

# The University of New Mexico SPIE Student Chapter Annual Report

December 2013



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## **Introduction**

The University of New Mexico's SPIE student chapter is proud to report its 2013 achievements, as well as its plans for 2014. Our chapter's headquarters are in the Center for High Technology Materials (CHTM) in UNM's Science and Technology Park. CHTM is a wonderful home for our chapter as its interdisciplinary research projects in optics, optoelectronics, materials engineering, physics, chemical engineering, electrical engineering, and other disciplines attract a variety of students from all over the world.

The mission of our chapter has been to advance light based technologies and help support its associated community through participation and organization of activities such as seminars, outreach projects, and social events. We are passionate in our pursuit of nurturing interest in science in young minds. Our aim is to nurture intellectual, communal and professional growth in each of our members, through seminars and networking opportunities. SPIE provides our members a network on a global scale.

## **Chapter Officers**

*January 2013 - Dec 2013*

**President:** Brianna Klein- [bklein01@unm.edu](mailto:bklein01@unm.edu)

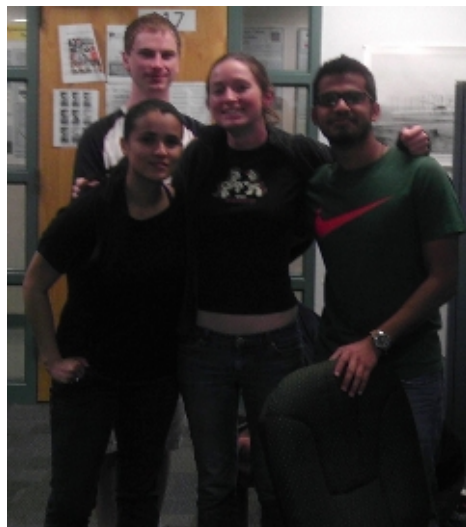
**Vice President:** Sadvikas Addamane - [addamane.sadvikas@gmail.com](mailto:addamane.sadvikas@gmail.com)

**Secretary:** Lilian Acosta - [lkacosta@unm.edu](mailto:lkacosta@unm.edu)

**Treasurer:** Theodore Schuler-Sandy - [tedschuler@gmail.com](mailto:tedschuler@gmail.com)

**Facebook Guy:** John Montoya - [lostinsocorro@gmail.com](mailto:lostinsocorro@gmail.com)

**Chapter Advisor:** Dr. Sanjay Krishna – [skrishna@chtm.unm.edu](mailto:skrishna@chtm.unm.edu)



2013 Chapter Officers

## **Student Chapter Members**

	<b>Name</b>	<b>Expiration Date</b>
1	Lilian Acosta	Mar 10, 2014
2	Sadhvikas Addamane	Nov 14, 2014
3	Mahmoud Behzadirad	Nov 13, 2014
4	Fei-Hung Chu	Jun 30, 2014
5	Erin Dughie	Nov 10, 2014
6	Tristan Garwood	Feb 28, 2014
7	Md. Mottaleb Hossain	Dec 18, 2013
8	Alireza Kazemi	Nov 13, 2014
9	Brianna Klein	Jul 24, 2014
10	Stephen Myers	Feb 8, 2014
11	Mohsen Nami	Oct 22, 2014
12	Orlando Romero	Sep 26, 2014
13	Theodore Schuler-Sandy	Jul 28, 2014
14	Brandyn Way	Feb 6, 2014
15	Seyedeh Marziyeh Zamiri	Aug 10, 2014

## **Alumni Members**

	<b>Name</b>
1	Alexander Albrecht
2	Jonathan Andrews
3	Paul Schanwald
4	Rajeev Sheno
5	Andreas Schmitt-Sody
6	Victor Gamiz
7	Alex Raub
8	Felix Morgan
9	Brian Newnam
10	Christopher Wilcox

## **Seminars**

This year, we had five main seminars that were organized directly by the SPIE student chapter, highlighted below. In addition, there were another 13 seminars co-hosted by our chapter (not included in this list).

### **Gary Wicks**

*"Advances in Semiconductor Infrared Detectors: Toward Defect Tolerant Devices"*

Monday, August 19th, 2013

Semiconductors have been applied to infrared detection for over 150 years. Throughout that history, the advance of semiconductor IR detectors has occurred via side-by-side developments in semiconductor materials and device architectures. The first semiconductor IR detectors were simple photoconductors constructed of naturally occurring crystals. Major advances, taken over 50 years ago, were the development of man-made semiconductor crystals, which enabled the development of photovoltaic detectors based on pn junctions. A more advance in IR detection employs unipolar barrier detector designs that are made possible by development of special types of heterojunction materials that have zero offsets in either the valence or conduction band. These new unipolar barrier materials and detectors have several advantages over their pn-based predecessors. An early unipolar barrier detector, the nBn detector, was developed to avoid generation of dark current via processes in the depletion layer of pn junctions, and it has proven to be very successful in this purpose. Interestingly, in several aspects the nBn detector's experimental progress preceded theoretical understanding. Fortuitously, unipolar barrier detectors have turned out to have additional, initially unanticipated, advantages over pn junction detectors, including reduced sensitivity to material defects and suppression of surface leakage currents. In hindsight, the physics of these characteristics of unipolar barrier detectors are becoming better understood, and point the way for further applications.

### **Rohit Prasankumar**

*"Using Ultrafast Optical Spectroscopy to Unravel Fundamental Properties of One-and-Two-Dimensional Nanostructures"*

Monday, July 15th, 2013

Low-dimensional nanostructures have attracted much interest in recent years due to their vast potential for applications in areas ranging from medicine to solar energy. Ultra-fast optical spectroscopy has attained prominence due to its ability to resolve dynamics in conventional metals and semiconductors at the fundamental time scales of electron and lattice motion. The presentation will discuss the recent measurements of carrier dynamics in one-and two-dimensional semiconductor nanostructures, which enabled his group to not only gain insight into their dynamical properties, but also to shed light on their intrinsic material properties. His group has an ongoing focus on ultra-fast carrier dynamics in quasi-1D semiconductor nanowires, where most recently they have performed spatiotemporally resolved ultra-fast optical microscopy to map carrier diffusion in single Si nanowires. In 2D graphene, they used ultra-fast infrared-pump, visible probe spectroscopy to demonstrate the relativistic nature of photoexcited quasi particles. These experiments provide fundamental insight into carrier relaxation in these novel systems, revealing information critical to optimizing their performance for applications in photovoltaics, mode-locked lasing, thermoelectrics, and solid-state lighting.

### **Saima Husaini (AFRL RYDP, Wright Patterson Air Force Base Dayton, OH)**

*"Graphene Based Saturable Absorbers"*

Monday, June 17th, 2013

In recent years graphene has attracted much attention due to its potential applications in electronics and photonics. Graphene exhibits a number of optoelectronic properties resulting from its unique bandstructure which has led to single layer graphene possessing a zero bandgap and exhibiting linear dispersion of Dirac electrons. Although much work has been devoted to investigate electronic properties of graphene, only recently has focus shifted on realizing the scope of graphene for optoelectronic devices. Particular attention has been given to studying the nonlinear optical properties of graphene as applicable to the development of devices such as saturable absorbers and optical limiters.

In this talk, I will discuss how graphene can be functionalized and its optical properties tuned to suit device platform.

Nonlinear transmission measurements carried out over a wide range of wavelengths indicate that the saturable absorption and optical limiting properties of graphene-based materials can be altered via fabrication procedures, concentration, host matrix and temporal regime. Work done to exploit such nonlinear behavior in various graphene-based samples will be discussed. Furthermore, preliminary fabrication and characterization work conducted to integrate the graphene-based materials in a device will be presented.

**Tony Krier** (Lancaster University)

*"Dilute Nitrides and Antimonide Nanostructures for Enhanced Photonic Device Application"*

Monday, February 11th, 2013

The mid-infrared spectral range is of enormous interest as the practical realization of semiconductor lasers, LEDs and photodetectors operating in the 2-5  $\mu\text{m}$  wavelength region offers potential applications in a wide variety of areas including; optical gas sensing, environmental pollution monitoring, chemical process control, non-invasive medical diagnosis, tunable IR spectroscopy and infrared countermeasures. However, the advantages of this wavelength range have not been fully exploited due to the lack of suitable high emittance sources and sensitive photodetectors which are capable of operating at room temperature. The principal challenges relate to the reduction of competing non-radiative processes associated with Shockley-Read-Hall (SRH) recombination in LEDs and Auger recombination at higher injection levels in diode lasers. Optical extraction, current spreading, free carrier and inter-valence-band absorption present additional problems. This talk will give an overview of novel dilute nitride semiconductor alloys and antimonide nanostructures, being developed in our laboratory at Lancaster, with a view towards overcoming some of these problems.

**Erik Bochov** (Air Force Research Laboratory, Albuquerque, NM)

*"A Geometrical Connection between Passive Beam Combining of Lasers and Biological Neural Nets"*

Friday, January 25th, 2013

Combining of fiber lasers into a phased array or by coherent beam superposition are approaches being attempted to scale beam brightness. The speaker was initially motivated to reconcile two seemingly contradictory ways of understanding passive coherent beam combining of lasers. One group uses conventional resonator mode analysis (e.g. following Fox & Li), while another gained insight based on notions of phase locking oscillators. The speaker will show how the two approaches are related using a geometrical construction represented by the "Hebbian Learning Matrix", which functions as a kind of "Ockham razor", and is named after Donald O. Hebb, a prominent Canadian physiologist (and former English and philosophy major) who explained behavior in terms of a theory of neural activity. After giving examples of applications to laser engineering, the speaker will present an algorithm to construct differential equations describing the dynamics of coupled lasers and suggests (a little preposterously) that the same approach could be tried to model the dynamics of neural assemblies. The resulting laser and neural models share intriguing properties such as multi-level self-organization, but in order to simulate a content addressable memory (CAM) a modified self-structuring learning matrix is introduced for the latter. The use of matrices and their relation to symmetry suggests a possible path to wider application, e.g. to ideas of morphogenesis through symmetry breaking (Mach, Turing).

## **Outreach Activities**

For our outreach projects, we have been working closely with CHTM's newly-made Outreach Work Group. We have had a number of outreach collaborations, with such people as Heather Armstrong, program specialist of nano-science and micro systems program, Stefi Weisburd, Outreach Manager of UNM Engineering Outreach Programs, and Doris Williams, Optical Science and Engineering Program Adviser.

### **Emerson Elementary Career Fair**

November 14<sup>th</sup>, 2013

Demonstrated optics, electronics, and electromagnetics to elementary school students to get them interested in science- and technology-based careers. This school is in one of the poorer parts of Albuquerque, where children don't have as many opportunities. By introducing these students to science careers, we hope to inspire them to achieve in school and go to college to study science.

### **Taft Middle School Presentation**

October 17<sup>th</sup>, 2013

Lilian Acosta gave a presentation on infrared imagers and then led a hands-on project with LEDs and batteries to teach kids about the efficiency of LEDs. Md Mottaleb Hossain also gave a talk and led a demo.

### **CHTM ECE101 Lab Tours**

February 20<sup>th</sup>, 2013

September 25<sup>th</sup>, 2013

October 9<sup>th</sup>, 2013

Gave tours of CHTM to the introductory-level Electrical and Computer Engineering class. This tour is designed to make freshmen university students interested in the optoelectronics research that happens at UNM.

### **Science and Technology Day at New Mexico State Fair**

September 13<sup>th</sup>, 2013

Demonstrated optics and optoelectronic related displays to children at the fair. Demonstrations included polarization, energy of different wavelengths of light, solar tracker demo (solar cell moves to optimize collected energy), and light bucket fiber optic demo. Gave away bracelets made with color-changing UV sensitive beads to teach kids about the electromagnetic spectrum.

### **Albuquerque Institute of Math & Science summer engineering camp**

July 22<sup>nd</sup>, 2013

Outreach at Smart Lighting week for middle school students

### **CHTM Tour to Middle School Students**

July 12<sup>th</sup>, 2013

Took middle school students on an interactive tour of CHTM. This included a liquid nitrogen demonstration in the molecular beam epitaxy lab, nano kits, and a nanobiology lab. One lucky student from each tour group got to dress up in a full cleanroom suit.

**Natural History Museum Nano Outreach Night**

June 14<sup>th</sup>, 2013

Teach an adult audience about nano science with demonstration kits. The theme is "Luau, Luau! When Albuquerque was a seacoast!"

**Whittier Elementary**

Tuesday, April 30<sup>th</sup>, 2013

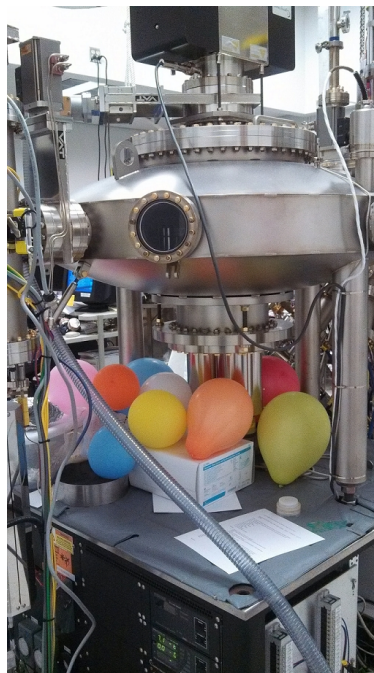
Md Mottaleb Hossain gave demos to elementary students on the basics of LEDs, free space communication via optical fiber link, and remote sensing

**Engineering Week at the National Museum of Nuclear Science & History**

February 13<sup>th</sup>, 2013

Md Mottaleb Hossain gave talks and demos to K-12 students about STEM career experiences and studies.





2013 Outreach Photos

## **UNM SPIE Student Chapter Individual Activities**

### **CHTM Outreach Workgroup Student/SPIE Representative – Lilian Acosta**

Volunteered to be the student representative for CHTM's Outreach Workgroup. This group's purpose is to organize and perform outreach activities for promoting optoelectronics, nanoscience, and engineering.

### **SPIE Student Travel Grant - Md. Mottaleb Hossain**

SPIE Optics + Photonics Conference, San Diego, CA, August 25-29, 2013

Presented his paper titled "*Theoretical characteristics of 1.55  $\mu\text{m}$  InN based quantum dot laser*"

### **Optical Science and Engineering Orientation – Brianna Klein**

August 21<sup>st</sup>, 2013

Gave a presentation to incoming graduate students in Optical Science and Engineering on the benefits of joining SPIE.

### **UNM SPIE Student Chapter Website – Brianna Klein**

We have a new website. This was built and maintained by Brianna throughout the year.

<https://sites.google.com/site/unmspiestudentchapter/>

## **Social Activities**

Our chapter organized and hosted the two social activities outlined below.

### **Annual SPIE/OSA Barbeque**

August 23rd, 2013

Meet other students in different departments at the annual barbeque

### **Table Tennis Tournament**

Friday, June 21st

Have fun at this semi-annual table tennis tournament in the front lobby of CHTM. This is an excellent opportunity to make new friends in a relaxed atmosphere.

## **Financial Summary**

<b>Description</b>	<b>Date</b>	<b>Expenses</b>	<b>Deposit</b>	<b>Balance</b>
Initial Balance	November 2012			\$166.26
2012 Activity Grant	November 2012		\$900.00	\$1,066.26
Seminars	2013	-\$298.88		\$767.38
Meetings	2013	-\$127.53		\$639.85
Outreach	September 2013	\$54.28 (donated)		\$639.85
BBQ with OSA	August 2013	-\$169.04		\$470.81
Table tennis tournaments	June 2013	-\$25.08		\$445.73
2013 Activity Grant	November 2013		\$900.00	\$1,345.73

Our chapter spent a total of \$620.53 in 2013. Seminars accounted for almost half of our spending (48%), chapter meetings was 21%, the annual SPIE/OSA barbeque was 27%, and the table tennis tournament was 4%. Supplies valued at about \$50 for the Science and Technology Day at the New Mexico State Fair were donated for this event.

## **Plans for 2014**

### **I. Outreach**

Below are a few of the outreach projects we are interested in for the beginning of the year.

#### **Expand your Horizons for girls in grades 5-8.**

January 25<sup>th</sup>, 2014

Volunteers needed to be presenters who give a short talk and then do a hands-on activity.

#### **VEX Robotics competition for K-12 students**

February 1<sup>st</sup>, 2014

Volunteers needed to help run the competition on that Saturday and/or help planning the event.

#### **Discover STEM week at the Nuclear Museum.**

Electrical Engineering is Wednesday February 5<sup>th</sup> and all engineering is Saturday February 8.

Give science demonstrations to ~200 middle school students.

### **II. Send Representative to Photonics West Student Chapter Meeting**

We are planning on sending Lilian Acosta as our student chapter representative to Photonics West. There, she will attend the student chapter meeting as well as present a talk on her investigations of absorption in InAs/GaSb Strained-Layer Superlattice.

### **III. Seminars**

We do not, as yet, have any speakers lined up for 2014, but we do anticipate organizing and hosting several seminars. One of our members, Anabil Chaudhuri, has suggested that we organize a short-course lecture series to learn from an expert. He has volunteered to head this project.

### **IV. Make SPIE Bulletin Board**

To encourage recruitment and make our activities known at UNM, we are planning on making a bulletin board at CHTM. This will be constructed in December 2013.

### **V. UNM SPIE Student Chapter Tee Shirts**

We have had several requests for UNM Student Chapter Tee-Shirts. This would be a fun team-building project as well as a fund-raising activity.

### **VI. Outreach Demonstration Improvement Projects**

Several of our outreach demonstrations need to be improved and repaired. We plan on doing this over winter break.

### **VII. 2014 Officer Elections**

At our last meeting, officer elections for 2014 were announced. We are planning on having a meeting for these elections before the end of the year. There are several very active members of our chapter that are excellent officer candidates. The current chapter president has agreed to support the training of a new president.

## **Thank you, SPIE!**

Without SPIE's funding and support, our many achievements of 2013 would not have been possible. We owe a special thanks to the devotion of Dirk, Tasha, Alison, and Ben who make student chapters possible. The SPIE community provides many unique opportunities to enrich our members' careers and lives. The travel scholarships, seminars, and conferences enable students to network with experts in their field, while funding support for outreach projects encourage the local community to learn about more about optics and science. We are proud to be a part of SPIE. As students studying optoelectronics- and optics-based fields, we realize the significance of SPIE's mission to advance light-based technology. Thank you, SPIE!

*-2013 SPIE Officers*