

Spring 2014

## EON, Vol. 02, No. 02

University of Dayton. Electro-Optics and Photonics Program

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# EON

Volume 2, Issue 2

Spring/Summer 2014

## Electro-Optics News, University of Dayton

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Mikhail Vorontsov  
Qiwen Zhan  
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Editor: Partha P. Banerjee

### Director's corner



This has been a rather eventful spring, and I apologize in advance for the tardiness of this newsletter.

First, it is with deep sadness that I have to state that our colleague Dr. Peter Powers, professor of Physics and EO passed away recently after a year-long courageous battle with pancreatic cancer. Throughout the numerous visits to different hospitals and stays at home, Peter always made it a point to come to his office and work with students in his lab, as well as teach his assigned courses. Although I did not get a chance to see him during his last hours, I am told that he was discussing science with his colleagues between passing

into periods of rest. The Optical Society made a special exception and mailed him his Fellowship Award this Spring. Peter will forever be remembered for his contributions to nonlinear optics, THz generation, and Metamaterials. Peter leaves behind his wife Debbie, who stood by his side all through this ordeal and devotedly updated entries in Caring-Bridge, and his four children who were extremely near and dear to him. Our admin Nancy Wilson lost her sister on the same day that Peter passed away. Finally, our Physics admin Linda Fiorina lost her husband suddenly due to a car accident. Our thoughts and prayers go out to families and friends of those we so unfortunately lost.

### Partha Banerjee

In other news, the School of Engineering just hired a new Dean, Dr. Eddy Rojas from the University of Nebraska, who will take over effective July 1, replacing Dr. Tony Saliba who will return to Chemical Engineering as a faculty member. LOCI, the center of excellence within EO, is looking for a new Director to replace Dr. Joe Haus, who will continue to be on the EO faculty. EO is offering 3 short courses again this summer. Dr. Mikhail Vorontsov offered a course on Atmospheric Optics this spring off-campus at Riverside Research. EO has also been very successful with funded research, and is expected to have over \$2.5M in research expenditures in 2013-14.

### More mirrors for a closer shave - brilliant!!



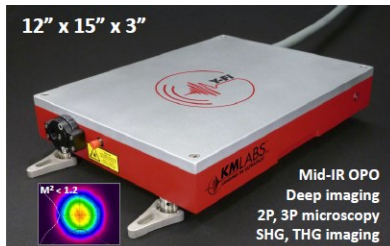
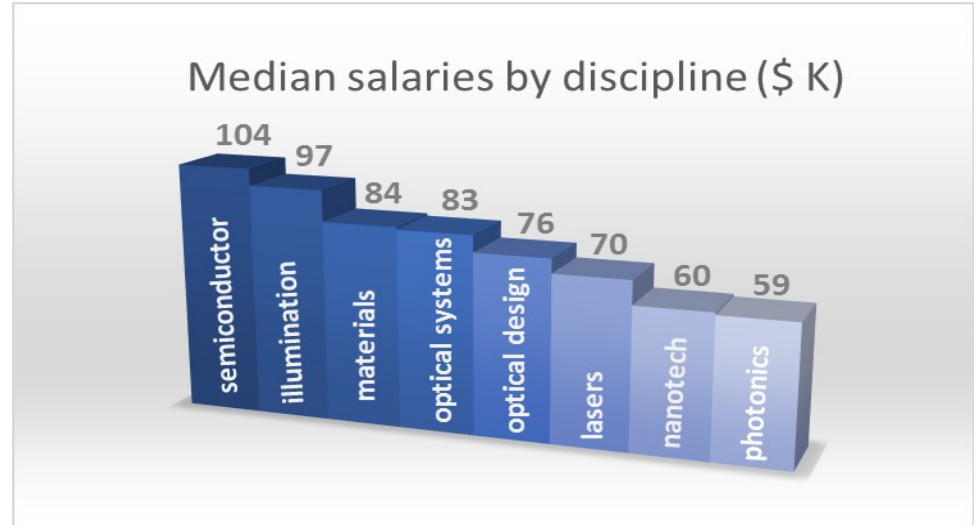
Adaptive mirror array in the Intelligent Optics lab of Dr. Vorontsov at Electro-Optics in UD. Dr. Vorontsov's group at UD is the lead team on a MURI project collaborating with AFIT, NC State, New Mexico State and Michigan Tech.

If you are not satisfied looking at your face in a mirror, Dr. Mikhail Vorontsov has an answer: use 21! Maybe adaptive ones, too, that will undoubtedly make you look your very best! Not sure if he has tried it out by himself for the perfect shave, but he certainly uses them to produce unaberrated beams of light for directed energy technology, which, someday, may find its use as laser cannons in the Navy. Vorontsov is more upbeat on its commercial uses: he is proposing coherently combining many laser beams from fiber arrays to produce a "brilliant" beam that can be used for 3D manufacturing, advanced material processing, and advanced laser communications. Unlike

current laser manufacturing technology, fiber-array laser systems can provide excellent beam quality, micron-accuracy control, and the ability to deliver multiple beams to predefined locations. By producing the perfect beam, manufacturers can weld dissimilar materials e.g. steel and aluminum, with very different melting temperatures, without cracking. Fiber-array technology also could be used to remotely charge unmanned aerial vehicle batteries while the UAV remains aloft, as well as for secure network laser communications. The research is being done at the Intelligent Optics Lab at UD along with Optonicus, a small business with 18 employees and \$3M in contracts for '14.

**Factoids**

- The median salary for SPIE's survey respondents is \$76,000.
- Survey respondents are highly satisfied with their jobs overall: 85% enjoy their work, while 90% respect the work of their peers.
- 39% of workers in higher-income Asian countries work 50 or more hours per week.
- 91% of workers in lower-income Asian countries expect a raise in 2014 versus 58% of lower-income Europeans.

**SPOTLIGHT: SPIE Photonics Global Salary Report 2013****ANDi Chong invents new fiber laser**

A mode-locked fiber laser based on the all normal dispersion (ANDi) fiber laser design is finally in the market. KMLabs Inc. announced Y-Fi, their first mode-locked fiber laser product which is based on the ANDi design.

The ANDi fiber laser (pictured left) was invented by Dr. Andy Chong when he was working as a research assistant in professor Frank Wise's group at Cornell University. Y-Fi provides ~150 fs pulses with ~400 nJ pulse

energy. Due to its compact size (12"x15"x3"), this laser is suitable for medical treatments such as nonlinear microscopies and eye surgeries even in small clinics.

[http://www.kmlabs.com/sites/default/files/Y-Fi\\_Datasheet\\_2014.01.29.pdf](http://www.kmlabs.com/sites/default/files/Y-Fi_Datasheet_2014.01.29.pdf)

*"The enrollment complexion in EO has evolved from class cohorts composed of nearly 100% US citizens to a more international group of students"*

*- Joe Haus, LOCI, EO*

**E0 Grads: 31 years and evolving**

The Electro-Optics Program passed its 30<sup>th</sup> anniversary in 2013. At this juncture let's look back at some activities of our alumni and at the recent trends in the evolution of the EOP. Through 2013 we have awarded 238 M.S. and 44 Ph.D. degrees. The enrollment complexion in EO has evolved from class cohorts composed of nearly 100% US citizens to a more international group of students mainly from China and India, but students from many other countries, such as Bangladesh and regions, such as Latin America also seek an EO degree. My program perspective has developed since I arrived at UD as EOP director in 1999. Since that time the EOP has seen a period of substantial growth in our faculty with substantial research activities, international outreach in both research collaborations and student body composition.

The largest employer of EOP

US graduates for many years has been the Air Force Research Labs. Our alumni are present as government workers and contractors in several different Directorates. Their research in materials, sensors and human factors contributes to the overall AFRL mission.

The earliest 1985 EOP graduates include Adam Coleman, Bill Lynn and Mark DeLong who have established their careers in Dayton. Blair Barbour ('86) founded his own company, Photon-X, to develop technology for 3D imaging. Applications are being developed in entertainment and health care industries, as well as simulations for the military sector. John Taranto ('86) has established a career and contributed to the success of Thorlabs.

AFRL has a seemingly insatiable appetite for optics research in disparate areas; in the early days Mike Lander MS '87 and Rebecca Courtney

MS '87 also took up the challenge to work at AFRL. Recent alumni Chris Brewer MS '97, PhD '01, Emily Heckman PhD '06 and Leo Gonzalez MS '97, PhD '09 are also building productive careers in Dayton and contributing to AFRL's mission.

I can only mention a few recent graduates here: Nkorni Katte PhD '11, originally from Cameroon, is now teaching and working at Wilberforce University. Recent students Yiyi Guan PhD '12, Jian Gao PhD '12, Wei Han MS '09, PhD '13 and Wen Cheng MS '09, PhD '13 represent the new evolution in the EOP. They are working in companies from the east coast (Vermont and New York) to the west coast (California) and bringing their knowledge and experience to bear on solving important problems in the commercial sector.

*- Joe Haus, EO director, 1999-2012.*

**Techfest 2014**

## Selected journal publications 2013

1. Banerjee, P. P., Evans, D., Lee, W., Reshetnyak, V., Tansu, N. (2013). Hybrid organic-inorganic materials for novel photonic applications. *Applied Optics*, 52, HM1-HM3.
2. Liebig, C., Buller, S., Banerjee, P. P., Basun, S., Blanche, P., Thomas, J., Christensen, C., Peyghambarian, N., Evans, D. (2013). Achieving enhanced gain in photorefractive polymers by eliminating electron contributions using large bias fields. *Optics Express*, 21, 30392-30400.
3. Dapore, B., Rabb, D. P., Haus, J. W. (2013). Phase noise analysis of two wavelength coherent imaging system. *Optics Express*, 21 (25), 30642.
4. Haus, J. W., Ibarra-Escamilla, B., Pottiez, O., Kuzin, E., Grajales-Coutiño, R., Zaca-Moran, P. Experimental investigation of self-starting operation in a F8L based on a symmetrical NOLM. *Optics Comm.*, 281, 1226-1232.
5. Haus, J. W., de Ceglia, D., Vincenti, M. A., Scalora, M. (2014). Quantum Conductivity for Metal-Insulator-Metal Nanostructures. *J. Opt. Soc. Amer. B*, 31(2), 259-269.
6. Scalora, M., Vincenti, M. A., de Ceglia, D., Grande, M., Haus, J. W. (2013). Spontaneous and stimulated Raman scattering near metal nanostructures in the ultrafast, high-intensity regime. *J. Opt. Soc. Amer. B*, 30(10), 2634-2639.
7. Vincennti, M. A., de Ceglia, D., Haus, J. W., Scalora, M. (2013). Harmonic Generation in Multi-Resonant Plasma Films. *Physical Review A*, 88(4), 043812 -5.
8. Fehrman, E., Aga, R., Lombardi, J., Bartsch, C., Sarangan, A. M., Heckman, E. (2013). Nanoimprint lithography of deoxyribonucleic acid biopolymer films. *SPIE Journal of Micro/Nanolith. MEMS MOEMS*.
9. Shah, P., Ju, D., Niu, X., Sarangan, A. M. (2013). Vapor Phase Sensing Using Metal Nanorod Thin Films Grown by Cryogenic Oblique Angle Deposition. *Journal of Sensors*, 2013.
10. Lachinova, S. L., Vorontsov, M. (2013). Exotic laser beam engineering with coherent fiber-array systems. *Journal of Optics*, 15(10), 105501.
11. Vorontsov, M. (2013). Speckle effects in target-in-the-loop laser beam projection systems. *Advanced Optical Technologies*, 2 (5), 369-395.
12. Vorontsov, M., Weyrauch, T., Lachinova, S., Ryan, T., Deck, A., Deck, M., Paramonov, V., Carhart, G. (2013). *Coherent beam combining and atmospheric compensation with adaptive fiber array systems* (pp. 167-191).
13. Minet, J., Vorontsov, M., Polnau, E. E., Dolfi, D. (2013)., *Enhanced Correlation of Received Power-signal Fluctuations in Bidirectional Optical Links* (vol. 15, pp. 022401). *Journal of Optics*.
14. Zhan, Q., Fu, J., Lim, M., Li, Z., Ou-yang, H. D. (2013). Potential energy profile of colloidal nanoparticles in optical confinement. *Optics Letters*, 38(20), 3995-3998.
15. Chen, W., Zhan, Q. (2013). In Zhan, Q. (Ed.), *Comprehensive Focal Field Engineering with Vectorial Optical Fields*. Singapore: World Scientific.
16. Rui, G., Zhan, Q. (2013). In Zhan, Q. (Ed.), *Plasmonics with Vectorial Optical Fields*. Singapore: World Scientific.
17. Zhan, Q. (2014). In Forbes, A. (Ed.), *Vector Beams*. CRC Press.
18. Zhan, Q. (2013). In Zhan, Q. (Ed.), *Cylindrical Vector Beams*. Singapore: World Scientific.
19. Zhan, Q. (2013). In Zhan, Q. (Ed.), *Optical Measurement Techniques Utilizing Vectorial Optical Fields*. Singapore: World Scientific.
20. Zhan, Q. (2013)., *Vectorial Optical Fields: Fundamentals and Applications*. Singapore: World Scientific.

For earlier publications in 2013, please see EON 2 (1), 2013.

## Selected conference publications 2013

1. Aylo, R., Banerjee, P. P., Basun, S., Evans, D. (2013). *Contribution of diffusion and photovoltaic effect to self-pumped reflection gratings in photorefractive lithium niobate* (vol. 8847, pp. 88470B - 8 pp.). *Proc. SPIE*.
2. Banerjee, P. P., Abeywickrema, U. (2013). In SPIE (Ed.), *A simple optical probing technique for nonlinearly induced refractive index* (vol. 8847, pp. 884710 6 pp.). *Proc. SPIE*.
3. Liebig, C., Basun, S., Buller, S., Evans, D., Banerjee, P. P., Blanche, P., Christensen, C., Peyghambarian, N., Thomas, J. (2013). In SPIE (Ed.), *Enhanced gain dynamics in photorefractive polymers* (vol. 8847, pp. 88470A). *Proc. SPIE*.
4. Aubailly, M., Vorontsov, M. (2013). *Digital adaptive optics and imaging through deep turbulence* (vol. 8610, pp. 86100Y). *Proc. SPIE*.
5. Minet, J., Vorontsov, M., Wu, G., Dolfi, D. (2013)., *Efficiency comparisons of spatial and spectral diversity techniques for fading mitigation in free-space optical communications over tactical-range distances* (vol. 8610, pp. 86100X). *Proc. SPIE*.

For earlier publications in 2013, please see EON 2 (1), 2013.



## Fall 2013

## Graduates

David Bricker, MS

Micah Gatz, MS

Zhijun Yang, MS

**Congratulations!**

*"It will revolutionize an entire industry"*

- Mikhail Vorontsov, WBI  
Endowed Chair, EO.,  
speaking on application  
of directed energy  
technology to  
manufacturing (see  
cover page).



The (mostly) UD EO-ECE contingent (pictured left) at an appropriately Papal setting in Buca di Beppo adjacent to the Moscone Center, the venue for SPIE Photonics West 2014. The annual event drew over 21,000 registered attendees to San Francisco this year, while the sold-out Photonics West Exhibition (above) included over 1250 exhibiting companies.



## EO @ UD

A joint initiative between  
electrons and photons



Institute for Development and  
Commercialization of Advanced  
Sensor Technology



Intelligent Optical Systems



## Did you know?

For futuristic applications like wearable body sensors, researchers need to ferry information along flexible routes. Electronics that bend and stretch have become possible in recent years. Now a team of researchers from the University of Ghent, Belgium, reports progress on what may be the first optical circuit that uses interconnections that are not only *bendable*, but also *stretchable* [Opt. Exp. Feb '14]. These are made of a rubbery transparent material called PDMS (poly-dimethylsiloxane) and guide light along their path even when stretched up to 30% and when bent around an object the diameter of a human finger.

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We are on the Web:  
[www.udayton.edu/engineering/  
electrooptics\\_grad/](http://www.udayton.edu/engineering/electrooptics_grad/)

## SUMMER SHORT COURSE SERIES

June 2-6, 2014

**DIGITAL HOLOGRAPHY.** Basic principles; holographic interferometry, microscopy and tomography; multi-wavelength digital holography; phase-shifting holography; compressive holography; dynamic holography; etc., with selected applications to real-world problems. Labs accompany lectures.\*

June 9-13, 2014

**INTRODUCTION TO LADAR.** Survey of principles of direct detection and coherent detection ladar systems; ladar sources and receivers; effects of illumination path and object scattering; basic ladar range equation; elements of detection theory as applied to direct detection ladar systems.

June 16-20, 2014

**FREE SPACE LASER COMMUNICATION.** Laser communications systems, atmospheric channels, propagation in turbulent and scattering media, fluctuation statistics, horizontal uplink and downlink; system performance, link analysis, bit-error-rate analysis; mitigation of atmospheric effects; UAV and mobile platforms, retro-modulators, adaptive optics, hybrid optical/RF communications. Lab demos.\*

\* can be also taken as 1 cr.hr. course.

## Powers, Zhan become OSA Fellows



Dr. Peter Powers (3rd from left) with his family at home. OSA specially mailed his plaque at the request of Dr. Ed Watson.

**Peter Powers**, Professor of EO and physics, was named an OSA Fellow in 2014 "for fundamental studies of nonlinear parametric interactions and for practical applications to the development of optical parametric devices operating from infrared to terahertz regimes". Peter is also Fellow of SPIE.

**Qiwen Zhan**, Professor of EO and ECE, was also named OSA Fellow in 2014 "for seminal contributions to the development of new optical polarization engineering techniques for controlling light-matter interactions on the nanometer scale". Qiwen is also Fellow of SPIE.

## Four AFRL researchers become research faculty

Drs. Dean Evans, Shekhar Guha, Rita Peterson, and Dave Rabb from AFRL have recently been awarded research faculty status at UD. They are actively engaged in advising graduate students in EO and collaborating with EO faculty. The following is a list of EO students being advised by them:

Dr. Evans (Materials): Ighodalo Idehenre, PhD student

Dr. Guha (Materials): David Lombardo, MS student

Dr. Peterson (Sensors): Dayen Voratovic, Brian Dolasinski, PhD students

Dr. Rabb (Sensors): Sarah Krug, MS student

In addition, Dr. Tim White (Materials) has taken on a new PhD student, Bradley Worth.

## Qualifying Corner

Here is a sample question from New Mexico State's qualifying exam in 2011:

A harmonic wave of frequency  $f$  is incident normally on an interface between two dielectric media of refractive indices  $n_1$  and  $n_2$  with  $n_2 > n_1$ . A fraction  $p$  of the energy is reflected and forms a standing wave when combined with the incident wave. Recall that on reflection, the phase of the electric field changes by  $\pi$  for  $n_2 > n_1$ .

- Find an expression for the total electric field as a function of distance  $d$  from the interface. Also find the positions of the maxima and minima.
- Repeat (a) but now for the magnetic field.
- When O. Wiener did such an experiment in 1890, he found minimum darkening of a photographic plate for  $d=0$ . Was the darkening caused by the electric or magnetic field, and why?