SPIE Purdue University Student Chapter Annual Report

November 2017 – October 2018
Chapter Advisor:
Prof. Alexandra Boltasseva (aeb@purdue.edu) Department of Electrical and Computer Engineering

Current Officers:
President: Soham Saha saha11@purdue.edu SPIE ID: 3715699
Vice president: Oksana Makarova omakarov@purdue.edu SPIE ID: 3722395
Treasurer: Deesha Shah shah263@purdue.edu SPIE ID: 3631716
Secretary: Sarah Chowdhury chowdh10@purdue.edu SPIE ID: 4081086

Current Student Chapter Members (18):

Member Roster
Total Student Members: 15  [Hide Roster]

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<td>Navin Lingrajah</td>
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<td>Ziping Liu</td>
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<td>Alexandra Moore</td>
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<td>Ogaaga Odele</td>
<td>7 May 2019</td>
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<td>Soham Saha</td>
<td>5 October 2019</td>
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<td>Deesha Shah</td>
<td>10 October 2019</td>
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<td>Paul Somers</td>
<td>7 December 2018</td>
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<td>Maowen Song</td>
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<td>James R. Uliczka</td>
<td>9 January 2019</td>
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<td>Todd Van Mechelen</td>
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<td>Di Wang</td>
<td>17 November 2019</td>
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<tr>
<td>Xuejing Wang</td>
<td>20 August 2019</td>
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Alumni Roster
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<tr>
<td>Justus Ndubufo</td>
<td>Vanderbilt Univ.</td>
<td>August 2017</td>
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<tr>
<td>Mikhail Shalaginov</td>
<td>Massachusetts Institute of Technology</td>
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Figure 1. SPIE Student Chapter Members at Purdue University
Chapter Activities

Conference: IONS MIDWEST 2018

This year, most of our activities and efforts were centered on the IONS Midwest Conference, which was co-hosted by Purdue University and Dayton University. The OSA and SPIE chapters at Purdue University are sister-organizations, and as a result, our chapter was heavily involved in the organization of the conference. The conference featured invited speakers, consisting of eminent lecturers in the field of Optics and Photonics. For professional development, we invited Arnold Chen, the Managing Director of Burton Morgan Entrepreneurship Center who led a workshop on “Entrepreneurship as a Research Path”. The event was interactive and stimulated research conversations between students from different disciplines, and the best speaker received a cash reward. We also had a poster exhibition after the seminar talks, and then concluded with a dinner banquet.

We received $4000 from OSA for this special event, and the SPIE Purdue Student Chapter received a FOCUS grant of $2200.00.

The conference grant provided by SPIE made it one of the Gold Level Sponsors, which entitled the society to be featured in all the advertising avenues. SPIE also hosted a Career Development Panel, where students had a chance to interact with a panel comprising of University Professors, Entrepreneurship Leaders, and Business Executives from the Industry.
Invited Speakers:

IONS featured 6 plenary and 5 invited speakers that spoke on topics spanning the broader conference themes:


Nicholas Peters, Senior Research Scientist in the Quantum Information Science Group, gave the first plenary talk entitled, Quantum Information Science with Photons”. The second plenary speaker was Thomas Murphy who gave a remote talk on “THz Nonlinear Optics in Graphene”. On August 3rd, the third plenary speaker was Gaurav Bahl who is an Assistant Professor at University of Illinois Urbana-Champaign. The title of his talk was, “Non-reciprocal photonics with optomechanical resonator systems.

On the first technical day in Dayton, former SPIE President, Paul McManamon spoke on “Lidar Technology and Systems”. Paul discussed many applications in the exploding technology referring mostly to autonomous vehicles, but also harped on the importance of networking and a personal account of using science in the court of law. Augustine Urbas (AFRL) discussed his work on, “Nonlinear Metasurfaces for optical applications”. Finally, Daniel Mittleman, Professor at Brown University, gave a talk entitled, “Laser Terahertz Emission Nanoscopy”.

Figure 2 Invited Speakers
Seminars:

The conference was divided into four major themes which are described below:

Micro/nanophotonics and Metamaterials (Session held at Purdue University, IN)
The last few years have witnessed tremendous progress in the fabrication of micron-scale and nanoscale optical devices. The demand for low-profile devices in applications like LiDAR, beam steering, and spectroscopy has resulted in a surge of interest in integrated optical devices and nanostructured artificial media. Some exemplary accomplishments include low loss and high efficiency plasmonic modulators, ultra-high Q optical microresonators, and novel waveguiding structures, among others. In terms of nanostructured optical materials, there has been a great deal of scholarship coming out on topics like hyperbolic metamaterials and dielectric metasurfaces. These developments have fed into applications like precision ranging, nanophotonic sensing, and thermal light management, among others. Under the umbrella of this theme, we hope to include these and other advances in the field of integrated optics and nanostructured media.

Quantum Information Science, Metrology, and Imaging (Session held at Purdue University, IN)
From the early days of the telescope to the recent detection of gravitational waves, measurement – whether it takes the form of imaging, ranging, or spectroscopy – has been at the heart of research in optics. This includes work on the classical side like superresolution imaging and chip scale dual-comb spectroscopy, as well as various other forms of metrology. Advances in the quantum realm include quantum-limited measurements of mechanical motion and information processing based on the characterization and manipulation of individual photons. This short list of developments is certainly not representative, let alone exhaustive, of all the work that falls under this theme. We hope to include all manner of advances in quantum optical science and precision metrology.

Lasers and Novel Phenomena in Non-linear Optics (Session held at University of Dayton, OH)
Lasers play a revolutionary role in opening new possibilities for scientific, medical, industrial, communications and security applications. Modern lasers bridge material science, physics, chemistry and biology, and engineering, through applications in areas such as additive manufacturing and nanofabrication, medical imaging and non-invasive surgery. Nonlinear optics has seen renewed interest with the advent of new fields such as nonlinear microscopy, optical frequency combs, all-optical and neuromorphic computing, quantum optics, high-harmonic and extreme UV generation, among others. Submissions are encouraged covering but not limited to topics such as novel laser sources, ultrafast laser technologies, laser applications for bio-medical uses, classical and quantum computing, spectroscopy, holography, UV to THz generation, and optical frequency combs.
Lasers and optical fibers opened the door to the field of optical communications, which has led to the development of the Internet, as we know it today. Additionally, the study of free-space propagation of laser light has been instrumental in development of new optical sensing platforms. This theme encompasses a broad range of areas including long-range optical communications through fibers and free space transport. Submissions are encouraged from remote sensing, environmental effects on light propagation, adaptive optics, spatial light modulators, and Lidar technologies. Additional topics include: photodetectors and advanced components for coherent transmitters and receivers, photonic and optoelectronic integration, multiplexing, fiber optical sensors, orbital angular momentum states and their propagation, mid-IR, and other fundamental and applied technologies that help push the field of optical communications and sensing forward.

Figure 3. Seminars by invited speakers and students
Poster Sessions:

Both Purdue University and University of Dayton hosted separate poster sessions on the four themes. The best poster presenters were awarded cash prizes.

*Figure 4. Poster sessions held at Purdue University*
Professional Development:

There were four separate events intended exclusively for professional development at the IONS conference, two at each conference site. Other events served as secondary professional enrichment and brief descriptions are included here. The events at Purdue University were a seminar by Arnold Chen on Entrepreneurship and a Career Panel featuring an open discussion between attendees and various speakers, researchers and professionals in optics. Arnold Chen is the Managing Director at the Burton Morgan Entrepreneurship Center at Purdue University. His seminar was mostly a semi-biographical description of all the possible career avenues and possibilities of an emerging professional in optics. Dr. Chen started his career in academic research before being given the opportunity to work for a large research and development company. He was afforded the opportunity to work in a smaller company with a professional acquaintance for several years before accepting his current position as Managing Director. Dr. Chen demonstrated the key differences between working for different companies and areas of optics research and development. He described the avenues for starting a small technical company, and showcased much of the work the Entrepreneurship center with students in building their own ventures. Following Dr. Chen’s seminar, there was an informal career panel including professionals from industry, established academia, and a new assistant professor just starting his academic career. A variety of questions were posed by the attendees such as: “what difficulties arise in starting an academic career?” , “How do you comfortably move from being a post-doc to a completely independent researcher?” , “How do you handle United States residency after graduation?”, “what are the biggest differences between working for large and small companies?”, “ What do you look for in a strong student or post-doc?”, “Do private industry employers shy away from post-docs and why?”. Each of these questions had different answers from different members of the panel, particularly questions about post-docs going to work for industry where panelists were in start disagreement. The information they were able to share with the attendees was highly invaluable, and gave insight into which career paths are best for particular students, what otherwise unknown challenges may lay in wait for new graduates, and what possibilities exist for the entrepreneurs amongst scientists. Starting your own company is certainly a great challenge, but as both Arnold Chen, and the career panel was able to convey, it is not impossible and can be highly rewarding.
Figure 5. SPIE Sponsored Career Panel
Tours:
The participants of the conferences were given comprehensive tours of the research facilities at Discovery Park, featuring the Bindley Bioscience Center and the Birck Nanotechnology Center. At UDawton, the attendees were taken to visit the AFRL.
Apart from the conference, our chapter carried on our regular annual activities, which comprised the following:

**Social Activities:**
Movie night at Birck Nanotechnology Center. We showed the Disney movie Coco. The event was co-hosted with OSA Purdue Student Chapter and Nanotechnology Student Advisory Council (NSAC) at Purdue. March 30, 2018.
Seminars:

Purdue University is one of the leading universities in the world in the field of optics and photonics. Our SPIE Purdue University Student Chapter, together with its partner organization, the OSA student chapter, organized a number of seminars and luncheons with visiting professors that were invited by both students and Purdue professors. During the luncheons, student members were given the opportunity to talk to the visiting professor not just about academic topics, but also about graduate school applications, life beyond graduate school, and the academic career path. These seminars provided a platform for the students and the professors where experiences were shared, ideas were exchanged, and collaborations were developed. This also gave the participants of our newly formed "Undergraduate Research in Optics" program an opportunity to network with professors from potential graduate schools.

Following is a list of the seminars we hosted in the 2017-2018 school year:

**Speaker:** Carmen Menoni, Professor at Colorado State University  
**Title:** Taming amorphous oxides with ion beams to optimize optical interference coatings for demanding applications  
**Date:** November 10, 2018
**Speaker:** Vladimir Aksyuk, Project Leader at NIST Center for Nanoscale Science and Technology

**Title:** Integrated Photonic and Plasmonic Signal Transduction for Micro and Nanomechanical Sensing

**Date:** January 29, 2018

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**Speaker:** Olivier Martin, Professor at the Swiss Federal Institute of Technology, Lausanne (EPFL)

**Title:** Plasmonics: From materials to metasurfaces in the linear and nonlinear regimes

**Date:** March 22, 2018
**Speaker:** Alexander Solnstev, Professor at the University of Technology Sydney

**Title:** Quantum Optics on a Nonlinear Chip

**Date:** April 20, 2018

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**Speaker:** Panos Patsalas, Professor at the University of Technology Sydney

**Title:** The implication of using conductive nitrides as alternative plasmonic materials: going beyond TiN and ZrN

**Date:** April 30, 2018
Speaker: Augustine Urbas, Air Force Research Laboratory

Title: Plasmonics and nonlinear metasurfaces for optical applications

Date: May 7, 2018
Speaker: Julia Medvedeva, Professor at Missouri University of Science and Technology  

Title: Transparent Conducting Oxides: Modeling, Understanding, Designing  

Date: May 11, 2018

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Speaker: Konstantin Vodopyanov, Professor at CREOL UCF  

Title: Massively parallel sensing of molecules with mid-infrared frequency combs  

Date: June 21, 2018
Speaker: Kristjan Leosson, General Manager at Innovation Center Iceland

Title: Metasurface Polarimetry

Date: July 6th, 2018

Metasurface Polarimetry
Dr. Kristján Leosson
Friday, July 6th
11:30am – 12:30pm
BRK 1001

Optical metasurfaces consisting of arrays of metal nan antennas have been used to construct fiber-coupled full Stokes polarimeters operating at telecom wavelengths. The compactness of the metasurfaces allows polarimeters to be integrated directly on fiber facets. By measuring four or more scattered signals from the metasurface, the polarization state of the incident light can be determined. In order to circumvent the inherent wavelength dependence of the device response, polarimeters were calibrated using deep neural networks, enabling accurate polarization measurements to be performed across the telecom c-band without a priori knowledge of the incident wavelength.

Speaker: Igor Bondarev, Professor at North Carolina Central University

Title: Spatial Dispersion and Optical Magnetism of quasi-2D Plasmonic Nanostructures

Date: August 31, 2018

Spatial Dispersion and Optical Magnetism of quasi-2D Plasmonic Nanostructures
Dr. Igor Bondarev
Friday, August 31st
11:00am – 12:00pm
BRK 1001

Contemporary techniques of material fabrication allow one to produce exceedingly perfect and uniform films of controlled thickness down to a few nanometers [1, 2]. Such films are the major components used to create optical metasurfaces for advanced applications in modern optoelectronics and quantum optics, including the optical information processing, memories, imaging, sensing, and probing the light-matter interactions at the nanoscale [3]. As opposed to bulk metals whose electron plasma spectrum and associated optical response are controlled by the material band structure, the plasma properties and optical response of metallic films can also be controlled by adjusting their thickness, chemical composition, and by using properly chosen substrate and superstrate materials [4]. This unique tunability makes optical metal (or plasmonic) films an attractive platform for the design of advanced multifunctional metasurfaces, nanocapsules with enhanced light control, and novel metamaterials for enhanced experiments and controls (as well as as an effective tool) to develop a physical understanding of the properties of quasi-2D plasmonic nanostructures of finite thickness and lateral sizes, that have revolutionized the intriguing regimes of optical spin control, detection, and new ultrafast applications. More specifically, when metal films are ultra thin, the plasma frequency of the plasmonic films is shown to express the spatial dispersion topic of metallic materials, gradually shifting to the red with the film thickness reduction [5]. The excess mass experiments done on ultrathin Ti Foils of nanometric variable thicknesses [6, 7] reveal the plasma dispersion and the associated optical response-measurement originating from the confinement-induced plasma frequency spatial dispersion can now be the new features of the dynamical magnetic response of the films [8]. In this report, we explore the magnetic permeability exhibits the changeable structure dependence shifting to the red as the film aspect ratio increases. When based appropriately, the characteristic times of the basic bias size and thickness can be negligible while the in the frequency range results. These features are connected with the general causality principle of spatially dispersion media [9]. They can be controlled by adjusting the film composition parameters, material quality and the aspect ratio of the film, as well as by tuning the exposure substrate and coating layers appropriately.

Dr. Igor C. Bondarev is a Research Professor and Physicist at the Department of Optics at the University of Iowa. His research interests include the development of new optical materials and devices for applications in quantum computing, optical sensing, and energy conversion. He has published over 150 scientific papers and is the author of several patents in the field of plasmonics. He has received numerous awards and recognitions for his contributions to the field, including the Presidential Early Career Award for Scientists and Engineers (PECASE) in 2015, the National Science Foundation CAREER Award in 2016, and the Iowa State University Research Excellence Award in 2017.
Officer Travel Grant 2018

Shaimaa Azzam participated in the SPIE Optics+Photonics conference in San Diego where she presented two talks about her work and attended many events and talks in the conference. She attended the Student Leadership Workshop the Saturday before the conference which was very useful and a lot of fun. She also presented an overview of our chapter’s activities in the e Student Chapter Exhibit Mixer where officers of different SPIE chapters get to meet and learn about the different activities each chapter host in their schools.

Figure 8. SPIE Optics + Photonics 2018

Callout:

We held a callout on September 24, 2018. We presented our chapter activities to the attendees, and invited Prof. Mahdi Hosseini from ECE department to give an inspirational talk titled “Collective Optomechanical Interactions”.
OSA & SPIE organize events related to optics and photonics research.
Join and get to know your colleagues at casual and formal events:
- Learn new research avenues at cross-departmental conferences
- Hear from invited talks in optics and related fields
- Share a passion for science with elementary grade students.
And more! Hear about it at the callout, dinner provided!

September 24th: 5:00 PM
Room: EE005
Speaker: Mahdi Hosseini
Collective Optomechanical Interactions
Outreach:

Nanodays, April 2018, the SPIE and OSA Purdue Student Chapters had a booth to demonstrate optical phenomena to K-12 students, using the outreach kits provided by SPIE and OSA.

Figure 10. Nanodays demonstrations
Planned Future Activities

Lectures and Seminars
Purdue University is home to some of the world’s leading experts in the fields of nanoelectronics and optics. This makes the SPIE student chapter here part of a diverse network of scientist and academicians, whom we often host through our professors. In the upcoming year, we plan to invite several scientists and industrial professionals working on the cutting-edge field of Optics and Photonics to present the latest research and products. According to our plan, at least 3 technical lectures/seminars are to be organized during the year of 2019. The main expense will be food and beverages for the audience.

Undergraduate Research in Optics Program:
So far, a majority of the students in the SPIE student chapter has comprised of graduate students only. We utilized this large resource of graduate researchers in optical science to start the Undergraduate Research in Optics Program, giving interested undergraduate students an opportunity to get involved in a research project. The SPIE and OSA officers took the initiative to find professors looking for undergraduate research assistants and initiated a callout where graduate students presented the research topics and interested undergraduate students signed up for the respective projects. As a part of this program, we give tours of Birck Nanotechnology center to enlighten the students about the exciting research facilities available in Purdue University, we let them interact with professors in our Seminars, and will be hosting a poster session with prizes in December. We plan on continuing this initiative in the upcoming years.

Social Events
Such activities are planned to bring together members of our SPIE chapter in a social environment, such as playing bowling, board games, ice-skating, laser tag, picnic, etc. The events are expected to promote more interaction among the SPIE student members.

Outreach
NanoDays is a traditional nano-science showcase that takes place annually. It caters to a diverse audience of K-12 students, teachers and parents, who are invited to visit three major research centers in Purdue University’s Discovery Park. As part of the tradition, we plan to have Optics & Photonics booth in Birck Nanotechnology Center on NanoDays and show intriguing optical demonstrations. Together with the OSA Purdue University Student Chapter, we will give simple optical demonstrations with the toolkits provided to us by SPIE and OSA to get the audience interested in optical science. We also plan to have a callout event in fall semester of 2019, to arouse interest in optics/photonics research among Purdue students and potentially recruit new members. We have also kept the Undergraduate Research in Optics Program to non-members, many of home have joined SPIE at various stages of the program.

The Women in Optics Program
We want to start a new program targeting underrepresented minorities in STEM, to guide and mentor interested students towards a career in Optics, be it academia, research, or industry. We have begun to communicate with the Women in Engineering Program. We will invite members of the organization and host regular tours of the research facilities at the Birck Nanotechnology Center, and host introductory workshops in optics. We will also initiate a mentorship program where a pair up a graduate student member of SPIE (the mentor) will be paired up with an undergraduate student member enlisted in the program (the mentee). The mentor and the mentee will meet every two weeks over lunch or dinner, and discuss any topic of interest. The idea is to help guide the student towards a successful career path, sharing experiences, and helping them cope with the stress of undergraduate life. To motivate the students towards a track in research, we will give regular tours of the Birck Nanotechnology Center and other labs affiliated with the Discovery Park Ambassadors Program, exposing them to the latest tools in experimental research. We plan to partially subsidize the dinners with our leftover funds.

Outreach Activity

We are also planning to give themed presentations to K-12 schools with the optical kits provided to us by SPIE, OSA, and the Society of Applied Spectroscopy. The various demonstrations will be fit under a central theme (e.g. Alice in Quantumland, Star Wars), and be presented to students in a fun and interactive manner. We will write a separate grant for funding this.

Conference

The IONS Midwest Conference held this year has turned out to be a great success in prompting interdisciplinary research activities. We want to continue our tradition of hosting an optics centered conference here. The main goal of promoting collaboration and cross-field learning will be unchanged. Due to the extensive expenses expected for organizing such a conference, additional funding will be applied for separately, both from SPIE and from other resources.

Financial Information

Beginning balance: $536.46

Income

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**Ending balance: $2442.29, as of 11/30/2018**

All events were co-hosted with the Purdue OSA student chapter. Hence, some events were financially covered by the OSA chapter, while others were fully covered by our SPIE chapter.