

New Faculty Positions

The Department of Electrical Engineering at Penn State has two open faculty positions. Candidates should have a Ph.D. in electrical engineering or a related discipline, the ability to establish and maintain an externally funded research program, and the ability and desire to teach at both the undergraduate and graduate levels. For detailed information on these positions, please see our website here: www.ee.psu.edu/positions-faculty.aspx.



Metamaterials Manipulate Light on a Microchip

Using a combination of the new tools of metamaterials and transformation optics, engineers at Penn State have developed designs for miniaturized optical devices that can be used in chip-based optical integrated circuits, the equivalent of the integrated electronic circuits that make possible computers and cell phones.

Controlling light on a microchip could, in the short term, improve optical communications and allow sensing of any substance that interacts with electromagnetic waves. In the medium term, optical integrated circuits for infrared imaging systems are feasible. Further down the road lies high-speed all-optical computing. The path forward requires some twists on well-known equations, and the construction of structures smaller than the wavelength of light.

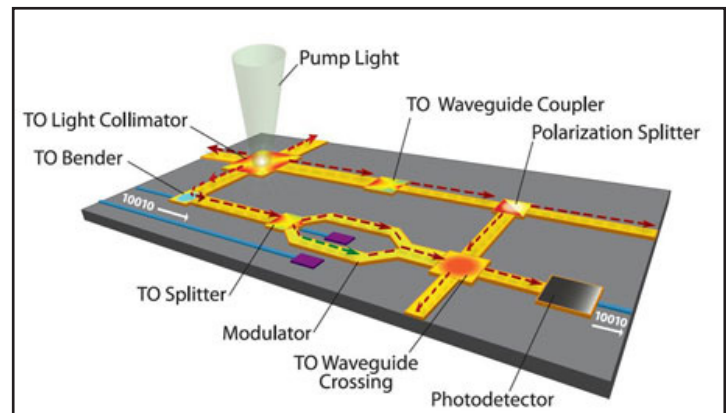
Light bends naturally as it crosses from one material to another, a phenomenon called refraction that can be seen in the way a stick seems to bend in water. Illusions, such as mirages in the desert or the shimmer of water on the road ahead on a hot day, are caused by a difference in the refractive index of layers of warmer and cooler air. The new field of transformation optics (TO) uses this light-bending phenomenon in a rigorously mathematical way by applying the 150-year-old Maxwell equations describing the propagation of light onto structures known as metamaterials, artificial constructs with custom-designed refractive indexes. The most famous applications of metamaterials are cloaking devices and perfect lenses, but those are just the tip of the optical iceberg.

In a paper in a new online journal, *Light: Science and Applications*, published by Nature Publishing Group, **Douglas Werner**, professor of electrical engineering, and his post-doc **Qi Wu** and Ph.D. student **Jeremiah Turpin** present a unified theory for designing practical devices on a single platform using transformation optics. "This field (transformation optics) is in its early stages, so there are many contributions to be made," Werner says. "Our big contribution is in figuring out how to develop TO designs with the simplest material parameters without impacting performance, and linking the devices together to form an on-chip integrative photonic system."

Among their designs are light collimators, which take light from a source and focus it into one or more tightly focused beams, waveguide couplers, which connect different sized waveguides, TO splitters, which divide power from an input waveguide to two or more output waveguides, waveguide crossings, which routes light in compact spaces without loss or crosstalk, and TO benders, which turn the light around corners without loss. These devices are only five to ten microns in size, and therefore many of them could fit on a centimeter-sized chip.

"It has been a joint effort to develop these transformation optics tools and designs," Werner says. "Jeremy wrote the algorithms behind the simulation tools. Qi is developing the designs to be simulated. In order to get the best design for a targeted application, thousands of simulations may have to be performed using powerful optimization techniques developed in our group."

Transformation optics devices that perform diverse, simple functions can be integrated together to build complex photonic systems for optical communications, imaging, computing, and sensing, say the authors. The current, non-TO approach is to design each device using different methods and materials that may not be compatible on a single platform. The Werner group's tech



Transformation optics devices that perform diverse, simple functions can be integrated together to build complex photonic systems for optical communications, imaging, computing, and sensing. (Photo Credit: Werner Group, Penn State)

Alumni Spotlight

Chanakya Mehta, an applications engineer at Texas Instruments (TI), discovered his passion for his work during his undergraduate career at Penn State. After he graduated in 2008 with a B.S. in electrical engineering, he went on to earn a master's degree in 2011.



Mehta's job and roles at TI include thinking as a problem solver: identifying, understanding, and tackling problems head-on to help his customers every day. He specifically works with automotive systems and along with his team, develops parts and systems for cars.

In the last two years of his undergraduate career at Penn State, Mehta became involved with the Humanitarian Engineering and Social Entrepreneurship (HESE) program, where he really developed his passion for problem solving and figuring out solutions for societal problems. He says that his role at TI is a mirror of what he grew to love in college.

Mehta earned a minor in Engineering Leadership Development, which gave him even more exposure to global engineering projects. In his current role at TI, he works with teams from Japan, Germany, and China on nearly a daily and this is a part of his job he loves.

As an alumnus, Mehta continues to give back to a program and university that he feels gave him so much. Since he participated in HESE at Penn State and enjoyed the lessons and experiences he had, Mehta has begun to work on establishing similar programs at other universities in Texas. He also mentors two current Penn State electrical engineering students.

The lessons that Mehta learned in and out of the classroom during his undergraduate career at Penn State have steered him to his success and his passion for what he does daily. He advises students in engineering to focus on the techniques and applications that they are being taught and that the skills they develop will help them to succeed in their future career.

"When you are close to graduating, you always fear that you are not ready for the real world," said Mehta. "But, with an education as good as Penn State's, you are ready. You may not feel so now, but in a few months, you will."

Written by Jackie Stare

Save the Date!

The Penn State Electrical Engineering Society is celebrating their 20th anniversary with a reception on March 19 at 6:00 p.m. at the Nittany Lion Inn.

More details will be announced at a later date!

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Metamaterials

nique, on the other hand, employs graded index metamaterial structures, such as patterned air holes or rods, on a silicon-on-insulator platform that can be easily integrated into on-chip photonic systems, providing broad bandwidth and low losses.

In order to keep their designs grounded in reality, the group works closely with nanofabricators at Penn State's Nanofabrication Laboratory who are themselves developing new approaches to implement the Werner group's designs. All of the designs described in the paper can be realistically built with current fab processes, says Werner. "It's like a CAD tool," he explains, citing the computer-aided design tools used in manufacturing. "We've developed customized transformation optics simulation and optimization tools for designing optical devices. Beyond that," he continues, "TO is flexible enough that it opens up the possibility of creating all sorts of new devices that don't currently exist."

"Integrated photonic systems based on transformation optics enabled gradient index devices," by Qi Wu, Jeremiah Turpin, and Douglas H. Werner, appears online November 23, 2012, in *Light: Science & Applications*, (DOI: 10.1038/lisa.2012.38). Partial support for this work was provided by the NSF MRSEC. Contact Prof. Werner at dhw@psu.edu.

Written by Walt Mills

Local Alumnus Receives Award

Dale Hoffman, BSEE 72, has been awarded the 2012 Volunteer of the Year by the Penn State Alumni Association. Hoffman has devoted much of his time to serving the University as a volunteer. He currently serves at the president of both the Centre County chapter of the Alumni Association and the Society of Penn State Electrical Engineers, and volunteers on numerous committees within the College of Engineering, including the APG Grants Committee, the APG Resource Committee, and the Development Committee. He is a mentor for the Electrical Engineering Alumni Mentoring Program; co-adviser for the College of Engineering Senior Design Showcase; a judge for the Penn State Rube Goldberg Machine Contest; a résumé coach during Fall Career Days; and a greeter at the Hintz Family Alumni Center. Hoffman is a familiar face around the department and a ready volunteer for any of our activities.



Dale Hoffman and Alumni Council Member Karen Sweeney

Department News

The Institute of Electrical and Electronics Engineers (IEEE) has named **Suman Datta**, professor of electrical engineering, an IEEE fellow. Datta was cited for contributions to high-performance advanced silicon and compound semiconductor transistor technologies.

The Institute of Electrical and Electronics Engineers (IEEE) has named **Kenji Uchino**, professor of electrical engineering, an IEEE fellow. Uchino was cited for his contributions to piezoelectric and electrostrictive actuators and electromechanical energy conversion.

Qiming Zhang, distinguished professor of electrical engineering, was recently elected a fellow of the American Physical Society. Zhang was cited for his pioneering work in electroactive polymers in exploiting defect modifications to significantly enhance the performance of materials and in advancing their application for energy conversion and energy storage.

Suman Datta, professor of electrical engineering, has been selected to receive the 2012 IBM Faculty Award. This internationally competitive award honors full-time professors who have an outstanding reputation for their contributions in their field. The IBM Faculty Award is a competitive worldwide program which fosters collaboration between researchers at leading universities worldwide and those in IBM research, development and services organizations and promotes courseware and curriculum innovation to stimulate growth in disciplines and geographies that are strategic to IBM. It comes with a monetary gift to further work in the field.

Ken Jenkins, professor of electrical engineering, recently was awarded the rank of IEEE Life membership. Life members are awarded when their age plus years of membership equals or exceeds 100 years. In addition to recognizing long term service, the rank of Life membership includes waived dues and reduced fees at some IEEE conferences and professional workshops.

Umamahesh Srinivas, Ph.D. candidate in the Department of Electrical Engineering, recently won the best paper award at the IEEE Geoscience and Remote Sensing Society meeting. The paper, titled "Discriminative Graphical Models for Sparsity-Based Hyperspectral Target Detection," is the collaborative research between Professor Vishal Monga's research group and Professor Trac Tran's group at Johns Hopkins University.

Jeremy Turpin, graduate student in electrical engineering, recently was selected to receive an IEEE Antennas and Propagation Society Doctoral Research Award. Turpin is a Ph.D. candidate in Doug Werner's research group.

Electrical Engineering undergraduate student, **Jamilya Sultanova**, presented a poster paper at the Signal Processing in Medicine and Biology Symposium that was held on December 1 at the City College of New York. Her paper titled, "Adaptive signal processing methods for removing maternal interference noise from fetal electro-cardiograms" was based on research she conducted through our Research Experience for Undergraduates (REU) program during the summer. Sultanova's mentors in the REU program were Professor **Ken Jenkins** and Assistant Professor **Dave Salvia**.

NSF I/UCRC on Optical Wireless Applications IAB Meeting

Improved security, the absence of electromagnetic interference, a solution to the current spectrum crunch and energy efficiency are a few of the topics that were discussed at the second Industry Advisory Board (IAB) meeting of the Industry/University Cooperative Research Center on Optical Wireless Applications (COWA), a joint center of the Pennsylvania State University and the Georgia Institute of Technology funded by the National Science Foundation.

The field of optics and photonics is extremely broad in terms of the technical science and engineering topics that it encompasses:

- Communications, information processing, and data storage
- Defense and national security
- Energy
- Health and medicine
- Advanced manufacturing
- Advanced photonic measurements and applications
- Strategic materials for optics
- Displays

The IAB meeting, held at the Georgia Tech campus Nov. 29-30, 2012, was intended for engineers, leaders and executives in industry, including light source manufacturers, communications engineers, researchers in the communications and optical fields and anyone interested in wireless communication.

The IAB meeting included a series of presentations on present work and discussion of appropriate future paths. **Mohsen Kavehrad**, W. L. Weiss Chair Professor of Electrical Engineering is the Director of COWA. For more information about COWA, please visit <http://cowa.psu.edu>.

IEEE Student Chapter News

The student chapter of IEEE is organizing their efforts for the Rube Goldberg machine contest in February. This year's theme is early video games and the IEEE team is being chaired by **Mike Rybar**. **Erik Bergstrom**, undergraduate student in electrical engineering, commented, "The team is trying to combine the magic of electrical engineering into the steps of the machine by using some of the core principals we learn in our EE courses." The team is gathering ideas and starting some concept designs.

Another group of students is working with Assistant Professor **Tim Wheeler** with Engineering Projects in Community Service (EPICS). This group is chaired by **Matt Franco**. Their current project involves a local children's museum, Discovery Space. Franco and his team are working closely with Wheeler and the curator of the museum to develop a unique concept to teach children about physics.

Visitor Wireless Access

Are you coming to campus? There are several ways to gain access to the internet while you are here.

1. Visitors to campus may have access to wireless internet service from a personal computer at participating visitor wireless locations. Visitors must purchase a wireless prepaid coupon at the computer store at the HUB on campus or through the website: <http://computerstore.psu.edu/>. More information about connecting to the internet can be obtained here: <http://wireless.psu.edu/visitorwireless.html>

2. If you are visiting the EE department specifically, our IT support staff can create a radiator account through the College. There is no cost for this service and is good for 90 days. Here is the link: <http://www.ecs.psu.edu/ComputerSupport/policies/PDFs/GuestWireless.PDF>. You must see an EE IT support staff for processing.

3. There is a limited supply of AT&T wireless cards for "hassle free" access for 1-day visitors (IT staff will have two; department head administrative support assistant will have two; manager of financial and administrative services will have 1). These are purchased by EE IT support staff and they do have an expiration date.

Electrical Engineering Golf Shirts

I have a few electrical engineering golf shirts available for sale. Mens size large and extra-large. They are navy blue with white lettering. \$30/each. Shipping one shirt is \$5.35. Email for details: CLS118@psu.edu

Depending on demand, we may reorder in January.

Thank You Alumni for Your Generous Support

Your gift to the Penn State Department of Electrical Engineering ensures that we can continue to focus on our mission of serving society through excellence in education, research, scholarship, and public outreach. You can contribute to the department in the following ways:

Make a gift online

Go to Giving to Penn State to make a gift online through Penn State's secure giving portal. To ensure that your gift goes directly to the department, select the checkbox at the bottom of the page to view a list of giving opportunities. Locate the "College of Engineering Future Fund" in the list and select the small triangle to the left of it. This allows you to view the various engineering departments and scholarship funds that you may select.

Mail your gift

Make your check payable to "Penn State" and mail it to the Director of Development, Penn State College of Engineering, 101 Hammond Building, University Park, PA 16802. Write "Department of Electrical Engineering" in the memo line of your check.

Make a deferred gift or establish a named endowment

An endowment is a gift that is held in perpetuity and provides dependable support for a specific need. Penn State invests the initial gift and spends only a portion of the average annual investment return. The remainder is added to the principal as protection against inflation. Endowments can be set up to support a wide range of purposes depending on the donor's area of interest—from scholarships to professorships, from degree programs to research laboratories, and more. For more information on deferred gifts or endowments, please contact [Mark Sharer](mailto:msharer@engr.psu.edu), Director of Development, at msharer@engr.psu.edu or 814-865-0173.

2012 Tailgate Pictures



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Penn State is committed to the affirmative action, equal opportunity, and the diversity of its workforce.

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