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EON

Volume 1, Issue 2

Spring 2013

Electro-Optics News, University of Dayton

Faculty

Partha Banerjee
Brad Duncan
Joseph Haus
Peter Powers
Andrew Sarangan
Mikhail Vorontsov
Qiwen Zhan

with

Vijay Asari
Monish Chatterjee
Andy Chong
Cong Deng
Matt Dierking
Dean Evans
Russ Hardie
Kiego Hirakawa
John Loomis
Paul McManamon
Nick Miller
Rita Peterson
Ernst Polnau
Guru Subramanyam
Ed Watson
Thomas Weyrauch
Perry Yaney

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Editor: Partha P. Banerjee

Director's corner



Welcome to EO at UD, one of a select group of universities with a specialized program in optics. Our vision is "to become an internationally recognized premier electro-optics program". Our mission is to (a) provide the highest quality graduate education in EO, support the educational needs of undergraduate students in other programs, serve the continuing educational needs of defense and industry, and enhance optics and photonics education at all levels; (b) create and disseminate new knowledge and innovations in optics and photonics by conducting, presenting, and publishing cutting-edge fundamental and applied research; (c) engage in development of Ohio's and the nation's knowledge-based and technology-based defense programs and industries, and create, foster, and sustain mutually beneficial re-

search collaborations and partnerships with defense and industry; and (d) engage in international research partnerships and become an internationally recognized leader in EO education and research.

The EO program contributes significantly to UD's national recognition. EO had \$2.5M in research expenditures last year. EO recently won a 5-year \$4.5M MURI from AFOSR as the lead institution, partnering with NC State, Michigan Tech, and AFIT. EO has a top-notch MS and PhD program with a consistent enrollment of over 40. Over 90% of students are RAs (many through AFRL, DARPA, Army) or TAs (from Physics). EO has provided AFRL consistently with needed expertise and a highly trained workforce.

EO prides itself in its laser radar and optical communication institute (LOCI), which works closely with the AFRL sensors division. LOCI is diversifying to other directorates at AFRL, viz., materials, who will

Partha Banerjee

also be funding our future students. The diversification of LOCI was discussed in the Board of Governors meeting last year. EO nurtures small companies e.g., Optonicus, DEC, FMI, and UtopiaCompression, who in turn hire our graduates.

For the first time, EO will be offering 4 short courses this summer on contemporary topics such as digital holography, nonlinear optics, LADAR, and thin-film engineering. These courses are open to students, as well as engineers and scientists in industry and government. We plan to offer these courses at the UD China Institute in 2015. This should help attract top-notch students from Chinese universities, one of which, Harbin, recently visited us. We are currently partnering with China Southern Glass Holdings, to fabricate electrochromic glass for commercial applications. We hope that this "thin-film diplomacy" will open the door to many more partnerships with China in the future.



Dr. Andrew Sarangan (right) with researchers from China Southern Glass Holdings (CSGH) who visited his nanofab facility to collaborate on research funded by CSGH on developing electrochromic thin film coatings on glass for commercial applications. Also participating in this joint project are Drs. Joe Haus, Cong Deng, and Jian Gao from EO.

Kwalifying Korner

SPOTLIGHT: OPTONICUS grows with strong EO ties

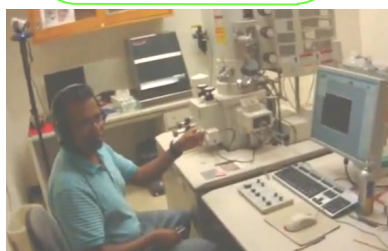


http://www.optics.unm.edu/exam_phd.htm

Now, a real qualifier question: How can you use a few glass plates to create linearly polarized light from unpolarized light? [U. of Michigan]

"We are currently working with the Dayton Regional STEM Center to develop two high school course modules on Nanotechnology that will be available to teachers across the nation."

- Joe Haus, LOCI, EO



Dr. Sarangan teaching from his lab (top), while students are viewing the lecture from the classroom (bottom).



Optonicus, a small business which was spun out of EO by Professor Vorontsov in 2009, has seen considerable growth due to close working partnerships with UD students, researchers and post-docs.

Optonicus now has a staff of 15, and is co-located with the Intelligent Optics Laboratory (IOL) in EO. It offers a unique opportunity for students to gain insight into the inner workings of a start-up company while studying for advanced degrees.

The Optonicus/UD team has won 3 Small Business Technology Transition Research (STTR) awards. The topics include: intelligent beam control for optical phased array transceivers, developing

an extended-range atmospheric sensing suite of instruments for deep turbulence characterization, and building scalable adaptive fiber-array elements for directed energy phased arrays. One of the Phase I's has now transitioned into Phase II. This growth, along with other Broad Agency Announcements (BAAs) and additional Small Business Innovative Research (SBIR) contracts has enabled Optonicus to grow and hire new staff, including Mr. Juan Gonzalez, a renewable and clean energy MS student, as a Jr. Software Engineer, and Mr. Guimin Wu, a fall 2012 MS EO graduate as an EO Engineer.

Recently, Dr. Arun Mazum-

dar, an expert in free space optical communications and co-author of a textbook on the topic, visited Optonicus to pursue areas of collaboration and to present a colloquium titled "Retrocommunications in presence of Atmospheric Turbulence".

Finally, Optonicus and UD are working together to promote funding of a Center for Advanced Laser Manufacturing (CALM) with intelligent fiber-array and robotic technologies to create the next generation of fiber-array laser tools for materials processing (joining, welding, cutting, precision hole drilling and additive manufacturing).



Optonicus and UD EO team members pose outside CPC. Shown from right to left, Susie Engle (Office Manager), Thomas Weyrauch (EO Senior Researcher), Gui Min (Design Engineer and EO MS graduate), Andrew Deck (Optonicus Mechanical Engineer), Mikhail Vorontsov (Optonicus CTO & Professor of EO), Rob Markovich (Optonicus CFO), Tom Tumillo, Jr. (Optonicus CEO), Michelle Kraczek (Optonicus and Intelligent Optics Lab Assistant Office Manager), Pavel Lougovski (Optonicus Research Scientist), and Jean Minet (Visiting EO Post-Doctoral Researcher).

Virtually nano: nanotech course with Lifesize video

Last Fall, Dr. Haus introduced a new *undergraduate* course called the **Principles of Nanotechnology** that examined electronic, optical and mechanical effects of materials that are structured on the nanoscale. Besides learning about nanofabrication tools, students also had a chance to speak with a researcher in the lab while experiments were in progress. Space limitations in the Nanofab Lab made it hard to place all stu-

dents in the facility. A new interactive video system was therefore developed by Dr. Sarangan using the joint UD - Sinclair Community College NSF grant. This innovative technique was built using a Lifesize Team 220 video conferencing system on a mobile platform. It has two high-definition cameras and two-way video and audio links to help engage viewers and give them an opportunity to participate in the experiments

(see YouTube video at: <http://www.youtube.com/watch?v=0PKtRHjGlgg>). Students were also introduced in class to a simulator, called the *Virtual NanoLab*, to explore all the steps required in making a nanoscale device, viz., deposition, patterning, lithography, and etching. Furthermore, guest speakers from industry and government gave seminars in the course, which contributed to a richer student experience.

Selected faculty, student journal publications 2012

P. Shah, H. Knachel, A. Sarangan, and K. Hansen, "Nanostructured columnar thin films for biological and chemical sensing applications", *J. Electrochem. Soc.* (2012).

A. Sarangan, P. Shah, and X. Niu, and K. Hansen, "High aspect ratio silver nanorod thin films grown at cryogenic substrate temperature", *Nanoscience Lett.* (2012).

X. Niu, P. Murray, and A. Sarangan, "Synthesis of Fe-Ni bimetallic nanoparticles from pixel target ablation: plume dynamics and surface characterization", *J. Nanoparticle Res.* (2012).

Q. Zhan, "Special Issue Introduction: Editorial", *Int'l J. Optics*, Hindawi (2012).

Q. Zhan, Z. Rui, R. Nelson, W. Chen, and D. Abeysinghe, "Hybrid spiral plasmonic lens: towards an efficient miniature circular polarization analyzer", *Opt. Exp.* **20**, 26299-26307 (2012).

Q. Zhan, Z. Rui, A. Liu, X. Ren, G. Guo, and G. Guo, "Encoding photonic angular momentum information onto surface plasmon polaritons with plasmonic lens" *Opt. Exp.* **20**, 24151-24159 (2012).

Q. Zhan, J. Wang, and W. Han, "Creation of uniform three-dimensional optical chain through tight focusing of space-variant polarized beams", *J. Optics* **14**, 055004 (2012).

Q. Zhan, W. Chen, and R. Nelson, "Efficient miniature circular polarization analyzer design using hybrid spiral plasmonic lens", *Opt. Lett.* **37**, 1442-1444 (2012).

Q. Zhan, "Trapping metallic Rayleigh particles with radial polarization: reply to comment", *Opt. Exp.* **20**, 6058-6059 (2012).

G. Nehmetallah and P. Banerjee, "Applications of digital and analog holography in three-dimensional imaging", *invited review article*, *Adv. Opt. Photonics* **4**, 472-553 (2012).

J. Haus, B. Ibarra-Escamilla, O. Pottiez, E. Kuzin, R. Grajales-Coutiño, and P. Zaca-Moran, "Experimental investigation of self-starting operation in a F8L based on a symmetrical NOLM", *Opt. Comm.* **281**, 1226-1232 (2012).

M. Scalora, M. Vincenti, D. de Ceglia, N. Akozbek, V. Roppo, M. Bloemer, and J. Haus, "Dynamical model of harmonic generation in centrosymmetric semiconductors at visible and UV wavelengths", *Phys. Rev. A* **85**, 053809 (2012).

M. Scalora, M. Vincenti, D. de Ceglia, M. Grande, and J. Haus, "Raman scattering near metal nanostructures," *J. Opt. Soc. Am. B* **29**, 2035-2045 (2012).

For earlier publications in 2012, please see EON 1 (1), 2012.

EON Helpdesk: How to write a winning PhD proposal

General structure

- Introduction: background, motivation, literature review
- Objective/Purposes/Hypothesis
- Methods
- Preliminary results
- Future work, timeline
- Bibliography

Important: *committee sees the proposal as a contract.*

The hardest part is the introduction. Remember:

1. It is not a literature review! It should be a summary of existing evidence that motivates your specific, proposed work.
2. Start broad, but become increasingly specific.
3. End with a review, and broaden out to discuss potential applications (importance) of the proposed work.
4. Topics to be addressed: what's been done; what hasn't; what is needed and why. Indicate your part or contribution clearly.
5. Intro should contain statements of objectives, purposes, and hypothesis.
6. When summarizing existing literature, it is not enough just to describe what authors X, Y, and Z did. Results should be interpreted, in context of overall review and study objectives.

<http://filebox.vt.edu/n/nussbaum/subpages/ProposalHowTo.pdf>

Fall 2012

Graduates

Maureen Crotty, MS

Craig Stonaker, MS

Chenchen Wan, MS

Erica Whitfield, MS

Guimin Wu, MS

Congratulations!

"Despite a number of observed violations, the classical Kolmogorov theory still plays a significant role for analysis of atmospheric optical systems."

- Mikhail Vorontsov, WBI Endowed Chair, EO.

Team bonding in a deeply turbulent atmosphere

Members of the UD MURI consortium on "Wave optics of deep atmospheric turbulence" had their kickoff meeting on October 4-5, 2012 at the UD River Campus to discuss collaborative research. Dr. Mikhail Vorontsov, WBI Chair Professor of EO at UD, leads the \$4.5M AFOSR project, which includes Air Force Institute of Technology (AFIT), Michigan Tech University (MTU), North Carolina State University (NCSSU), New

Mexico State University (NMSU) and University of Miami (UM) [EON,1(1),2012].

Dr. Vorontsov noted that the classical Kolmogorov theory of turbulence can be successfully applied not only for short optical paths near the ground, but also for fully developed turbulence within heights up to 14 km. Above this, the presence of well distinguished atmospheric layers characterized by sharp variations in refractive index

can result in strong optical refraction effects such as optical mirages, signal fading, and caustics. The 2 day workshop included talks by Drs. Kent Miller (AFOSR), Tom Farrell and Mike Eismann (AFRL), Steve Fiorino (AFIT), Sukanta Basu (NCSU), Dave Voelz (NMSU), Olga Korotkova (UM), and Tom DeFelice (ARL). Along with research, the team will also offer a new course on Atmospheric Optics in Fall 2013.

*Introducing a new course
Fall 2013*

Introduction to Atmospheric Optics

- Fundamentals of atmospheric physics, global and macro optical effects
- Atmospheric optical turbulence
- Optical waves propagation in atmosphere; deep turbulence effects
- Atmospheric optical effects: analysis and simulations
- Atmospheric effects: mitigation and exploitation.

Instructors: Dr. Vorontsov & MURI team members

EO @ UD

A joint initiative between
electrons and photons



Institute for Development and
Commercialization of Advanced
Sensor Technology



Intelligent Optical Systems



Did you know?

Between EO faculty and technical staff, there are 17 fellows of national & international organizations:

Partha Banerjee, Fellow, OSA, SPIE; FinstP
Joe Haus, Fellow, OSA, SPIE, APS
Paul McManamon, Fellow, IEEE, OSA, SPIE, MSS, AFRL
Peter Powers, Fellow, SPIE
Ed Watson, Fellow, OSA, SPIE, AFRL, MSS
Qiwen Zhan, Fellow, SPIE

Partha P. Banerjee
Director
Electro-Optics Program
300 College Park
Dayton, OH 45469, USA

Phone: 937.229.2797
Fax: 937.229.2097

E-mail: pbanerjee1@udayton.edu
Admin: Nancy Wilson; nwilson1@udayton.edu

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

SUMMER SHORT COURSE SERIES

June 3-7, 2013

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.*

NONLINEAR OPTICS. Overview of nonlinear optical effects and devices; second harmonic generation, difference frequency generation, phase matching, parametric amplification, Raman amplification, Brillouin scattering. Emphasis on real-world applications. This course gives a common mathematical and conceptual framework to describe nonlinear phenomena.

June 10-14, 2013

THIN-FILM ENGINEERING. Fundamentals of thin film design and deposition; PVD & CVD; optical properties of thin film materials; numerical methods & optimization; metal film optics; thin film metrology; lab demonstrations of selected optical coating processes.*

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.

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

Zhan, Sarangan receive awards, recognition



Top: Dr. Zhan (center) with his Fellowship plaque at 2013 SPIE Photonics West. **Bottom:** Dr. Sarangan (left) and his (nano)-Fab Five in EOP 632.

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In the next issue:

- Short courses kick off at EO for first time
- New agreement with AFRL supports new EO students

Qiwen Zhan, Professor of EO and ECE, has been elected **Fellow of SPIE** for "*achievements in space variant polarization engineering*". SPIE is the International Society for Optics and Photonics. Fellows are Members of distinction who have made significant scientific and technical contributions in the multidisciplinary fields of optics, photonics, and imaging. They are honored for their technical achievement, for their service to the general optics community, and to SPIE in particular. Dr. Zhan was recognized and received his Fellow Award at the SPIE Photonics West Conference at San Francisco in February 2013. Dr. Zhan's research interests include Plasmonics, Nanophotonics, Physical Optics, Metamaterials, Polarization Optics and Metrology.

To date he has 1 book chapter, over 70 journal articles and 60 conference publications, 4 patents and 1 patent application. Interested readers are referred to the invited review monograph in the inaugural issue of the *Advances in Optics and Photonics* (2009) on *cylindrical vector beams: from mathematical concepts to applications*.

Andrew Sarangan, Professor of EO and ECE, has been chosen as one of the 2013 Affiliate Societies Council Outstanding Scientists & Engineers Awards winners. Dr. Sarangan is being recognized in the category of Research, for "*many superior contributions to nano-technology, image sensor technology, and thin film technology*". Using a \$2M research award from the Ohio Third Frontier

program, Dr. Sarangan established the nano and MEMS fabrication lab at UD, which has now become the centerpiece for education and commercialization of nanomaterials, IR detectors, medical imagers, and novel optical thin films. In particular, he has developed new methods to engineer the basic material properties of thin films by controlling their structure at the atomic level. Recently, he won a NSF grant for promoting nanotechnology at the undergraduate level, and, with Dr. Haus, offered a new nanotech course last Fall. Along with Drs. Haus, Deng and Gao, Dr. Sarangan recently also initiated a joint partnership with China Southern Glass Holdings to fabricate electrochromic glass for commercial applications.