EON

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Electro-Optics News, University of Dayton

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Inside this issue

Editor: Partha P. Banerjee

Director's corner

Partha Banerjee

On December 20, 2013, the United Nations (UN) General Assembly's 68th Session proclaimed 2015 as the **International Year of Light (IYL)**. In proclaiming an international year focusing on the topic of light science and its applications, the UN has recognized the importance of raising global awareness about how light-based technologies promote sustainable development and provide solutions to global challenges in energy, education, agriculture and health. More information on this can be obtained from the IYL webpage www.light2015.org.

In the spirit of IYL, the Electro-Optics (EO) Program at the University of Dayton (UD) continues to educate young minds on various applications of optics and photonics. As one of the premiere institutions in the nation on photonics, we strive to excel in a variety of areas, including lasers, imaging, quantum optics, nonlinear optics, holography, polarization, nano-optics, propagation through turbulence, LIDAR, and optical sensing. We have a group of dedicated faculty from EO, Physics, and Electrical & Computer Engineering, which boasts 20 Fellows of professional organizations, along with about 35 MS and 30 PhD students. Last year, we graduated 3 PhDs and 15 MS students, who are all gainfully employed or are continuing their studies at UD or other universities. EO is part of a research center of excellence, CETRASE, that has been newly created to foster research in thin-films and surface engineering.

To follow up on the last newsletter, there will be a special session at SPIE's Photonics West in 2015 to honor Dr. Peter Powers, who unfortunately passed away last year. I am sure Dr. Power's legacy will live on through the work of his students and fellow collaborators.

Dr. Joe Haus was recently bestowed an honorary doctoral degree for his tireless work and collaboration with researchers from the National Institute of Optics and Electronics (INAOE) in Peubla, Mexico. UD now has a joint partnership with the Fraunhofer Institute, with Dr. Qiwen Zhan being the Managing Director of the joint center. Dr. Andy Chong, a young faculty in Physics and EO, known for his discovery of the ANDi fiber laser, is on leave this year at the Deutsches Elektronen-Synchrotron (DESY), a research center of the Helmholtz Association in Germany. Optonicus, a small business within EO, continues its excellence in developing high energy fiber laser systems. It was featured in Optics and Photonics News (Oct 2014), and is a finalist for the 2015 SPIE Prism award.

I wish you all a very happy, illuminating, and productive year!

A New Name: CPC is now Fitz Hall

What once was known as College Park Center has been renamed Raymond L. Fitz Hall. This is a tribute to Brother Ray Fitz, who served as president of UD from 1979 to 2002. Fitz, an electrical engineering alumnus and professor, believes in the Marianist values of learning, leading, and serving. It is the goal of the Electro-Optics Program (EOP) to demonstrate its commitment of implementing these values within our program. EOP is located in the 5th floor of Fitz Hall (39.738669N, 84.183668W), with its nanofab facilities located in the Science Center.

SPOTLIGHT: Optonicus Plays a Major Role in Optics and Global Security

Selection of current high-energy laser (HEL) sources:

- Area Defense Anti-Munitions (ADAM): Lockheed Martin
- GAMMA: Northrop Grumman
- **EXCALIBER: Optonicus**
- High Energy Liquid Laser Area Defense System (HELLADS): General Atomics
- Laser Weapon System (LaWS): Kratos
- Robust Electric Laser Initiative (RELI): Northrop Grumman, Boeing, Lockheed Martin
- Solid-State Laser - Technology Maturation: Kratos, Raytheon, Northrop Grumman, BaE Systems

Directed-energy weapons systems could provide efficient, cost-effective countermeasures in an age of drones and other airborne threats. Recent scientific and engineering breakthroughs are bringing these systems closer to deployment.

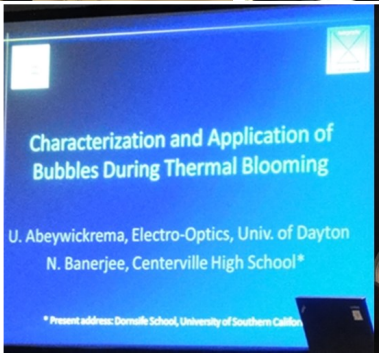
Valerie Coffey, OPN

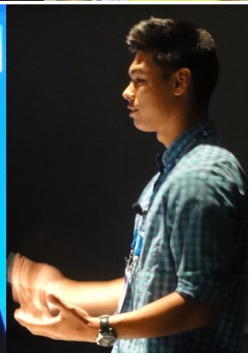
The October 14, 2014 Issue of ***Optics and Photonics News (OPN)*** carried a special section on Optics and Global Security: New Advances in Defense Applications—High Energy Lasers.

The concept of pointing a powerful laser at a target to vaporize it is a *very* simplistic take on what is actually required to create an operational HEL weapon. In turbulent atmospheric conditions, the laser must propagate efficiently and stay accurately focused on the target. The system must compensate for the movement of the target, the motion of the platform and the distortion of the beam from weather or environmental conditions. The platform must be compact enough to fit on a vehicle or even a soldier's shoulder, while the optics must be ruggedized to withstand shock and high irradiance. In addition to these requirements for size, weight and power (SWaP), they must be safer to use than chemical-based high energy lasers.

Optonicus, based within EO, has developed a 21-element optical phased array (OPA) for DARPA's Excalibur program, with low power requirements, long-range turbulence correction and scalability. The nature of the phased-array design enables control of the individual fiber lasers to correct for atmospheric turbulence and aberrations on a sub-millisecond timescale to maximize the laser irradiance at the target 6.4 km away at a power efficiency of 35% and near-perfect beam quality.—*OPN*

Students in the News





EO and ECE were well represented at the 2014 SPIE Annual Meeting in San Diego. All presented papers at the conference. ***Top left***: (l-r) Shiyi Wang, Chuan Ni, and Junxin Wang, EO, at the student reception. ***Top right***: Fares Almehmadi, ECE, with Prof. Monish Chatterjee (r). Ujitha Abeywickrema, ***bottom left***, and Neil Banerjee, ***bottom right,*** presenting their papers at SPIE. Chuan, Ujitha and Fares are PhD students at UD, and Junxin joined the PhD program at the University of California, San Diego. Neil, who was a Centerville High School student, did his science fair project on nanoparticle agglomeration around thermally generated microbubbles with Ujitha. He is currently a freshman at the University of Southern California.

Selected Journal and Conference Papers

Journal Papers

1. C. M. Liebig, S. H. Buller, P. P. Banerjee, S. A. Basun, P.-A. Blanche, J. Thomas, C. W. Christenson, N. Peyghambarian, and D. R. Evans, "Achieving enhanced gain in photorefractive polymers by eliminating electron contributions using large bias fields," Opt. Exp. **21**, 30392-30400 (2013).

2. L. Williams, P. P. Banerjee, G. Nehmetallah, and S. Praharaj, "Holographic volume displacement calculations via multiwavelength digital holography," Appl. Opt. **53**, 1597-1603 (2014).

3. R. Aylo, G. Nehmetallah, H. Li, and P. P. Banerjee, "Multilayer periodic and random metamaterial structures: analysis and applications," IEEE Access **2**, 437-450 (2014).

4. D. de Ceglia, M. A. Vincenti, C. De Angelis, A. Locatelli, J. W. Haus and M. Scalora, "Second harmonic generation from dipole nanoantennas: Role of antenna modes and field enhancement," Opt. Exp. accepted (2014).

5. D. de Ceglia, M. A. Vincenti, S. Campione, F. Capolino, J. W. Haus and M. Scalora, "Second harmonic double resonance cones in dispersive hyperbolic metamaterials," Phys. Rev B 89, 075123 (2014). arXiv 1305.5430

6. J. W. Haus, D. de Ceglia, M. A. Vincenti and M. Scalora, "Nonlinear quantum tunneling effects in nano-plasmonic environments," J. Opt. Soc. Am. **B 31**, A13-A19 (2014).

7. J. W. Haus, D. de Ceglia, M. A. Vincenti and M. Scalora, "Quantum conductivity for metal-Insulator-metal nanostructures," J. Opt. Soc. Am. B **31**, 259 (2014). arXiv 1309.1363.

8. M. Scalora, D. de Ceglia, M. A. Vincenti and J. W. Haus, "Nonlocal and quantum tunneling contributions to harmonic generation in nanostructures: electron cloud screening effects," Phys. Rev. A90, 013831 (2014).

9. L. Wang, P. E. Powers, A.M. Sarangan and J. W. Haus, "Image revivals in multi-mode optical fibers with period ic multiple sub-apertures," Opt. Commun. **326**, 57-63 (2014).

10. M. Benson, P. Shah, M. Marciniak, A. M. Sarangan and A. Urbas, "Optical characterization of silver-nanorod thin films grown using oblique angle deposition," J. Nanomaterials, **2014**, Article ID 694982, 1-9 (2014).

11. B. Gu, Y. Pan, G. Rui, D. Xu, Q. Zhan and Y. Cui, "Polarization evolution characteristics of focused hybridly polarized vector fields," Appl. Phys. B **117,** 915-926 (2014) doi: 10.1007/s00340-014-5909.

12. D. Ju, Y. Bai, W. Zhao, Y. Jiang, and Q. Zhan, "Tailored unidirectional spectral responses generated by an asymmetric plasmonic cavity," J. Opt. Soc. Am. **B 31**, 3067-3073 (2014).

13. G. Rui and Q. Zhan, "Highly sensitive beam steering with plasmonic antenna," Sci. Rep. **4**, 5962, (2014).

14. G. Rui and Q. Zhan, "Trapping of resonant metallic nanoparticles with engineered vectorial optical field," Nanphotonics, **3,** 351-361 (2014) doi:10.1515/nanoph-2014-0006.

15. O. D. Herrera, K.-J. Kim, R. Voorakaranam, R. Himmelhuber, S. Wang, V. Demir, Q. Zhan, L. Li, R. A. Norwood, R. L. Nelson, J. Luo, A. K.-Y. Jen, and N. Peyghambarian, "Silica/Electro-Optic Polymer Optical Modulator With Integrated Antenna for Microwave Receiving," J. Lightwave Technol. **32**, 3861-3867 (2014).

16. X. Zhang, A. Hosseini, H. Subbaraman, S. Wang, Q. Zhan, J. Luo, A. K.-Y. Jen, and R. T. Chen, "Integrated Photonic Electromagnetic Field Sensor Based on Broadband Bowtie Antenna Coupled Silicon Organic Hybrid Modulator," J. Lightwave Technol. **32**, 3774-3784 (2014).

Conference Papers

1. M. S. Alam, J. Khoury , P. P. Banerjee, W. M. Durant, D. M. Martin, and G. T. Nehmetallah, "Performance evaluation of optimal filters for target detection using SAR imagery ", Proc. SPIE **9094**, 90940C (2014).

2. U. Abeywickrema and P. Banerjee, "Phase-shifting holography using Bragg and non-Bragg orders in photorefractive lithium niobate," Proc. SPIE **9200**, 92000Z (2014).

3. U. Abeywickrema and P. Banerjee, "Characterization and application of bubbles during thermal blooming," Proc. SPIE **9194**, 91940H (2014).

4. P. Banerjee, H. Liu, and L. Williams, " Experimental evaluation of digital holographic reconstruction using compressive sensing," Proc. SPIE **9006**, 90060Y (2014).

5. C. Ni, P. Shah, and A.M. Sarangan, "Effects of different wetting layers on the growth of smooth ultra-thin silver thin films," Proc. SPIE **9170**, 91700L (2014).

6. J. Wang and A. Sarangan, "Nanoimprint fabrication of wiregrids micro-polarizers in near infrared spectra using SU-8 as an intermediate film," Proc. SPIE 9170, 917010 (2014).

5. M. Vorontsov, "Performance comparison of conventional and fiber-array beam director systems over tactical range distances," Technology Exchange Meeting on Maritime Horizontal Path Turbulence Modeling, Testing and Prediction (2014).

6. M. A. Vorontsov and S. L. Lachinova, "Target-in-the-loop atmospheric turbulence characterization based on remote sensing invariants," Imaging and Appl. Opt. OSA Technical Digest (online) paper PW2E.1 (2014).

7. M. A. Vorontsov and S. Lachinova, "Target-in-the-loop atmospheric turbulence characterization based on remote sensing invariants," Third International Workshop on Advanced Threat Warning, Tracking and Laser Countermeasures in Atmospheric Turbulence. Ettlingen, Germany (2014).

Faculty Spotlight
Imad Agha

What do Peter Powers, Andy Chong and Imad Agha have in common? Here is a hint: all passed through Cornell on their way to UD. Peter started out from Canada, Andy from Korea, and Imad from Lebanon. As diverse as it may seem, it is true that their convergence to Cornell, albeit at different periods, showed them the way to Dayton, located at the crossroads of America, and to a successful future.

Born and raised in Beirut, Lebanon, Imad moved to Cornell University in Ithaca, NY, in 2002. His dissertation involved the fabrication of high-Q silica microspheres, and the generation of broadband frequency combs via cascaded four-wave mixing. After his PhD, he moved to the Institut d'Optique in Palaiseau, France, where he worked on generating squeezed states of light in atomic vapors, and then on to Telecom Paristech where he worked on producing correlated photons in nonlinear crystals and distributing them on DWDM networks. After moving back to the US, Imad worked at NIST as a research associate in the Nanofabrication Research Group on the generation of single photons in quantum dot structures. Currently Imad is an Assistant Professor in Physics and EO at UD, working on developing novel structures in lithium niobate and in silicon for high speed quantum information processing applications.

I still like being in the nanofab or the machine shop more than anything else.

Imad Agha, Physics and EO, UD

EO @ UD

A joint initiative between electrons and photons

A Nobel Year for Optics

In 2014, the Physics and Chemistry Nobel prizes went to groups working in the general area of optics. The Nobel Prize in Physics was awarded jointly to Isamu Akasaki, Hiroshi Amano and Shuji Nakamura *"for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources"*. The Nobel Prize in Chemistry was awarded jointly to Eric Betzig, Stefan W. Hell and William E. Moerner *"for the development of super-resolved fluorescence microscopy"*. We warmly congratulate the recipients and look forward to further recognitions in the area of optics in the near future.

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udayton.edu/engineering/departments/electrooptics_grad/index.php

Factoid

According to Google Scholar, Andy Chong, assistant professor of Physics and EO, has amassed over 2427 citations! The paper "All normal dispersion femtosecond fiber laser", Opt. Express (2006) alone has 417.

EO Graduates

Spring 2014

Emily Fehrman, PhD
Ziruo Cui, MS
Shane Gillespie, MS
Michael Kerns, MS
Steven Zuraski, MS

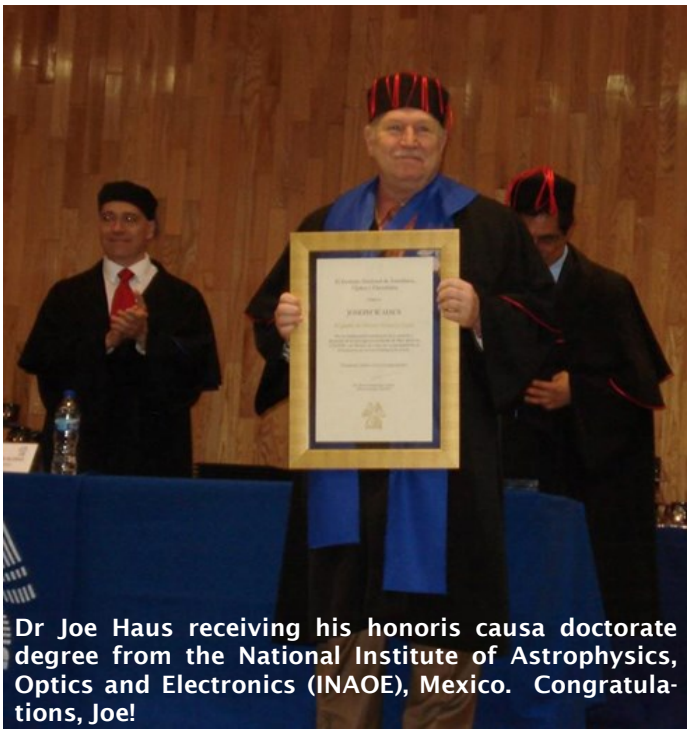
Summer 2014

Logan Williams, PhD
Qian Cao, MS
Haipeng Liu, MS
Sarvenaz Memarzadeh, MS
Chuan Ni, MS
Junxin Wang, MS

Fall 2014

Brian Dolasinski, PhD
Amit Benharushnega, MS
Josh Forbes, MS
Yue Liu, MS
Jonathan Slagle, MS
Yuanshi Sun, MS
ZhiCheng Xiao, MS

Faculty receive award, recognition



Dr Joe Haus receiving his honoris causa doctorate degree from the National Institute of Astrophysics, Optics and Electronics (INAOE), Mexico. Congratulations, Joe!

EOP, Optonicus receive recognition

PRISM AWARDS FINALIST

An innovative laser transmitter system jointly developed by the Intelligent Optics Lab of the Electro Optics Program at the University of Dayton, and Optonicus (**see p. 2**), has been named a finalist in the SPIE's prestigious Prism Awards.

The Prism Awards for Photonics Innovation is a leading international competition that honors the best new photonic products on the market. Optonicus' innovative INFA product was selected as one of three finalists in the category of Scientific Lasers. The winners will be announced Wednesday, 11 February 2015 at Photonics West in San Francisco, California during a gala event known as the "Oscars of Photonics".

Selected Invited Talks 2014

April 25, 2014
Siddharth Ramachandran, Boston University. *Light that Twists inside Fibers.*

May 15, 2014
Anjan Ghosh, Tripura University, India. *Improving BER in a MIMO Free Space Optical Communication System in a Turbulent Channel with Spatial Arrangement of the Transceiver Arrays.*

July 29, 2014
Willie Rockward, Morehouse State University. *Micro/Nano-Optics and Engineering (MORE) Laboratory.*

October 17, 2014
Enam Chowdhury, Ohio State University. *Ultra Intense Lasers and Laser-Matter Interaction.*

November 14, 2014
Akhlesh Lakhtakia, Penn State University. *Seduced and Murdered: an Optical Suspense.*
David Look, Wright State University. *Zinc Oxide: Sunscreen, Electronics, Plasmonics.*