya Hayashi
Dai Nippon Printing Co. Ltd., Japan

Tom Mackay
Univ. of Edinburgh, United Kingdom

Winston Schoenfeld
Univ. of Central Florida, USA

Continued on page 13 ▶

SPOTLIGHT on
SPIE Fellows in defense and aerospace communities

The new class of 67 SPIE Fellows includes 21 leading optics and photonics experts whose research, teaching, and innovation have been funded by or involved in the defense, security, space, and remote-sensing communities.

Because of their close involvement with SPIE Defense, Security, and Sensing, five in this group have elected to receive their recognition at the annual symposium on Monday 25 April.

SPIE Professional will highlight the achievements of several groups of Fellows and SPIE Senior Members during the year, beginning with this set whose achievements range from imaging extrasolar planets and human biological tissue to building better photodetectors, electronic displays, biosensors, lasers, and other equipment for soldiers, astronauts, cancer patients, and ultimately all of humanity.

Herzl Aharoni (Israel)
Ben-Gurion University

Herzl Aharoni is professor emeritus of electrical and computer engineering at Ben-Gurion University of the Negev where he has won numerous excellence-in-teaching awards over nearly 40 years of teaching. He is honored for his achievements in the research, development, invention, and realization of two-terminal and multi-terminal monolithically integrated, single-crystal silicon light-emitting devices (SiLEDs) and for innovative contributions to the research and realization of ion-beam-sputtered thin indium-tin-oxide (ITO) film properties, and ITO/InP photovoltaic devices. An Israeli Air Force veteran who served as a radio electronics technician, Aharoni also conducted research with the NASA Jet Propulsion Lab in the USA.

Susan Allen (USA)
Arkansas State University

Susan Allen, director of the Arkansas Center for Laser Applications and Science and distinguished professor of chemistry and electrical engineering at Arkansas State University, is an expert in the use of lasers and spectrometers to study basic optical properties of materials. She is recognized for her seminal contributions in laser-assisted particle removal, laser-driven reactions, and laser-matter interactions. Allen was one of the first people to use focused lasers to deposit materials with a process that she and her colleagues termed laser chemical vapor deposition (LCVD). Her research, which has received funding from the U.S. Army and Air Force as well as DARPA and industry, has applications in improving optical qualities of materials, repairing circuits, detecting surface defects, sensing remote objects, and others.

Shlomi Arnon (Israel)
Ben-Gurion University

Shlomi Arnon, associate professor and founding member of the department of electro-optical engineering at Ben-Gurion University, is honored for his work with laser satellite communication, optical wireless communication, and sensor networks. Arnon has expanded his research to include underwater optical wireless communication where there is a growing need for ocean observation systems. He and his colleagues have proposed a nonline-of-sight network concept using back reflection of the propagating optical signal at the ocean-air interface to derive a mathematical model of the channel. Arnon has also involved his students in projects to develop systems that would detect human survival after earthquakes, infant respiration to prevent cardiac arrest and apnea, and falls in the case of epilepsy sufferers and elderly people. An optical radar system developed by his students helps blind people maneuver around obstacles. He has served on the organizing committee for the free-space laser communications conference at SPIE Security and Defence.

Farzin Amzajerdian (USA)
NASA Langley Research Center

Farzin Amzajerdian, senior research scientist for aerospace systems at NASA Langley Research Center, is recognized for laser remote sensing technologies. Amzajerdian devised the concept, designed, and built laboratory and prototype units of a continuous wave all-fiber coherent lidar capable of providing wind velocity and high-precision ground velocity and altitude data. This lidar instrument is expected to become a standard landing sensor for all NASA landing vehicles for future trips to the moon and Mars. He has won numerous NASA awards for his innovations in developing new instruments and technologies for applications ranging from improved weather prediction to autonomous landing and hazard avoidance and laser risk reduction.

Alexander Dirochka (Russia)
Orion Research and Production Association

The scientific secretary in Orion, the State Scientific Center of the Russian Federation, Alexander Dirochka is honored for his pioneering work in the fields of semiconductor cathodoluminescence and the optics of quasi-two-dimensional layered semiconductors. His achievements also extend to

the study of optical and photoelectric phenomena in layered semiconductors. Dirochka, a member of the former SPIE Russia Chapter, has chaired a number of conferences co-sponsored by SPIE on night-vision devices, and is a professor and deputy head of the Physical Electronics Department at the Moscow Institute of Physics and Technology.

Wolfgang Ecke (Germany)

IPHT Jena

A professor at the Institute of Photonic Technology in Jena, where he is vice-head of the fiber-optic systems research group, Wolfgang Ecke is honored for achievements in the science and implementation of fiber-optic sensors for structural monitoring, particularly with fabrication of large arrays of fiber Bragg grating sensors suitable for extreme environments. He is also recognized for his collaborations with industry, which have brought his research into practical applications in the monitoring of spacecraft health and other structures. Ecke is a program committee member for the Fiber-Optic Sensors and Applications conference at SPIE Defense, Security, and Sensing.

J. Gary Eden (USA)

University of Illinois at Urbana-Champaign

Gary Eden is director of the Laboratory for Optical Physics and Engineering at the University of Illinois at Urbana-Champaign and the 2010 winner of the SPIE Harold Edgerton Award. He is honored for achievements in laser physics, ultrafast science, and molecular spectroscopy where he has been active in developing technologies for commercial applications. Eden, co-founder of a high-tech startup, Eden Park Illumination, has 53 U.S. patents granted or pending. His discovery and development of microcavity plasma light sources has demonstrated a novel class of photonic devices with major scientific and commercial applications in high-luminance lighting, chemical sensing, high-resolution displays, versatile photodetectors, and phototherapeutics. Working at the U.S. Naval Research Lab in the 1970s, Eden made contributions to ultraviolet and visible lasers and laser spectroscopy, including co-discovery of the KrCl excimer gas laser emitting in the UV.

Christoph Grein (USA)

University of Illinois at Chicago

An entrepreneur and professor at the University of Illinois at Chicago, Christoph Grein is honored for his award-winning work in novel HgCdTe materials and infrared detectors. He has been a leader in demonstrating how superlattice design can impact the charge carrier lifetime through the suppression of Auger recombination mechanisms, and his modeling efforts have played a pivotal role in several defense and aerospace contracts for the development of type-II superlattices for IR detectors. Grein is director of graduate studies and associate director of the Microphysics Laboratory in the Physics Department at UI. He also has executive roles in EPIR Technologies and Sivananthan Laboratories.

Fredric M. Ham (USA)

Florida Institute of Technology

Fredric Ham, assistant dean for research and professor of electrical engineering in the College of Engineering at Florida Institute of Technology, is one of the leading figures in the computational intelligence and signal-processing communities and is honored for development of optical methods for determining blood glucose concentrations. An award-winning teacher and co-author of "*Principles of Neurocomputing for Science and Engineering*, Ham's cutting-edge research involves artificial neural networks, biomedical signal processing, biosensors, acoustics, digital signal processing, digital image processing, and wireless network security. Ham has also been involved in the planning and session chairing for the Independent Component Analyses, Wavelets, Neural Networks, Biosystems and Nano-engineering conference at SPIE Defense, Security, and Sensing. As a staff engineer with the Harris Corp. in the 1980s, he worked on the Hubble telescope.

Ali Javan (USA)

Massachusetts Institute of Technology

Ali Javan, the Francis Wright Davis Professor of physics at MIT, is the inventor of the HeNe gas laser and one of the many luminaries celebrated during the 50th anniversary of the laser last year. He is honored for his original contribution and leadership role in the fields of laser and quantum electronics. Javan has conducted pioneering work for defense and other industries on high-resolution laser spectroscopy, fiber optics, and radar.

Sanjay Krishna (USA)

University of New Mexico

Sanjay Krishna, the 2008 recipient of the SPIE Early Career Achievement Award and recipient of the Defense Intelligence Agency's 2007 Chief Scientist Award, is honored for achievements in quantum dot-in-a-well (DWELL) and strained layer superlattice infrared photodetectors. An innovator in semiconductor material development, Krishna is associate director of the Center for High Technology Materials at University of New Mexico where he is also professor of electrical and computer engineering. He is also CTO and co-founder of SK Infrared, a spin-off company from UNM that is investigating the use of IR imaging for non-invasive medical diagnostics. He was named the 2010 UNM Teacher of the Year and is the adviser to the SPIE Student Chapter.

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SPIE Fellows in defense and aerospace

◀ Continued from page 11

Jay Kumler (USA)
Jenoptik Optical Systems

Jay Kumler, honored for his achievements in optical design and fabrication, serves on the SPIE Board of Directors and is the current president of the American Precision Optics Manufacturing Association. Along with being an entrepreneur, Kumler has invented innovative optical designs for hyperspectral imaging, UV corrected photography lenses, fisheye lenses for several formats, wide-angle projection lenses for flat screens, cameras for detection of biohazards, tracking telescopes, and image-intensified cameras. The company he formed in Florida, Coastal Optics, was acquired by Jenoptik in 2006 and Kumler now serves as director of Jenoptik's North American business. Coastal Optics has been a key supplier for Lockheed Martin and Ball Aerospace for the Webb Space Telescope and the United States' airborne laser program.

Yung-Sheng Liu
National Tsing Hua University, Hsinchu

Yung-Sheng Liu, vice chancellor of the National Tsing Hua University and former director of the Institute of Photonics Technologies there, is honored for his pioneering research and leadership in high-power, solid-state, short-pulse lasers; laser direct writing and ablation; optical interconnect; and LEDs. His long career has included initiating the first LED lighting program at GE and leading the largest government-sponsored LED research team at the Taiwan Industrial Technology Research Institute. Some of his work with DARPA is classified, but he received recognition in 1998 for leading a large project on polymer optical interconnect technology. Liu founded the Taiwan Optical Communication Industry Association in 2001 and the Semiconductor Lighting Industry Association in 2003.

Bruce Macintosh (USA)
Lawrence Livermore National Lab

Bruce Macintosh, principal investigator on the Gemini Planet Imager under construction for the Gemini Observatory and physicist at the Institute of Geophysics and Planetary Physics at Lawrence Livermore National Lab, is honored for high-contrast astronomical imaging of extrasolar planets. He has designed techniques, instruments, and methods to resolve the faint signal of an extrasolar planet, leading the team that used adaptive optics to detect the three-planet system orbiting the star HR8799 in 2008. Macintosh leads the team at LLNL that developed the spatially-filtered wavefront sensor, predictive Fourier control, and comprehensive error budgets that will be used in the GPI project, which will be the most advanced adaptive optics system in operation when it sees first light, scheduled for 2012.

Allen Mann (USA)
AM Associates

Allen Mann, a lens designer of visual and infrared optical systems and manager of complex electro-optical systems, is honored for innovative achievements in optical design, with particular emphasis on refractive and reflective visual and IR zoom lens systems. He retired from Hughes Aircraft after managing projects involving military gunsights, target designators, beam directors, and similar projects and is now an independent consultant. He also taught a course in scientific Russian to engineers and scientists at Hughes and will teach a course on IR optics and zoom lenses in April at SPIE Defense, Security, and Sensing. He served in the Air Force Intelligence Service from 1950 to 1954 where he learned Russian.

Jerry Meyer (USA)
Naval Research Laboratory

Jerry Meyer, head of quantum optoelectronics at the U.S. Naval Research Laboratory, is honored for development of midwave IR semiconductor lasers, especially quantum cascade lasers (QCL). His group work with inter-sub-band QCL (IQCL) demonstrated CW operation above room temperature in 2008, establishing IQCL's potential for medical, defense, and industrial applications. He is also a leading authority on "negative luminescence" devices that absorb blackbody radiation but strongly suppress re-emission, making them "appear" much colder than they actually are. Meyer was a guest editor for a special issue of *Optical Engineering* last year on QCLs and ICQLs.

Peter Powers (USA)
University of Dayton

Peter Powers, chair of the Physics Department at University of Dayton, is honored for achievements in nonlinear optics, especially parametric processes. Powers has developed innovative and practical frequency-conversion sources from the mid-infrared to the terahertz spectrum. Tools such as the seeded optical parametric generator are vital for a wide range of applications in spectroscopy, environmental science, safety and security, biomedical imaging, and trace gas detection and sensing. Often collaborating with the nearby Air Force Research Lab, Powers has developed a rapid frequency scanning technique for an IR chemical-sensing system and a technique to produce tunable CW THz radiation to locate structural cracks in metal and plastic for aircraft inspection.

Stanley Rogers (USA)
Air Force Research Lab

Stanley Rogers of the U.S. Air Force Research Lab, the technical lead for Photonic MEMS and Electronics and a technical representative for DARPA's Large Area Coverage Optical Search Track and Engage (LACOSTE) sensor program, is honored for achievements in photonic MEMS (spatial light modulators) and nanotechnology. An author of technical books

and an academic adviser for University of Dayton students, Rogers has distinguished himself by carrying out and leading significant research in memristors, metamaterials, MEMS, and nanophotonics technologies. He was a key technical contributor on a DARPA surveillance system that employs a MOEMS micro-shutter array to enable persistent tactical surveillance of moving vehicles in a large urban battlefield.

Kalluri Sarma (USA)
Honeywell Aerospace Advanced Technology

Kalluri Sarma, senior research fellow for Honeywell Aerospace Advanced Technology, is honored for achievements in electronic displays, including AM LCDs, AM OLEDs, and flexible displays that Honeywell supplies for cockpit display systems for the space shuttle and military aircraft. His seminal work to improve the viewing angle for AM LCDs, by developing halftone pixel circuits that match the unique electro-optical characteristics of AM LCD pixels, has enabled cross-cockpit viewing. Sarma has also been instrumental in starting the U.S. Army Research Lab Flexible Display Center at Arizona State University.

Alexander Toet (Netherlands)
TNO Defence Security and Safety

Alexander Toet, senior research scientist in the Perception and Simulation Department at TNO, is honored for achievements in image fusion and digital image processing. He has made important contributions in target-detection and human-perception models, electro-optical device performance evaluation, signal and imaging processing, computational human-vision models, target-acquisition simulation, and camouflage development. Toet has developed several grayscale and color image fusion techniques as well as a patented color-transfer method that provides stable colorization under variations of scene content.

Quing Zhu (USA)
University of Connecticut

Quing Zhu, a professor of electrical and computer engineering at University of Connecticut, is honored for achievements in combining near IR diffused light and ultrasound technologies for medical diagnostics. Under the Department of Defense Breast Cancer Research Program, Zhu developed a combined NIR and ultrasound approach to distinguish early-stage breast cancer from non-cancerous lesions. This optical tomography modality allowed researchers to calculate the concentration of oxygen-carrying blood cells — or hemoglobin — and microvessels present in each lesion. Since a high density of microvessels in a tumor is known to be highly correlated with malignancy, this technique has potential for non-invasively distinguishing malignant and benign masses and thereby reducing the number of biopsies. Preliminary results also suggest that once one type of imaging has pinpointed a tumor, OT may predict response to chemotherapy in advanced-stage disease. ■

SPIE Fellows

◀ *Continued from page 9*

Dan Schonfeld
Univ. of Illinois at Chicago, USA

Janis Spigulis
Univ. of Latvia, Latvia

Andrew Woods
Curtin Univ., Australia

Chandra Shakher
Indian Institute of Technology Delhi, India

Xiaowei Sun
Nanyang Technological Univ., Singapore

Chih-Chung Yang
National Taiwan Univ., Taipei

Geoffrey Smith
Univ. of Technology Sydney, Australia

Malvin Teich
Boston Univ., USA

Yu-Jin Zhang
Tsinghua Univ., China

Robert Socha
ASML US Inc., USA

Alan Willner
Univ. of Southern California, USA

Voting for SPIE leadership 27 June – 10 August

The SPIE election for officers and members of the Board of Directors will be held from 27 June to 10 August. Members eligible to vote will receive an e-mail message with instructions on the electronic voting process.

Members will select four new directors and vote on candidates for vice president and secretary/treasurer. Directors serve three-year terms and officers serve for one year.

The candidates for vice president are:

- James Grote, Air Force Research Lab (USA)
- H. Philip Stahl, NASA (USA)

Brian Lula, Physik Instrumente LP (USA), is the nominee for secretary/treasurer.

SPIE members will choose four candidates for director from eight members nominated:

- Henri-Jean Drouhin, École Polytechnique (France)
- Judy Fennelly, Air Force Research Lab (USA)
- Maryellen Giger, University of Chicago (USA)
- Leonid Glebov, University of Central Florida (USA)
- John Greivenkamp, University of Arizona (USA)
- Fernando Mendoza Santoyo, Center de Investigaciones en Optica (Mexico)
- Seung-Han Park, Yonsei University (South Korea)
- Sergio Restaino, Air Force Research Lab (USA)

The election results will be announced at the SPIE annual general meeting in San Diego (USA) in August.

Ballots have changed

New for this election, the ballot will not list candidates for president or president-elect. Under the SPIE bylaws, the winning candidate for vice president automatically becomes president-elect the following year, and the president-elect for the current year becomes president the following year.

Thus, Eustace Dereniak of University of Arizona (USA), president-elect for 2011, will be seated automatically as president in 2012. William H. Arnold of ASML USA, serving as vice president for 2011, will automatically become president-elect for 2012.

Questions for the candidates?

If you would like to learn more about SPIE vice-president candidates Grote and Stahl to help decide your vote, send questions to governance@spie.org.

SPIE may use the questions and answers in an upcoming news release or article. ■

Nominations for next year

The SPIE nominating committee is now accepting recommendations for the 2012 election slate.

A candidate for SPIE officer or director must be a member in good standing of SPIE and available to participate in three board meetings each year.

To make a recommendation, or for more information, e-mail governance@spie.org. Please include a paragraph stating why the person is qualified to serve.

SPIE grant helps high schoolers learn and teach diffraction, refraction

High-school science teacher Deborah Carder has stretched her optics lessons across the entire Fruitvale, TX (USA), school district with the aid of an SPIE education outreach grant.

The equipment the 2010 grant paid for "is constantly in use in all of my science classrooms as well as other science classes," she says.

Her students also used SPIE grant funds to purchase materials for an annual Science Show that brings hands-on science lessons to elementary, middle, and junior high school students. The high-school students build projects for the Science Show and lead the younger students in inquiry-based, age-appropriate experiments and demonstrations.

"This causes the older students to learn about their chosen topics in depth (since they will have spent prior weeks researching and preparing) and allows the younger students to see how exciting science can be," Carder says.

Last October, Carder's students previewed the 2011 Science Show, to be held 13 May, to a group of younger students who learned about refraction and reflection while wearing a pair of goggles with glass lenses that cause images to be distorted and turned upside down.

Carder's students also used grant funds to build an inflatable tent with a reflective interior for the event. Students entering a fog-filled tent with handheld lasers learned how a laser beam is reflected in different directions due to the curved interior reflective surface. Another student constructed a tent lined with holiday lights. He then passed out diffraction-grating glasses to each child and directed them through the maze of lights.

A high-school student fits a boy with goggles at the Science Show.

"I believe the students have a much greater understanding and love of optics because of this equipment," Carder says.

The Fruitvale school was one of 32 non-profits from around the world that received SPIE education outreach grants in 2010.

The next deadline to apply for an SPIE grant is 31 May. Apply online at spie.org/outreach. ■

Creativity FIRST

An American entrepreneur advocates for the next generation of science and technology innovators.

By **Dean Kamen**

For many years, I didn't think that I had much in common with my father career-wise. He was a commercial artist for comic books, magazines, and the like. Art is something for which I have no discernible talent; give me a ruler and I can barely draw a straight line. It therefore came as a surprise, and a welcome one, when someone pointed out that the bridge between art, entrepreneurship, and inventing certainly does exist: Creativity.

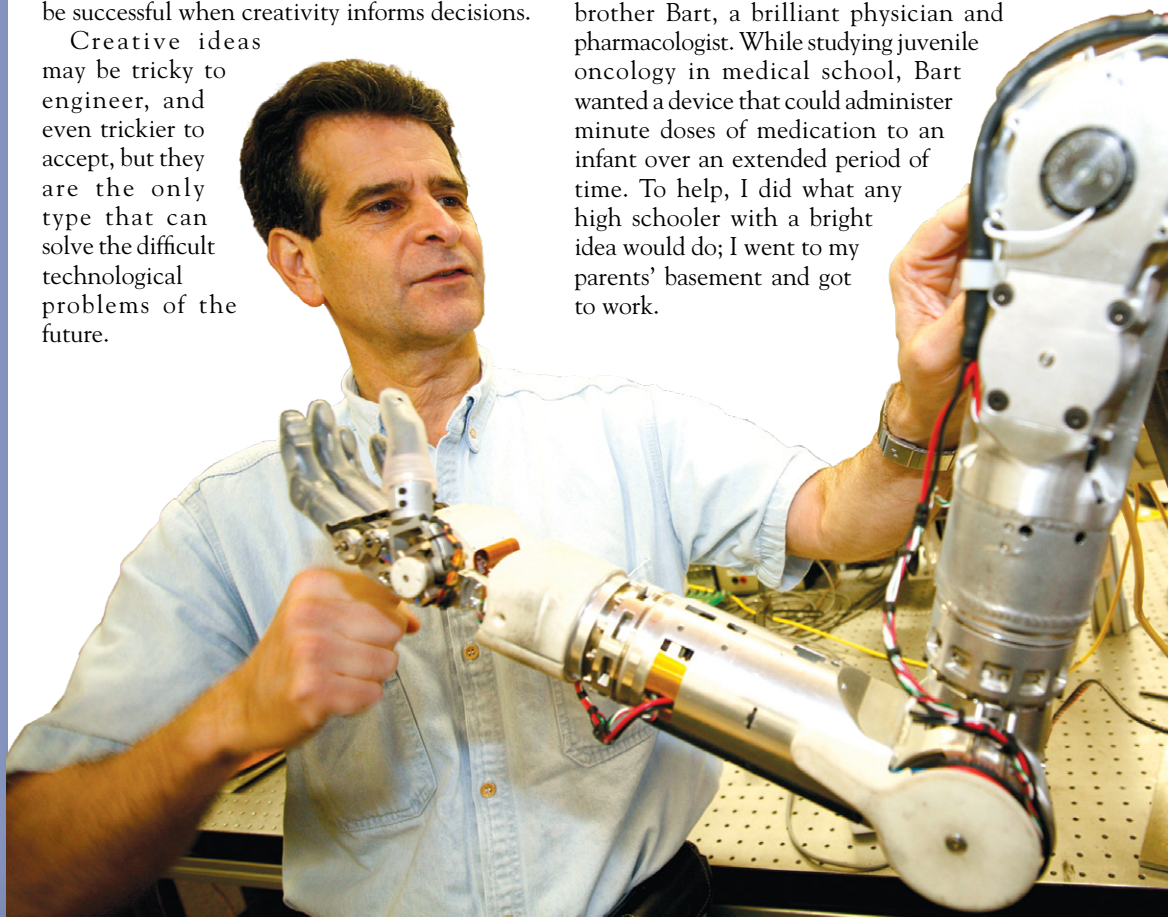
The motto of my company, DEKA Research & Development Corp., is "Evolved Thinking." My talented team of engineers in New Hampshire dedicate themselves to finding new solutions to old problems. Innovation and invention can only be successful when creativity informs decisions.

Creative ideas may be tricky to engineer, and even trickier to accept, but they are the only type that can solve the difficult technological problems of the future.

Beginning with light

My first foray into entrepreneurship was in the field of photonics. During the mid-1960s, the Hayden Planetarium, a staple of the New York museum scene and a short distance from my childhood home on Long Island, was looking to revamp its light show. The device I presented them — an electronic box far smaller and simpler than the obsolete equipment they had been using — raised a few eyebrows. However, they apparently felt I came for the right price (which, not by coincidence, was just enough to buy my first car).

My focus on medical technologies came as a result of another family member — my older brother Bart, a brilliant physician and pharmacologist. While studying juvenile oncology in medical school, Bart wanted a device that could administer minute doses of medication to an infant over an extended period of time. To help, I did what any high schooler with a bright idea would do; I went to my parents' basement and got to work.



Dean Kamen with a DEKA prosthetic arm in 2009.

FIRST® in science

FIRST® (For Inspiration and Recognition of Science and Technology) is a not-for-profit organization founded in 1989 by technology entrepreneur and prolific inventor Dean Kamen.

Led by Kamen's vision, it designs accessible and innovative programs that motivate young people to pursue education and career opportunities in science, technology, engineering, and math while also building self-confidence, knowledge, and life skills.

FIRST programs include an annual robotics competition and real-world research for kids age 6 to 18. Included are activities for the younger children, age 6 to 9, that introduce real-world engineering challenges and Gracious Professionalism™, the idea that fierce competition and mutual gain are not separate notions.

The organization will also provide $14 million in college scholarships from more than 140 scholarship providers this year.

More information: www.usfirst.org.

My prototype eventually evolved into the first portable infusion pump, with applications for a variety of conditions, including diabetes. In 1976, at the age of 25, I founded AutoSyringe to manufacture and market the pumps.

Creativity without restraint

Within five years, the company confronted a particularly difficult entrepreneurial decision: to sell, or not to sell?

The great benefit of being a technologist and an entrepreneur is the freedom that comes with determining your own goals and priorities. The decision to sell AutoSyringe to Baxter International not only gave me the freedom to form DEKA, but also to focus exclusively on those aspects of the inventing process that truly interest me and my engineers: front-end research and development.

DEKA's ability to chart its own course has allowed us to focus on the development of new technologies for a variety of corporate clients. Our inventions include the HomeChoice peritoneal dialysis system, the Hydroflex surgical irrigation pump, an improved design for the stent, the iBOT mobility device, and the Segway Human Transporter.

Creative freedom unburdened by external restraints has also allowed DEKA to develop internal projects directed at solving some of the world's most pressing problems.

We are currently working on the next generation of Stirling cycle engines — portable, point-of-use generators that produce clean electricity from any liquid or gaseous fuel. (A trial unit that was set up in Bangladesh powered a village's lighting and computers using only the methane released by a pit of cow dung.) Our Slingshot water purification system can produce 1000 liters of water per day using the same amount of electricity as a handheld hair dryer.

Given that billions of people are currently deprived of the basic necessities of water and power, these technologies have the potential to fundamentally change the human condition. And it is because of entrepreneurial freedom that DEKA has had the ability to develop them.

Photo by Connor Gleason

Something worth doing

Most of the time, however, outside clients come to DEKA and propose a research project to our engineers. This was the case for one of our most recent, exciting, and challenging projects: a prosthetic arm for U.S. military veterans.

Several years ago, a group of passionate and committed representatives from DARPA (the Defense Advanced Research Projects Agency) came to my office in Manchester, NH.

Photo by Lipofsky.com

The Black Eyed Peas singer will.i.am (in suit) joined Dean Kamen (in blue) at Southern New Hampshire University (USA) in January to launch the 20th season of the FIRST® Robotics Competition. The international robot-building contest challenges high-school students, working with professional mentors, to experience the excitement of science, math, engineering, technology, and innovation. The championship event will be held in Missouri in April.

Their order was as concise as it was daunting: design a prosthetic arm that has the ability to pick up a grape (without breaking it) or a raisin (without dropping it). It also needed to offer multiple degrees of freedom and mimic the size and weight of a human arm.

I was candid; I told the DARPA folks they were nuts.

My reaction should have been the first clue that it was a project worth taking on. Most great inventions were thought to be crazy at some point. The next day, I agreed that DEKA would take on the challenge.

A year later, our engineers had produced a prototype that performed the tasks laid out by DARPA. This story highlights what I think is the most important rule of inventing and entrepreneurship: when you take a bunch of people with intelligence, drive, and just a hint of madness, there is nothing that they cannot do.

> "You have teenagers thinking they're going to make millions as NBA stars when that's not realistic for even 1% of them. Becoming a scientist or engineer is."

Career in invention

As proud as I am of the many beneficial technologies that DEKA has produced, the project that gives me the most joy and rewards is FIRST®, a nonprofit I founded 20 years ago to get kids interested in science and technology.

The future belongs to the innovators, and at this moment, the next generation of Americans is not prepared to lead the way. The United States currently ranks 17th in science and 24th in math out of 65 developed countries. As

Continued on page 18 ▶

Segway inventor and entrepreneur **Dean Kamen** holds more than 440 patents. Many of his inventions, such as the first insulin pump for diabetics and a lightweight robotic arm, have expanded the frontiers of health care across the globe. Kamen was inducted into the National Inventors Hall of Fame in 2005 and received the National Medal of Technology in 2000. He attended Worcester Polytechnic Institute in Massachusetts and is an avid advocate for science and technology education.

Creativity First

◀ *Continued from page 17*

Europe and East Asia continue their forward progress toward technological superiority, the United States is more and more at risk of losing our place as one of the world's leading economies.

Now more than ever, young people need to educate themselves in the fields of science, engineering, and technology and, more importantly, find the enthusiasm that will lead to careers in invention and innovation.

> All engineers and technology careerists must take up the mantle of inspiring the next generation of scientific leaders.

Using robotics competitions at various age levels as the catalyst, FIRST teaches kids not only science and technology skills, but also cooperation, teamwork, corporate relations, and communications.

FIRST is not a class, nor would it ever attempt to focus on education. America is not suffering from a lack of qualified science and math teachers, but from a crisis of demand. Kids need to be inspired, not lectured at.

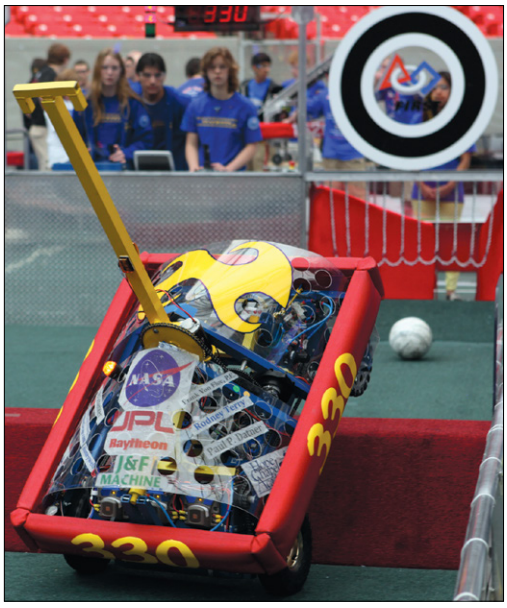


Photo by Adriana M. Groisman

An entry in the FIRST Robotics Competition.

Just as sports and entertainment have given young people no shortage of idols and role models, FIRST uses mentors and engineering professionals to show students the endless possibilities that exist when they exercise the most powerful "muscle" of all — the one between their ears. All engineers and technology careerists must take up the mantle of inspiring the next generation of scientific leaders. The future of this country entirely depends on it.

Future of creativity

A wise man once opined that the harder he worked, the luckier he seemed to be. What was true then is equally true today, especially in the fields of innovation and entrepreneurship.

The true agent of change in this world has always been the will and creativity of smart people.

The world will face many difficult technological challenges in the future. We must do what we can to ensure that future generations are prepared to take on the challenges. ■

SPIE grant enables hands-on learning for after-school sciences program

The Academy of Natural Sciences in Philadelphia, PA (USA), used an SPIE education outreach grant in 2010 to purchase an IR camera, a handheld IR thermometer, and related equipment for its "Seeing Eye to Eye" program. The Academy offers a 90-minute, inquiry-based science lesson to Philadelphia high-school students so they can explore the properties of light and the electromagnetic spectrum and learn about different visual systems in the animal kingdom.

Here, the Academy's Timshel Purdum (right) shows eighth-grade girls in an after-school science program how to use the Extech IRC40 FLIR IR camera. The handheld camera helps students visualize how a snake in complete darkness can detect the IR signature of their mammalian prey by using heat-sensing pits near their jaws. Research suggests that the nerves from these pits transmit data to the snake's optic tectum.

The IR camera has also been used during public events such as the Academy's "Heat Wave" weekend in January as a way of investigating the Albedo affect.

"Having access to this equipment is a unique opportunity," Purdum says, adding that "The student response to using the IR camera in the class has been overwhelmingly positive."

Photos courtesy Timshel Purdum.

Timshell Purdum (center) uses UV lights, a cell phone camera, and other equipment to show students how to view UV reflection on butterfly wings. Male butterflies reflect ultraviolet patterns for mate selection.

The Academy was one of 32 non-profits from around the world that received SPIE education outreach grants in 2010 to buy supplies for science programs and fairs, train teachers, and support summer camps and other activities that increase optics and photonics awareness. Some $85,000 in funding is available.

The next deadline to apply for an SPIE grant is 31 May. Apply online at spie.org/outreach. ■

Free Resources

In addition to education outreach grants, SPIE provides free educational resources to introduce the fields of optics and photonics into the classroom and to the general public.

Educational DVDs and CDs communicate basic principles about light, and posters on infrared radiation, lithography, metamaterials, biophotonics, remote sensing, lasers and photonics in medicine, and related topics increase public awareness about how light is used in daily life.

Kits that allow students to build kaleidoscopes and telescopes are also available.

And SPIE supports science and engineering fairs across the globe by providing awards and helping to find judges.

For more information, go to spie.org/educators

Free online courses for SPIE members

Complimentary online courses from SPIE are a new benefit for membership in the Society.

Two courses taught by science and business educator Jean-luc Doumont are currently available: "Effective Technical Presentations" and "Effective Scientific Papers."

Each of these courses is eligible for .35 units of continuing education credits and is designed to be taken on your time and at your pace. The courses run approximately four hours and are delivered with full video of the instructor, guided presentations (display slides), and tests.

Go to spie.org/courses to learn more about these and other professional development courses from SPIE.

Doumont

Biotronics for defense

There is "out-of-the-blue" potential for DNA in security and defense applications.

By **Emily Heckman**

Emily Heckman, who has a PhD in electro-optics from the University of Dayton, is an electronics research engineer with the Sensors Directorate at the U.S. Air Force Research Laboratory. She is currently the Sensors Directorate representative of the AFRL Biotronics Strategic Technology Thrust (STT) research program.

She has served as co-chair of the Nanobiosystems conference at SPIE Optics and Photonics and is co-chair for the Optical Materials in Defence Systems Technology conference at SPIE Security and Defence.

For a growing number of scientists and engineers, salmon is much more than dinner: it's the natural biological source of genomic DNA that lays the foundation for their research. The use of DNA derived from salmon waste products in photonic and electronic device applications has been growing in scope for the past decade.

The field has developed so extensively, in fact, that recently a new term has been coined to describe it: biotronics. Biotronics is a newly emerging research area that uses biologically based materials for photonics and electronics applications. Currently, DNA and silk are the most prevalent of these materials.[1]

The applications for the DNA-based biopolymer range from the commercial (telecom[2]) to the whimsical (cigarette filters[3]) to the practical (efficient LEDs[4]). Many applications, however, are focused on security and defense. This is due, in large part, to the role of the U.S. Air Force Research Laboratory (AFRL) in promoting this material for optical and electronic device applications.

Several of the DNA-based applications for security and defense have been developed in the past few years. These include electro-optic (EO) modulators, bio-field-effect transistors (BioFETs), electrochromics, energy storage, and electromagnetic interference (EMI) shielding. The research teams in this field are both national and international and hail from academia, government, and the commercial sector.

Purified DNA processed from salmon waste products.

Salvaging salmon waste

The DNA biopolymer most frequently integrated into photonic and electronic devices was developed in collaboration with researchers in Hokkaido, Japan, and the AFRL. Shown above, the DNA is derived from salmon milt and roe sacs, waste products of the large Japanese fishing industry.[5] It is then precipitated with a surfactant complex to make a

SUSTAINABLE RESEARCH: Salmon waste is used in photonic and electronic device applications because it is so plentiful in Japan, inexpensive and is almost 90% pure DNA.

water-insoluble biopolymer.[6]

The unique properties of this low-cost material make it well suited for many photonics applications. It is easily fabricated into a spin-coated thin film and thermally stable. It has low optical loss, low microwave-insertion loss, and has tunable properties such as refractive index, dielectric constant, electric permittivity, and electrical resistivity.

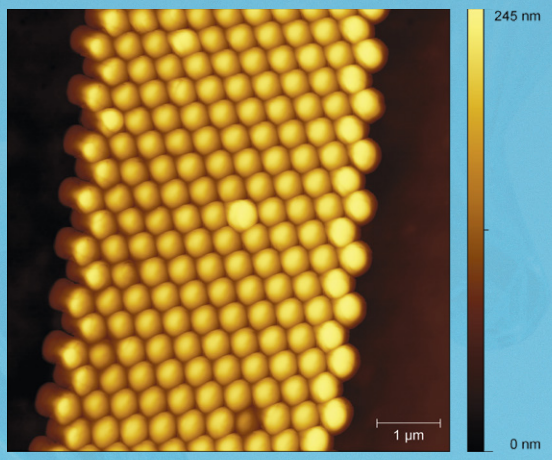
AFRL researchers have found that integrating DNA as the cladding layer in electro-optic waveguide modulators can increase the poling efficiency while maintaining low optical loss.[7] This will potentially allow for low-power EO technology alternatives for applications such as telecom, beam steering, and optical sensing. DNA is also being investigated for use as the active and passive layers in organic FETs. AFRL researchers were able to demonstrate a field-effect current amplification by doping the DNA to increase its conductivity.[8]

Additional DNA research being conducted at the AFRL focuses on the design and fabrication of flexible sensor systems. DNA or RNA oligomer sequences (also known as aptamers) can be specifically selected to bind a target. These targets can range from small molecules to proteins to bacteria, or to other DNA sequences. These aptamers can then be integrated into a number of photonic or electrical systems to transduce the target-binding event into a detectable signal.

Some of the DNA- and RNA-aptamer-based systems currently being investigated are nanoparticles-based colorimetric sensors,[9] fluorescent reporting riboswitches,[10] and aptamer-integrated field-effect transistors (AptaFET).[11]

Blended technologies

Several other research teams from academia and the commercial sector are collaborating with the AFRL to develop DNA-based devices with security and defense applications. At the University of Arizona, researchers have been looking at DNA/sol-gel blends to improve the performance in capacitor applications in energy storage.[12] They found that a 5% DNA /sol-gel blend gave an energy-storage capacity about 50 times larger than that of commercial polypropylene capacitors.



AFM topography image of printed DNA biopolymer nanostructures. Color intensity scale indicates height of pillars.

This technology is expected to impact an array of avionics needs ranging from providing energy storage for solid-state elements to providing materials with exceptional dielectric properties that can be used for a variety of specialized applications.

Also at the University of Arizona, researchers have developed a variant of the nanoimprint lithography (NIL) technique with which nano- and microstructures and devices can be printed in a DNA biopolymer without the need for high temperature and pressure.

The attractive advantage of this approach is that it is possible to incorporate any optically active organic component into this biopolymer, and optical/photonic devices can be faithfully replicated with high fidelity and ease. The figure above shows an AFM topography image of the pillar structures of about 380nm diameter.

Continued on page 23 ▶

More on security and defense

See page 36 for information about the upcoming SPIE Defense, Security, and Sensing meeting 25-29 April.

Get the latest technical and business news about optics and photonics in defense and security at the SPIE Newsroom: spie.org/news-defense

EC proposes R&D reform

The European Commission (EC) has proposed major changes to EU research and innovation funding to make participation easier, increase scientific and economic impact, and provide better value for money.

The proposed "Common Strategic Framework," to be introduced in the next EU budget after 2013, would bring together the current Framework Programme for research, the Competitiveness and Innovation Programme, and the European Institute of Innovation and Technology.

The EC is seeking stakeholder views on the proposed changes and on specific questions set out in a green paper it issued in February.

"We want EU funding to realize its enormous potential to generate growth and jobs and improve quality of life in Europe in the face of daunting challenges like climate change, energy efficiency, and food security," says EC Commissioner Máire Geoghegan-Quinn.

Submit comments by 20 May at ec.europa.eu/research/csfri

LASER Research Advances

More than 50 years after the invention of the laser, laser research continues to make advances in sensing, medical diagnostics, and other areas.

Lasers ID skin cancer

A team at Duke University has developed a promising two-laser microscopy technique that could help doctors better diagnose melanoma, the deadliest form of skin cancer, while potentially saving thousands of lives and millions of dollars in unnecessary biopsies each year.

The tool probes skin cells using two lasers to pump small amounts of energy into a suspicious mole. Scientists analyze the way the energy redistributes in the skin cells to pinpoint the microscopic locations of different skin pigments.

For the first time, scientists have the ability to identify substantial chemical differences between cancerous and healthy skin tissues, says SPIE member Thomas Matthews, a Duke graduate student who helped develop the technique.

Matthews and his collaborators, who include SPIE members Martin Fischer, and Warren S. Warren, director of Duke's Center for Molecular and Biomolecular Imaging, will present an invited paper on "Differentiation of eumelanin and pheomelanin in skin lesions using transient absorption microscopy" at SPIE/OSA European Conferences on Biomedical Optics in May. Their results also appear in the 23 February *Science Translational Medicine*.

Air laser senses bombs

Princeton University engineers have developed a laser-sensing technology that may allow soldiers to detect hidden bombs from a distance and scientists to better measure airborne environmental pollutants and greenhouse gases.

A practical "air laser" would be a powerful tool for remote measurements of trace amounts of chemicals in the air, determining how many contaminants or explosive vapors are in the air and the identity and location of those contaminants.

"We are able to send a laser pulse out and get another pulse back from the air itself," says Richard Miles, professor of mechanical and aerospace engineering at Princeton, the research group leader, and co-author of a paper to be presented at SPIE Defense, Security, and Sensing in April. "The returning beam interacts with the molecules in the air and carries their fingerprints."

The new technique uses a UV laser pulse. The returning beam of light is not just a reflection or scattering of the outgoing beam. It is an entirely new laser beam generated by oxygen atoms whose electrons have been excited to high-energy levels.

Miles collaborated on a paper published in the journal Science with three other researchers from Princeton: Arthur Dogariu, lead author on the paper; James Michael, a doctoral student; and SPIE member Marlan Scully, a professor who holds a joint appointment at Texas A&M University.

Miles, Dogariu, and Michael will present their research on remote air lasing for trace detection at the Advanced Environmental, Chemical, and Biological Sensing Technologies conference at SPIE Defense, Security, and Sensing in Orlando 25 April.

Anti-laser made from loss

Yale University scientists have reported the development of an "anti-laser," in which incoming beams of light interfere with one another in such a way as to perfectly cancel each other out.

The device, which team leader A. Douglas Stone calls a coherent perfect absorber (CPA), takes the laser concept in reverse: In a normal laser, the beam is created by feeding light or electricity through a gain medium like gallium arsenide, with reflectors positioned to keep the beams bouncing through. As the light bounces back and forth, the medium adds more photons to the mix and one of the reflectors is partially transparent to let the amplified beam through the laser.

The structure of the anti-laser device is similar except the incoming laser is countered with a beam that's the opposite of itself, and the medium, silicon, is optimized to make the beam experience a loss of coherence rather than a gain. The result is that the two beams dissipate in the medium and the energy is released as heat.

The discovery could pave the way for a number of novel technologies with applications in everything from optical computing to radiology. Stone and co-authors Wenjie Wan, Yidong Chong, Li Ge, Heeso Noh, and Hui Cao published their findings, "Time-Reversed Lasing and Interferometric Control of Absorption," in the journal *Science* in February. ■

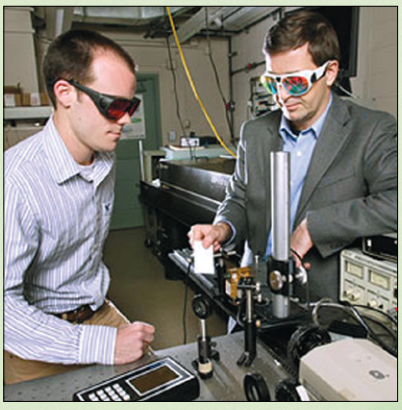


Photo by Frank Wojciechowski

Research team from Princeton that developed the "air laser" technology includes James Michael (left), a doctoral student, and Arthur Dogariu, a research scholar.

Biotronics for defense

◀ Continued from page 21

Composite materials

Researchers at the Universidade de São Paulo in Brazil have been investigating DNA-based, ion-conducting membranes for electrochromic device applications.[13] They found that electrochromic devices made with DNA-based membranes exhibited inserted/extracted charge densities suitable to make them promising materials to be used as solid electrolytes in electrochromic devices.

Electrochromic devices such as these have potential widespread use in security as well as commercial applications. Smart windows can regulate the solar gains of buildings, for instance, and other electrochromic devices can attenuate the glare in windows and mirrors.

Finally, work is being done by researchers at U.S.-based Ipitek on DNA-based composite materials consisting of the DNA biopolymer and metal particles for EMI shielding applications. The materials exhibit excellent EMI shielding effectiveness over a wide RF spectrum ranging from DC to tens of GHz while being non-conductive. The unique properties of these materials (non-conductive, light-weight, easy, and inexpensive to process) could have a significant impact for anti-Electro-Magnetic Pulse (EMP) military defense applications as well as for commercial applications such as EMI-suppression in broadband and high-speed electronics.

Biopolymer future

These applications are only a small sampling of the many possibilities in this emerging research field. As the properties of these biopolymer materials continue to be explored and understood, the applications are sure to expand in scope.

For now, the field of biotronics remains a small but growing community that views their research with delicious potential.

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Biotronics engineering is interdisciplinary

The area known as biotronics or bioelectronics is an interdisciplinary research field that includes elements from biology, chemistry, engineering, and the physical sciences. It can be broadened further to include nanotechnology and nanoscience.

Biotronics engineering technology has the potential to revolutionize the next-generation of polymers and organic-based photonics devices.

Find links and more information about biotronics online at spie.org/spieprofessional.

Student researchers get travel aid

Nineteen students received Newport Spectra-Physics Research Excellence Travel Awards at SPIE Photonics West in January. They were:

Serap Aksu, Salvatore Campione, Ludwig De Clercq, Sarah Erickson, George Fercana, Liang Gao, Melanie Gault, Eric Glowacki, Dag Heinemann, Ninad Ingle, Stephanie Kennedy, Jong-Ha Lee, Wonju Lee, Jheng-Jie Liu, Paul McNamara, Gilad Sharon, Shivaranjani Shivalingaiah, Tristan Swedish, and Bowen Wang.

The awards program provides funding for university students to attend SPIE Photonics West and SPIE Optics and Photonics.

Apply Now

Students with accepted papers for SPIE Optics and Photonics in August should submit their applications for the Newport Spectra-Physics travel awards no later than 10 June. More information: spie.org/travelgrant.

See page 4 for participants and winners of the biophotonics startup challenge at SPIE Photonics West.

R&D Highlights

From Photonics West 2011

Nearly 4000 papers from the top researchers in lasers, green photonics, biomedical optics, optoelectronics, and other light-based fields were presented at SPIE Photonics West in January.

The accepted papers are published in the SPIE Digital Library (SPIEDigitalLibrary.org), the world's largest collection of optics and photonics literature. Citations are given below, if known before press time, and refer to the volume and paper/page in *SPIE Proceedings*.

Green photonics

Among the numerous awards that were presented to students, early career professionals, and veteran researchers were papers in the new Green Photonics virtual symposium. SPIE President Katarina Svanberg and SPIE Fellow Stephen Eglash, chair of Green Photonics, presented green photonics awards to:

- Manfred Ruske and Holger Schwab of Philips Technologie (Germany) for "Laser-based manufacturing of shunt lines for OLED lighting"
- Tino Petsch, Jens Hänel, Bernd Keiper, Maurice Clair and Christian Scholz of 3D-Micromac (Germany) for "Laser processing of organic photovoltaic cells with a roll-to-roll manufacturing process" (7921-7921OU)
- Gregory N. Nielson, Murat Okandan, Jose L. Cruz-Campa, and Paul J. Resnick of Sandia National Labs (USA); Mark W. Wanlass of National Renewable Energy Lab (USA); and Peggy J. Clews, Tammy C. Pluym, Carlos A. Sanchez, and Vipin P. Gupta of Sandia National Labs for "Microfabrication of microsystem-enabled photovoltaic (MEPV) cells" (7927-79270P)
- SPIE members Aaswath P. Raman and Zongfu Yu with SPIE Fellow Shanhui Fan of Stanford University (USA) for "Broadband all-dielectric nanophotonic light trapping for thin active layers in organic solar cells"
- SPIE member Daisuke Nakamura, Akio Kumeda, Kazuyuki Toya, Kota Okazaki, Kazuki Kubo, Koji Tsuta, Mitsuhiro Higashihata, and SPIE member Tatsuo Okada of Kyushu University (Japan) for "Synthesis and characterization of layer structured ZnO nanowire for ultraviolet light emitting diode"

SPIE President Katarina Svanberg (left) presents a Green Photonics best paper award to 3D-Micromac CEO Tino Petsch.

- Alex Henzen of IREX Technologies (Netherlands) for "Improvements in in-plane electrophoretic displays" (7956-7956OB)
- Soichiro Nakanishi and SPIE member Wakao Sasaki of Doshisha University (Japan) for "A novel approach to smart grid technology for electrical power transmission lines by a self-organized optical network node based on optical bistability" (7959-7959OP)
- SPIE member John A. Rogers, director of the Nanoscale Science and Engineering Center University at Illinois at Urbana-Champaign (USA), for "Microscale, printed LEDs for unusual lighting and display systems" (7927-7927OT)

John Rogers

Rogers, who is also the Lee J. Flory Founder Chair in Engineering Innovation, described how unconventional designs for inorganic LED lighting and display systems may find use in biomedicine and robotics. His paper discussed systems that consist of arrays of interconnected, ultrathin inorganic LEDs configured in mechanically optimized layouts on unusual substrates such as elastic membranes and bands, sheets of aluminum foil,

paper, balloons, thin ribbons, and fine threads.

Light-emitting sutures, implantable sheets, and balloon catheters that are compatible with complete immersion in biofluids illustrate the suitability of these technologies for possible use in biomedicine, Rogers says. Waterproof proximity sensor tapes capable of conformal integration on curved surfaces of gloves are also a possibility in robotics.

PV retinal prosthesis

James Loudin, a postdoctoral research fellow at Stanford University (USA) received the Pascal Rol Award for best paper in Ophthalmic Technologies during the Ophthalmic Technologies XXI conference. Loudin presented "Photovoltaic retinal prosthesis" (7885-788513) in which he and co-authors Keith Mathieson, Ted I. Kamins, Lele Wang, Ludwig Galambos, Philip Huie, Alexander Sher, James Harris, and Daniel V. Palanker have designed and conducted initial testing on a high-resolution PV retinal prosthesis.

The device, intended to restore sight to patients with retinal degenerative disorders, is fabricated with a pixel density of up to 177 pixels/mm^2. Photodiodes within each pixel of the subretinal array directly convert light to stimulation current, avoiding the use of bulky coil implants, decoding electronics, and wiring and thereby reducing surgical complexity. A video camera mounted on goggles captures the visual scene and transmits data to a pocket processor. The image is replicated using pulsed infrared light (~900 nm) from a laser diode array. The resulting images are projected into the eyes, to the subretinal implant with enough intensity to activate retinal neurons. Using infrared avoids complications from any residual viable retina.

The group reports that electrophysiological tests in two mammalian models demonstrate that PV stimulation is possible with multi-diode circuits as well as single-diode circuits.

Topcon Advanced Biomedical Imaging Lab sponsors the award through the Pascal Rol Foundation.

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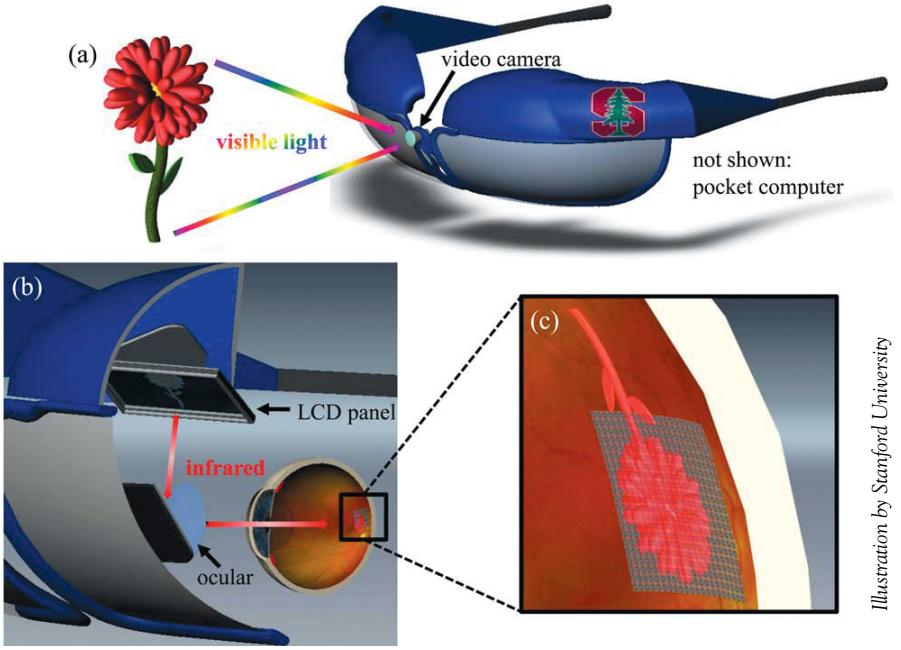


Illustration by Stanford University

The PV retinal prosthesis includes a goggles-mounted video camera (a). Images it captures are then processed by a pocket computer and projected onto the retina (b) using a near-to-eye projection system built into the goggles. A subretinally-placed array (c) photovoltaically converts this light directly to electric current in each pixel, which stimulates nearby inner retinal neurons.

R&D Highlights

◀ *Continued from page 25*

Ultrafast optics

SPIE member Kouhei Kimura of Utsunomiya University (Japan) received the Frontiers in Ultrafast Optics: Biomedical, Scientific, and Industrial Applications best paper award for his presentation, "Holographic spatiotemporal lens (HSTL)" (7925-792508). Kimura and collaborators at Utsunomiya, Satoshi Hasegawa and SPIE member Yoshio Hayasaki, have proposed an HSTL as a new focusing technique of a femtosecond laser pulse to improve spatial resolution of two-photon excitation.

Runner-up in the ultrafast optics conference was SPIE member Sören Richter of Friedrich-Schiller-Universität-Jena (Germany), for "Breaking stress of glass welded with femtosecond laser pulses at high repetition rates" (7925-79250P).

The competition was among graduate and undergraduate students.

Imaging and Sensing

At the BiOS symposium, four groups of researchers received awards sponsored by Seno Medical for best oral presentation and best poster presentation in the Photons Plus Ultrasound: Imaging and Sensing Conference.

For best poster in the Photons Plus conference, two groups from Washington University in St. Louis (USA) were cited for their work on photoacoustic imaging and sensing.

Konstantin Maslov with SPIE member Song Hu and SPIE Fellow Lihong V. Wang won for "Second generation optical-resolution photoacoustic microscopy with improved sensitivity and scanning speed" (7899-789933). It was Maslov and Hu's fourth best paper or poster award at Photonics West within the last five years.

Adam Q. Bauer, Ralph E. Nothdurft, Changhui Li, Lihong V. Wang, and Joseph P. Culver also received a poster award for "Quantitative high resolution photoacoustic spectroscopy by combining photoacoustic imaging with diffuse optical tomography" (7899-789930).

Wang is editor in chief of the SPIE *Journal of Biomedical Optics*, the Gene K. Beare Distinguished Professor of Biomedical Engineering at Washington University, and served as co-chair of the Photons Plus conference with Alexander Oraevsky.

Two groups from Europe won a best oral paper award from the Photons Plus conference:

- SPIE member Krista Jansen, Geert Springeling, and Robert Beurskens from Erasmus MC (Netherlands); Antonius F. W. van der Steen from Erasmus MC and Interuniversity Cardiology Institute (Netherlands); and SPIE member Gijs van Soest from Erasmus MC for "A 1.2 mm diameter integrated photoacoustic and ultrasonic catheter for intravascular imaging"
- Jan G. Laufer, Peter Johnson, Edward Z. Zhang, Barbara Pedley, and Paul C. Beard of University College London (UK) for "In vivo longitudinal photoacoustic imaging of subcutaneous tumours in mice" (7899-789915)

Young Investigators

Two researchers received the PicoQuant Young Investigator Award for the best oral presentation at the Single Molecule Spectroscopy and Imaging conference. The award is for presenters under the age of 35.

Daniel Aquino of the Max-Planck-Institut für Biophysikalische Chemie (Germany) was awarded a PicoQuant prize for "Optical switching and time-sequential coherent detection of markers through opposing lenses enables multicolor 3D-nanoscopy with 10-nm resolution of large intracellular volume."

Julie Biteen of University of Michigan (USA) also won for "Live-cell single-molecule and

Editor's Recommendation:

Journal of Nanophotonics

SPIE Fellow Akhlesh Lakhtakia, editor-in-chief of the *Journal of Nanophotonics*, recommends "Laser emission from self-assembled active photonic crystal matrix," published online in October 2010.

Authors Sunita Kedia, Ramarao Vijaya, Alok Kumar Ray, and Sucharita Sinha have found an inexpensive and quick self-assembly route to fabricate photonic crystals from Rhodamine B dye-doped polymeric colloids.

Each colloid is made from dye-doped polystyrene, thus providing an ordered matrix arrangement for the emitter in the crystal, unlike the standard practice of infiltration of the active medium into the voids of a passive photonic crystal.

The large number of ordered layers yields the high reflectance needed for efficient feedback in a laser oscillator. Both stimulated emission and possible suppression of spontaneous emission were observed.

Source: *Journal of Nanophotonics* 4, 049506 (2010); doi: 10.1117/1.3506524.

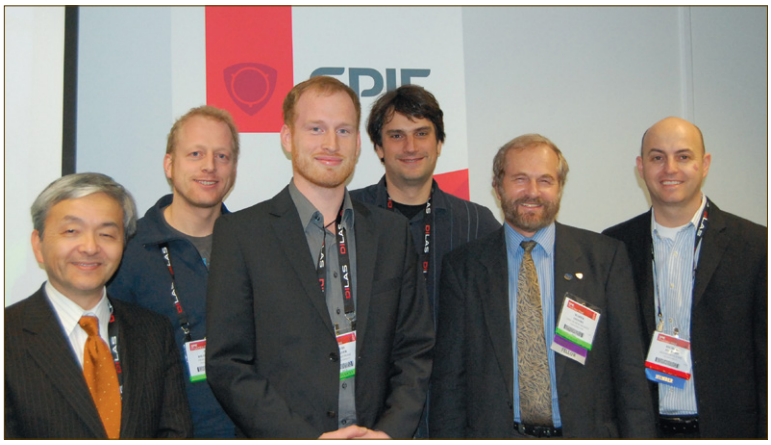
Left to right at the Photons Plus Ultrasound conference: Lihong Wang, Konstantin Maslov, Alexander Oraevsky, Janet Campbell (CEO of Seno Medical), Krista Jensen, and Jan G. Laufer.

superresolution imaging of proteins in bacteria." (7905-79050Q)

The $750 prize was donated by PicoQuant of Germany.

A team of European researchers won the Ocean Optics Young Investigator Award for a paper given in the Colloidal Quantum Dots/Nanocrystals for Biomedical Applications conference. The paper was "Time-resolved and steady-state FRET spectroscopy on commercial biocompatible quantum dots," (7909-79090D) by David Wegner, Daniel Geissler, and Hans-Gerd Löhmannsröben of University of Potsdam (Germany) and SPIE member Niko Hildebrandt of Fraunhofer-Institut für Angewandte Polymerforschung (Germany).

The award consists of $1000 cash to the lead author, Wegner, and $2000 worth of Ocean Optics equipment to Hildebrandt's Fraunhofer laboratory where the work was performed. Hildebrandt is currently at Université Paris-Sud 11 (France). ■



Left to right: Colloidal Quantum Dots conference co-chair Kenji Yamamoto, Niko Hildebrandt, David Wegner, conference co-chairs Wolfgang Parak and Marek Osinski, and Richard Pollard, COO of Ocean Optics.

Chris Mack named editor of journal

Lithography expert and SPIE Fellow Chris A. Mack will become editor of the *Journal of Micro/Nanolithography, MEMS, and MOEMS* (JM^3) in January 2012.

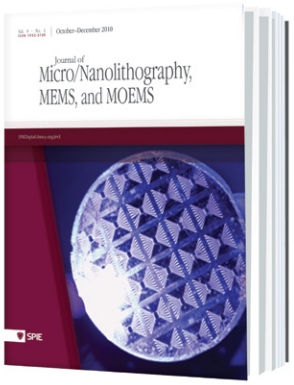
Mack, adjunct faculty member at the University of Texas at Austin, developed the PROLITH Toolkit™ of lithography simulation and analysis programs and has authored more than 140 technical publications, two books, and several book chapters on lithography. Known as the Litho Guru and the Gentleman Scientist, Mack received the SPIE Frits Zernike Award for Microlithography in 2009.

He will succeed JM^3 founding editor Burn Lin of Taiwan Semiconductor Manufacturing Co.

JM^3 publishes peer-reviewed papers on the development of semiconductor fabrication, packaging, and integration technologies. It was founded in 2002 and publishes quarterly.

"Since its founding, JM^3 has become the preeminent journal in the various fields of microfabrication," Mack says. "I'm thrilled to be continuing the work of Burn Lin and to carry on the tradition of excellence at this journal." ■

For more information, see spie.org/JM3.



R&D Highlights

SPACE-TIME Cloak

UK scientists have a theoretical design with metamaterials to hide an object's movement so that an observer doesn't notice.

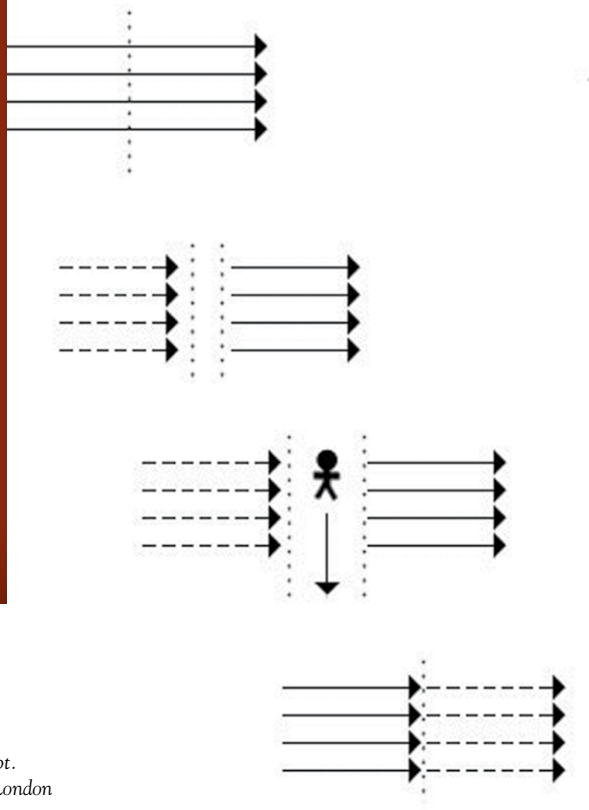
Scientists in the UK have developed a method for manipulating the speed of light as it passes over an object, creating a proof-of-concept design for a new type of electromagnetic cloak that conceals events rather than objects.

The group's space-time cloak (STC) makes it theoretically possible to hide an object's movement with metamaterials so that an observer doesn't notice. The space-time cloak, also called a history editor, was reported in the November *Journal of Optics*.

An Imperial College London team led by Sir John Pendry previously showed that metamaterials could be used to make an optical invisibility cloak by bending light around an object. Now another team, led by SPIE Fellow Martin McCall from the Department of Physics at Imperial, has mathematically extended the idea of Pendry's cloak to create an undetectable blind spot for events.

Martin McCall

"Light normally slows down as it enters a material, but it is theoretically possible to manipulate the light rays so that some parts speed up and others slow down," McCall says. When light is 'opened up' in this way, rather than being curved in space, the leading half of the light speeds up and arrives before an event, while the trailing half lags behind and arrives too late.



The space-time cloak concept. Courtesy Imperial College London

Teasing Relativity

Imperial College's Alberto Favaro is one of four UK scientists who have developed a proof-of-principle design for the space-time cloak.

"Imagine computer data moving down a channel to be like a highway full of cars," he explains. "You want to have a pedestrian crossing without interrupting the traffic, so you slow down the cars that haven't reached the crossing, while the cars that are at or beyond the crossing get sped up, which creates a gap in the middle for the pedestrian to cross. Meanwhile an observer down the road would only see a steady stream of traffic."

One issue that cropped up during the group's calculations was to speed up the transmitted data without violating the laws of relativity.

Favaro solved this by devising a material whose properties varied in both space and time, allowing the cloak to be formed.

The result is that for a brief period, the event is not illuminated and escapes detection. Once the concealed passage has been used, the cloak can then be 'closed' seamlessly.

Such a space-time cloak would open up a temporary corridor through which energy, information, and matter could be manipulated or transported undetected.

"If you had someone moving along the corridor, it would appear to a distant observer as if they had relocated instantaneously, creating the illusion of a Star-Trek transporter," McCall says. "So, theoretically, this person might be able to do something and you wouldn't notice."

Many potential applications

While using the space-time cloak to make people move undetected is still science fiction, there are many serious applications for the new research.

Paul Kinsler, one of four authors of the paper, developed the proof-of-concept design using customized optical fibers, which would enable researchers to use the event cloak in signal processing and computing. A given data channel could, for example, be interrupted to perform a priority calculation on a parallel channel during the cloak operation. Afterwards, it would appear to external parts of the circuit as though the original channel had processed information continuously, so as to achieve 'interrupt-without-interrupt.'

"We're sure that there are many other possibilities opened up by our introduction of the concept of the space-time cloak," McCall says, "but as it's still theoretical at this stage, we still need to work out the concrete details for our proposed applications."

Metamaterials have a vast array of potential applications in defense, security, medicine, data transfer, and computing. Ordinary household devices that work using electromagnetic fields could be made more cheaply or to work at higher speeds. Metamaterials could also be used to control other types of waves as well as light, such as sound or water waves, opening up possible applications for protecting coastal or offshore installations, or even engineering buildings to withstand earthquake waves.

Redacting history by concealing events also has major implications for research in metamaterials, slow light, and phase modulation. Curving light rays in space-time rather than in space sets new challenges for metamaterials design, the authors say. But these challenges can be minimized through "judicious manipulation of the refractive index of the metamedium."

The authors, who include SPIE member Allan Boardman of the University of Salford (UK), acknowledged funding from the Engineering and Physical Sciences Research Council (EPSRC) and the Leverhulme Trust. ■

Invisibility Cloaks

Find more news and technical articles on metamaterials and invisibility cloaks on the SPIE Newsroom (newsroom.spie.org).

PRISM AWARDS 2010 honoring photonics innovators

New technologies for lasers and laser-based instruments that were introduced during the 50th anniversary of the laser, along with optical sensors, an imaging system for detecting melanoma, and other cutting-edge products, were honored with 2010 Prism Awards for Photonics Innovation (PhotonicsPrismAwards.com).

The awards were presented by SPIE and Photonics Media in January during SPIE Photonics West. The global competition recognizes photonics products and technologies that improve life, break conventional ideas, and solve problems.

A panel of industry experts judged some 100 entries for the Prism Awards, selecting nine winners in separate categories from among 26 finalists who had launched the new products in 2010.

The winning entries came from small and big companies in Europe and North America, highlighting the diverse creativity and expertise behind their development and the wide range of applications in which optics and photonics technologies play a vital function.

The Prism Award winners are part of the "great photonics enterprise that has already contributed so much to enhance our lives and that will play an increasingly important role in a sustainable future," says Eugene Arthurs, SPIE executive director.

Among the winning laser-based devices and technologies were Block Engineering's quantum-cascade laser spectrometer for stand-off materials detection, IPG Photonics' quasi-continuous-wave industrial fiber laser, EKSPLA's series of nanosecond tunable wavelength lasers, and Energetiq Technology's wide-band light source, based on a laser plasma, used for advanced spectroscopic and imaging applications.

General Electric won for an analytics system that can perform eight water-quality tests simultaneously, Edmund Optics received an award for its hybrid aspheric lenses, and JenLab was honored for its tomographic skin imaging system. PHOTONIS USA's optical receiver module with a fast photomultiplier tube won in the information and communication category, and a measurement sensor shaped like a microscope slide won for Lumen Dynamics Group, formerly EXFO Life Sciences & Industrial.

"The products and processes submitted for review are world-class," says Thomas Laurin, president of *Photonics Media*. "They reflect both the leadership and expertise of the organizations in the field." More information about the winning products in each category is on the following pages.

†Denotes SPIE Corporate member

International Competition

The nine companies honored in the 2010 Prism Awards for Photonics Innovation are from North America and Europe.

Four of the U.S. companies are from Massachusetts: Block Engineering, Energetiq Technology, IPG Photonics, and PHOTONIS USA.

Other companies honored that have American headquarters are General Electric (Connecticut) and Edmund Optics (New Jersey).

Lumen Dynamics is headquartered in Ontario, Canada. (Riverside, its parent company, is a global private equity company with executive offices in the United States and elsewhere.)

EKSPLA's main office is in Vilnius, Lithuania.

JenLab was founded in Jena, Germany, in 1999.

Defense and Security

Block Engineering

LaserScan Analyzer

The LaserScan QCL-based spectrometer is a handheld, mid-IR quantum-cascade-laser spectrometer that analyzes surfaces from a standoff of six inches to two feet. No broadband emitting source or Michelson interferometer is required in this approach for spectroscopy. Instead, the laser source can be widely (600 cm^{-1}) and rapidly tuned to create a spectrum. Extremely fast electronics allow the detector to essentially correlate the light that it collects with the specific wavelength of the laser as it rapidly and continuously tunes across the range. LaserScan can be used to detect explosive materials, traditional and nontraditional chemical agents, toxic industrial chemicals and other surface contaminants or chemical threats. It also has many commercial applications including cleaning validation for pharmaceutical manufacturing, analysis of polymers, and quality assurance and control.

Detectors, Sensing, Imaging, and Cameras

General Electric

TrueSense Personal Water Analytics

GE's TrueSense™ personal water analytics system is based on multicolor LEDs and a 44-cell sampler platform for wavelength-multiplexed quantitative and highly selective chemical analysis of industrial water. The field-deployable system performs eight water quality tests from a single 3-ml sample in minutes, decreasing previous sample times from 50 minutes to eight minutes. Employing simplified, easy-to-perform testing procedures, the TrueSense system minimizes the need to maintain an inventory of reagent chemicals and equipment for testing and considerably cuts testing costs. GE has 10 granted and pending US patents for sensing array devices like TrueSense for the industrial water chemical analysis market.

Industrial Lasers

IPG Photonics†

YLR-150/1500-QCW-AC

The YLR-150/1500 quasi-continuous-wave AC fiber laser was created to replace aging flashlamp-pumped, solid-state lasers with smaller and longer-lasting diode-pumped devices. This long-pulse, high-pulse-energy fiber laser uses proprietary pump diodes that can be pulsed at 10 times their average power, producing 15 J from a 150-W fiber laser. It also has a smaller rack-mounted, air-cooled package that has 30% wallplug efficiency. The new type of laser is recommended for spot welding, seam welding, and drilling in the long-pulse operation mode.

Information and Communication

PHOTONIS USA

Optical Receiver Module

The PHOTONIS Optical Receiver Module is an optical communications detector that provides fast optical communication using a photomultiplier tube that electron-optically converts a large input diameter to a much smaller flow of electrons inside a vacuum envelope without degrading the signal. The device approaches data speeds of 2GHz, a three to five times increase in speed over other photomultiplier tubes, while providing an active signal input diameter of 12 mm. The reliability of signal current in the blue-green wavelength range improves without significant bit error rates, enabling through-the-air or underwater communications. The receiver's low power requirements also mean that it can be used in unmanned locations.

Michael Mertin
CEO, JENOPTIK

Award Presenters

The Prism Awards for Photonics Innovation were presented by Stuart Schoenmann (CVI Melles Griot), Marita Paasch (SCHOTT), Bill Shiner (IPG Photonics), Ken Kaufmann (Hamamatsu), Ronald Driggers (U.S. Naval Research Lab), Robert Edmund (Edmund Optics), Milton Chang (Incubic Management), Michael Mertin (JENOPTIK), and David Hardwick (IMRA America).

2010 Prism Awards

◀ Continued from page 31

Life Sciences and Biophotonics

JenLab GmbH†

MPTflex

The MPTflex is a clinical multiphoton tomograph for skin imaging that overcomes the poor resolution of other methods such as ultrasound, OCT, and reflection. By using two-photon technology, the JenLab system's in vivo high-resolution skin imaging provides marker-free optical biopsies. The novel tomograph is a compact system for clinical examinations with a flexible scan head that includes two detectors for simultaneous measurement of autofluorescence and the second-harmonic generation.

Optics and Optical Components

Edmund Optics†

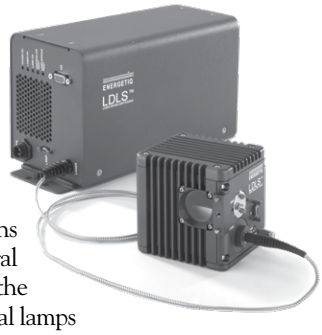
TECHSPEC Plastic Hybrid Aspheric Lenses

Edmund Optics' plastic hybrid aspheric lenses provide optical designers with a single-element solution for achieving diffraction-limited focusing performance at high numerical apertures with broadband light sources. These low-cost optical components are the first to be designed to work in the visible spectrum and are free of both spherical and chromatic aberration. The technology has been previously applied to infrared components by diamond turning a few diffractive rings (a 0.63 NA on Germanium at 4 microns requires 17 rings over a 25mm aperture). To achieve the same NA at 587nm on plastic, 425 rings are needed in that same 25mm space.

Other Light Sources

Energetiq Technology†

EQ-99 LDLS™ Laser-Driven Light Source



The EQ-99 laser-driven light source is a compact, highly stable source of broadband deep ultraviolet, visible, and near-infrared light for advanced spectroscopic and imaging applications requiring ultra-long lamp life. Its spectral output provides more than 10 times the brightness and lifetime of conventional lamps and a broader bandwidth than xenon and deuterium lamps. Used for advanced spectroscopic and imaging applications, it is changing the paradigm in broadband illumination and enabling a new generation of smaller, faster, more precise spectroscopy or imaging instruments.

Employing Energetiq's patented laser-driven xenon plasma technology, the EQ-99 provides a single-light source solution for researchers and engineers who typically need to purchase and operate multiple lamps or lasers.

Scientific Lasers

EKSPLA†

NT200 series nanosecond tunable wavelength lasers

The NT200 series include the first nanosecond lasers that offer tunability from the UV (210 nm) to the IR (2600 nm) without gaps in the tuning range and that can operate at a computer-controlled, hands-free pulse repetition rate of 1 kHz. The high repetition rate opens the way for scientific experiments that were not possible before the development of such a widely tunable monochromatic light source. The system integrates a nanosecond Optical Parametric Oscillator (OPO) and Diode-Pumped Solid-State (DPSS) Q-switched pump laser into a single compact housing.

Europe envisions 10% growth rate for photonics

Emphasizing the importance of an innovation-friendly market as well as support for research, European Commission Vice President Neelie Kroes accepted the Photonics21 Vision document from Photonics21 President Martin Goetzeler in Brussels in February.

Despite the recent economic crisis, Photonics21 estimates the annual growth rate of the photonics sector at greater than 10%, much faster than the overall growth of European GDP and faster still than the growth of the global market.

SPIE leaders joined Photonics21 at its annual meeting, underlining the success achieved by the platform in having photonics named as one of only five key enabling technologies for Europe.

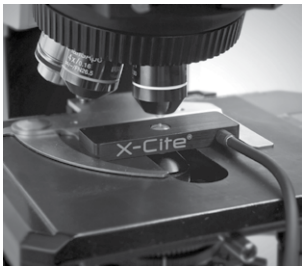
PHOTONICS 21

Test, Measurement, Metrology

Lumen Dynamics Group

(formerly EXFO Life Sciences & Industrial)

X-Cite XP750



The X-Cite XP750 is an optical power measurement sensor shaped like a microscope slide. It fits in standard microscope stage clips to hold it in place during use, unlike wand and disc-shaped devices that are awkward to use. The X-Cite is thin enough (9 mm) to fit under the objectives on an upright microscope without the stage or condenser having to be removed. Other novel features for microscopists include: a dynamic power range from 5uW to 500mW without requiring the user to engage attenuating filters; programmable favorite wavelength settings; and a centering target for use on inverted microscopes.

Harnessing the Photonics Industry

Optical technology affects our daily lives in ways we sometimes barely notice, because we so quickly accommodate to new technologies. Today, items such as infrared remote controls, LEDs, and laser printers are as common to us as coffee cups.

Yet optical science and engineering have created life-altering devices such as lasers used in modern surgery and optical fibers that transport voices and images around the world. Studies of high-efficiency light sources show the promise of greatly reducing electricity consumption, which could also have a positive impact on environmental conservation. Capturing the photonics from the sun is the most promising and "natural" solution to the energy challenge. Industry uses optical engineering in everything from the manufacture of computer components to the construction of satellites.

In 1998, the National Academies in the United States and its operating arm, the National Research Council (NRC), published Harnessing Light: Optical Science and Engineering for the 21st Century. This 360-page study surveyed the many emerging applications for optical technology, reviewed the status of the optics industry, assessed research and education in optics, and identified actions that could enhance the field's contributions to society and facilitate its continued development.

"When *Harnessing Light* was first published," says Michael Mertin, president and CEO of Jenoptik, "it sounded a bit like science fiction, that the 21st century should become the century of the photon. Yet, if you look at the many applications in medical technology, communications, and entertainment, photonics is now something natural in our daily lives."

Since the publication of *Harnessing Light*, optical science — and society — have changed a great deal. And while the original report has been extremely useful to academic, industrial, and governmental organizations throughout the world, SPIE has been pressing for an update of the study.

Starting with a "Dream Team"

That study is now under way, with its key aim to identify current strengths and challenges to the optics field, including economic impact, workforce needs, and future research directions. After assessing the current state of optical science and engineering in the United States and abroad, the committee is expected to make recommendations for the United States to develop and maintain global leadership in optics and photonics.

The National Academies' committee on Harnessing Light: Capitalizing on Optical Science Trends and Challenges for Future Research is a "dream team" of luminaries in the field, says SPIE Fellow Alan Willner, who co-chairs the committee with SPIE Fellow Paul McManamon.

Willner is a professor at University of Southern California and McManamon, formerly with the U.S. Air Force Research Lab, is owner of Exciting Technology and works at the University of Dayton.

SPIE Fellows Charles Falco (University of Arizona), Prem Kumar (Northwestern University), Duncan Moore (University of Rochester), and Ed Moses (National Ignition Facility) are among the scientists, economists, educators, and business leaders on the committee.

The committee held its first meeting in Washington, DC, in February to gather input from the agencies sponsoring the new study: the Defense Advanced Research Projects Agency (DARPA), the Department of Energy, the National Science Foundation, National Institute of Standards and Technology, and the Army Research Office.

Representatives from SPIE and other organizations with a stake in the study also attended and stand ready to provide information as needed.

"It's incredibly exciting what the future will hold," Willner says, "given how optics has cemented itself in an enormous number of applications in society" since the first study. "This is all about the future, and the future impact will only grow dramatically."

Defining the role of photonics

In January, SPIE hosted a special "Future of Photonics" forum at Photonics West in San Francisco to begin gathering input. Erik Svedberg, study director and senior program officer with the National Academies, and Eugene Arthurs, CEO of SPIE, moderated the event.

Assessing the impact of optics

SPIE Executive Director Eugene Arthurs cites photonics growth in several economies and suggests that strategic analyses have provided insights and guidelines to their success.

In September 2009, the European Commission designated photonics as one of five key enabling technologies for future prosperity in Europe, and several reports — including the Second Strategic Research Agenda issued by Photonics21 — have helped identify opportunities.

The Photonik 2020 report issued in Germany noted that German enterprises are world market leaders in several optical technology fields, with an export quota over 60%. Leading markets are production, health, communication, energy and environment. By the year 2015, an approximate production increase of 8% per year is expected.

Taiwan has established a Ministry of Science and Technology and National Science Council to help inform its several science parks, which collectively logged sales of more than $62 billion in 2007.

Last year, the Canadian Photonics Consortium issued a report on "Illuminating a World of Opportunity: Photonics in Canada."

Discussion at the forum showed that a wide range of opinions will have to be taken into account. International Traffic in Arms Regulations (ITAR), the scarcity of measurable statistics showing the socio-economic impact of photonics, the importance of rare earth materials, as well as the influence of the original Harnessing Light report on European thinking were just a few of the points given consideration.

"The report would consider "the technology areas where optics is an enabler that can dramatically impact the economy of the country," Svedberg says.

The finished study would be used to inform industry and government agencies by providing a unique view of the future directions for photonics science and technology and for market trends.

Approximately one year will be spent on information gathering, forums, and committee meetings before the findings and recommendations are published, possibly in 2012.

"Much has happened since the original Harnessing Light study was published in 1998," Svedberg says. "Revisiting the technology and policy issues today would be quite timely. The new report has the possibility to address the role photonics plays in national competitiveness and innovation."

Focusing on education

The topic upon which everyone agrees is the need for maintaining the skills base that has built the existing photonics industry.

"This is especially critical for the United States, if we wish to maintain a prominent role, and jobs, in the future of optics," McManamon says.

There is understandable concern about the number and quality of science and engineering graduates and PhDs in the United States and Europe, particularly when compared with the huge recent increase of Chinese equivalents.

"Fortunately, the United States has had strong immigration of high-tech talent, which has partially offset the lack of home-grown, advanced-degree graduates."

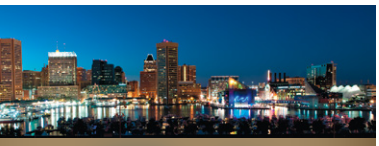
Putting optics on the map

Arthurs notes that, "irrespective of the economic conditions, optical science and engineering is headed toward another strong growth period, driven by developments in advanced materials, solid-state lighting, solar technologies, sensors, lasers, imaging, fiber-optic communications, digital photography, diagnostic medicine, computing/processing, and consumer displays and TVs."

It will be up to the photonics community to make the case for the future of the industry and meet the challenges ahead. As Arthurs sums up, "Harnessing Light put us on the map. Now we have a chance to do it again."

For more information on the project, see bit.ly/e9FZoe. ■

–Karen Thomas (SPIE Staff)



SPIE Defense, Security+Sensing

Baltimore in 2012

The annual SPIE Defense, Security, and Sensing symposium will have a new venue in 2012: Baltimore, MD, just 39 miles northeast of Washington, DC.

The move to an East Coast location closer to the U.S. capital will provide more opportunities to expand the conferences and exhibition.

The 2012 symposium will be held 23-27 April.

Defense meetings to reflect on oil spill

Sensing and measurement technologies deployed in response to the April 2010 explosion of the Deepwater Horizon oil drilling platform in the Gulf of Mexico will be the subject of a special joint session of two conferences at SPIE Defense, Security, and Sensing this year.

The symposium in Orlando, FL (USA), 25-29 April, will also include a plenary keynote by SPIE member Paul Lewis of the National Geospatial-Intelligence Agency on the lessons learned from the largest accidental oil spill in history. Lewis will discuss the evolution of U.S. airborne chemical and radiological remote sensing programs for emergency and natural disaster response and their importance and effectiveness.

Aircraft in one of those programs, the Airborne Spectral Photometric Environmental Collection Technology (ASPECT) project, flew more than 75 missions in the four months after the accident to provide air-quality monitoring during oil-burning operations in the Gulf. Infrared spectroscopy and multispectral infrared imagery acquired by ASPECT also aided disaster responders by characterizing and analyzing trends in the surface oil and locating suitable deposits of surface oil for skimmer vessels to contain and burn.

Photonics technologies were used to monitor air quality in the Gulf of Mexico because of burns like this.

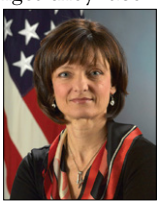
Lewis' talk is scheduled for Wednesday 27 April, as is the joint session of the Ocean Sensing and Monitoring conference and a new conference on Sensing Technologies for Global Health, Military Medicine, Disaster Response, and Environmental Monitoring.

The joint session on the marine oil spill will include presentations on radar satellite imagery, fluorometry, high-frequency radar, trajectory forecast systems, spectrometry, and other important tools in mitigating environmental disasters in the oceans. The new conference will cover those topics as well as technologies for disease surveillance, traumatic brain injury, and virtual reality exposure therapy for combat-related PTSD.

Emphasis on innovation

In addition to these events, more than 2400 unclassified technical presentations on sensors, security systems, and defense-related technologies will be presented at the symposium. Combined with a two-day

job fair, a 500-company exhibition, more than 50 courses, and a special session on U.S. government funding, SPIE Defense, Security, and Sensing puts a strong emphasis on connecting scientists and engineers with those who need optical and photonics solutions to the challenges they face.


Dugan

DARPA director Regina Dugan, who has experience in technology development in the private sector as well as with the Department of Defense, will give the keynote talk at a symposium-wide plenary Tuesday 26 April.

More than 50 courses on sensors, signal processing, and other technologies used in civil and military applications will cover basic, intermediate, and advanced topics in:

- Lab-on-a-chip technology
- Military laser safety
- Infrared optics
- Radar micro-Doppler signatures
- Target and pattern recognition
- Unmanned and robotic systems
- U.S. trade and export regulations
- Chemical and biological detection
- Scanning microscopy in forensic science

Funding session


McManamon

SPIE Fellow Paul McManamon, retired from the U.S. Air Force Research Lab (AFRL), has organized the government funding session on Wednesday, 27 April.

Representatives from U.S. defense agencies will provide insights into probable areas of future funding available for businesses and researchers.

"If companies know what funding agencies want," McManamon says, "they can vector their efforts more precisely so they can solve a problem of interest to the funding agency, and therefore win future contracts."

Speaking on behalf of their agencies will be Joe Sciabica, executive director of the AFRL at Wright-Patterson Air Force Base; David L. Neyland, director of the Tactical Technology Office at DARPA, and Edward J. Baranoski, director of the new Office of Smart Collection for the Intelligence Advanced Research Projects Activity (IARPA).


Sciabica


Neyland


Baranoski

McManamon, owner of Exciting Technology and former SPIE president, notes that connections made at the session benefit the funding agencies as well.

"They get industry working on the right problems that the agency needs solved," he says.

Networking and collaboration


Pellegrino

A "Hot Topic" panel discussion moderated by John Pellegrino, director of the Computational and Information Sciences Directorate of the U.S. Army Research Lab (ARL), will bring another perspective on collaboration between industry and defense agencies. In a forum titled "Data to Decisions: Sensors are No Longer King," panelists are expected to take a holistic perspective and identify technology needs for making informed decisions on the battlefield. The panel is also scheduled for Wednesday, 27 April.


Fitzpatrick

SPIE Fellow Colleen Fitzpatrick will be the speaker at an SPIE Women in Optics reception on Tuesday, 26 April. Fitzpatrick, a forensic genealogist and retired optical scientist, will discuss her role in identifying the remains of a serviceman who was aboard a commercial aircraft that crashed in Alaska in 1948.

Other special events organized by SPIE include

- Early career professional networking social
- Panel discussion on getting hired in 2011
- Student lunch with the experts
- SPIE Fellows luncheon, with DARPA's Larry B. Stotts giving a presentation on free space optical communication and submarine laser communication
- Vendor presentations and IR images on display Monday evening


Stotts

William Jeffrey, president and CEO of HRL Labs, is symposium chair. Kevin P. Meiners of the Office of the Secretary of Defense is symposium co-chair. More information: spie.org/dss ■

Demos and Displays

New technology demonstrations and displays will be located in the exhibition hall Tuesday 26 April through Thursday 28 April.

Cartwright to receive award for achievement

U.S. Marine Corps Gen. James E. Cartwright, vice chairman of the Joint Chiefs of Staff, will receive a Lifetime Achievement Award and speak at an awards banquet at SPIE Defense, Security, and Sensing, Wednesday 27 April.

Cartwright, the nation's second highest ranking military officer, serves on several Pentagon panels that oversee U.S. weapons purchasing and research funding.

SPIE/OSA European Conferences on Biomedical Optics

The European Conferences on Biomedical Optics occurring 22-26 May have become the largest such event in Europe for researchers, scientists, engineers, and clinicians who are developing solutions to problems in biomedical science and medicine.

The biennial meeting, jointly sponsored by SPIE and OSA in cooperation with Deutsche Gesellschaft für Lasermedizin, will have seven conferences in Munich addressing medical laser applications, laser-tissue interactions, and advanced techniques for OCT, CT, microscopy, spectroscopy, and other optical imaging.

Prague, Munich host key meetings in April and May

Some of the top researchers and industry representatives working in high-power laser energy, petawatt photonics, x-ray optics, metamaterials, optical metrology, biomedical spectroscopy, optoelectronics, and related fields will gather in Prague and Munich this spring for networking and idea exchange in a series of important technical conferences organized by SPIE.

SPIE Optics and Optoelectronics and SPIE Mictrotechnologies will be held the week of 18 April, co-located at the Prague Congress Centre in the Czech Republic.

Optoelectronics and lasers

SPIE Optics and Optoelectronics, 18-21 April, will have 15 technical conferences, with a strong track on ultrafast lasers; a special workshop on the proposed European High-Power Laser Energy Research facility (HiPER); a two-day exhibition of the latest product innovations in optics and optoelectronics; and plenary speakers from the HiPER project, the photonics unit at the European Commission, and the National Ignition Facility (NIF) in the United States.

More than 550 presenters will report advances in the field and exchange information about challenges and opportunities for photonics in Europe.

A two-day workshop will feature and report on three years of design work and experiments on the HiPER project, a collaboration of 26 partners in 10 countries who are developing the route to commercially viable power production from laser-based fusion.

Microtechnologies

An overview of the impacts that microtechnologies have on smart sensors, wireless communication systems, biomedical systems, actuators, and integrated photonics will be discussed during 250 presentations at SPIE Microtechnologies 18-20 April.

Three plenary sessions will cover the requirements and applications for intra-aircraft communications, supply chain technologies, and wireless sensor networks.

Metrology in Munich

New research in optical-measurement technologies, including those dedicated to preserving works of art and architecture, will be presented at SPIE Optical Metrology 23-26 May in Munich where SPIE/OSA European Conferences on Biomedical Optics and Laser World of Photonics will also be held.

Conference tracks at the International Conference Centre Munich will cover metrology topics such as surface examination and analysis, luminescence imaging, structure and material analyses, 3D topography and volume image tomography, and new methods and applications for the study, preservation, conservation, and restoration of cultural artifacts and archaeological sites.

SPIE Europe and Technology Transfer Initiative are also organizing an "Industry Meets Academia" workshop during the week to address cooperation and collaboration between industry and universities on intellectual property, technology evaluation, and contract and negotiation strategies. ■

2011 SPIE Events Around the World

APRIL

Science-Engineering-Technology Congressional Visits Day
6-7 April
Washington, DC (USA)

SPIE Microtechnologies
18-20 April
Prague (Czech Republic)
spie.org/emt

SPIE Optics and Optoelectronics
18-21 April
Prague (Czech Republic)
spie.org/eoo

SPIE Defense, Security, and Sensing
25-29 April
Orlando, FL (USA)
spie.org/dss

MAY

SPIE Optifab
9-12 May
Rochester, NY (USA)
spie.org/ofb

SPIE/OSA European Conference on Biomedical Optics
22-26 May
Munich (Germany)
spie.org/ebo

SPIE Optical Metrology
23-26 May
Munich (Germany)
spie.org/eom

SPIE Optics+Photonics

21-25 August
San Diego, CA (USA)
spie.org/op

Astronomical instrumentation conferences will return to SPIE Optics and Photonics in San Diego, CA (USA), this year, interspersed with more than 3000 presentations from the scientists, researchers, and developers of technologies that will transform the future.

Pioneers advancing the latest developments in solar energy, nanotechnology, illumination engineering, and photonic devices and applications join researchers 21-25 August working in the traditional optics-based fields of remote sensing, space communications, x-ray optics, imaging and signal processing, and optical design and fabrications.

The week's activities will kick off Saturday, 20 August, with a SPIE Student Chapter Leadership Workshop where dozens of students from across the globe will find tools and inspiration for their Chapters and their careers.

Students are also expected to participate in the second annual Optics Outreach Olympics, a competitive event for student leaders to demonstrate the educational projects they have organized in their communities.

SPIE President Katarina Svanberg, chief oncologist at Lund University Hospital (Sweden), will preside over the SPIE annual general meeting in San Diego, and a banquet will honor SPIE annual award winners.

Technology and product demonstrations are also scheduled during a three-day exhibition, Tuesday through Thursday, 23-25 August.

Take advantage of your SPIE member discount when registering.

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www.optimaxsi.com

Software Spectra, Inc. 2
www.sspectra.com

Information Online

You can always find the most up-to-date information about, or register for, SPIE events at spie.org/conferences

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

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