Message from Dean Breneman

Colleagues and Friends,

The semester ended on a high note with a celebration of our graduates at the 209th Commencement. Festivities began on Friday, May 29 with the School of Science Commencement brunch held at the Hilton Garden Inn for our graduates, their families, and the faculty and staff of the School. Several undergraduates, graduate students, faculty and staff were recognized for their contributions and achievements in their work (more details in the Commencement 2015 section.) I was especially proud of the fact that the 2015 J. Erik Jonsson prize for highest overall academic achievement was won by Ryan McAvoy, a School of Science student!

Later in the afternoon, all were invited to attend the President’s Annual Commencement Colloquy titled “Resilient Leadership for a Resilient World” which featured renowned voices in national affairs. The ensuing discussion was fascinating, particularly when Admiral Michelle Howard described how she used multidisciplinary teams to devise and implement the strategy that saved the real “Captain Phillips” from Somali pirates.

The big event of Commencement itself took place on warm and windy Saturday morning at the East Campus Athletic Village (ECAV) stadium where over 500 students graduated with a degree from the School of Science. It was a truly inspiring experience to see so many talented young individuals culminate one aspect of their lives and head out to achieve even bigger and better things. We are so proud of our graduates and look forward to seeing what you will do to change the world!

Curt Breneman, Dean of Science
Commencement 2015: Josue San Emeterio – Making the Most of Opportunity

Josue San Emeterio chose Rensselaer Polytechnic Institute (RPI) after his first campus visit. “I was able to see that it was a school with great resources and an intelligent and engaged student community,” said Emeterio, a native of Mexico City. “It was exactly the type of environment in which I knew I could succeed.”

On May 30, San Emeterio graduated with a bachelor’s degree in applied physics from the School of Science, and a resume that includes a research internship in Ames National Laboratory, and his experiences with the outreach group Science Ambassadors, the Society of Physics Students, and the Rensselaer Debate Club.

“The community was small enough that you were able to know professors on a one-to-one basis, and yet large enough that there was always something else to learn and more people to meet,” San Emeterio said. “Particularly for me, I benefited a lot from all the resources on campus. I was able to take many classes outside my major that enabled me to learn most of the things I wanted to learn. Similarly, though my professors, I had access to many tools to build and use science demonstrations.”

San Emeterio, who will be pursuing a doctoral degree in applied and engineering physics at Cornell University, took advantage of many of the opportunities Rensselaer offered. In his freshman year, he elected to forego an introductory physics class, enrolling directly in a more advance quantum physics class.

“I was the first generation of freshmen to do that, and it was one of the hardest but most rewarding classes I’ve taken,” San Emeterio said. “I simply enjoyed the material, so I worked really hard.”

Read more

National Center for Women & Information Technology Supports Rensselaer Chapter of Association for Computing Machinery’s Women in Computing

Ten students from the newly founded Rensselaer Polytechnic Institute (RPI) chapter of the Association for Computing Machinery’s Women in Computing (ACM-W) will attend a regional conference on women
in computing with the help of a seed grant funded by Symantec and the National Center for Women & Information Technology.

According to its website, the National Center for Women & Information Technology (NCWIT) is a nonprofit community of more than 600 universities, companies, nonprofits, and government organizations nationwide working to increase women’s participation in computing and technology. NCWIT equips change leaders with resources for taking action in recruiting, retaining, and advancing women from K–12 and higher education through industry and entrepreneurial careers.

The NCWIT Academic Alliance partnered with Symantec to offer the NCWIT Student Seed Fund, a $1,000 award given to student-run programs and initiatives that promote increased participation of women in computing and IT programs. The grant will allow the Rensseleaer chapter of ACM-W to send 10 students to the New York Celebration of Women in Computing (NYCWiC) 2016 conference.

Rensseleaer was one of only 10 schools to have received the competitive grant for the spring 2015 round. Cameron Mine, a first-year student and vice-chair of the Rensseleaer chapter of ACM-W, said the conference will be an opportunity for Rensseleaer women in computing to build a network within their field, learn about the latest developments, and interact with women who have been successful in their industry.

“NYC-WiC brings together women who have overcome a variety of tribulations to make it to the level of success they are at,” Mine said. “By interacting with these women, ACM-W members will have a chance to meet role models for their future, and to gain the tools they need to succeed in their own careers.”

The seed grant is one of a slew of successes of the chapter since its establishment at the start of the spring 2015 semester, according to Mine and chapter chair Sarabeth Jaffe, a junior. In accordance with its mission to celebrate, inform, and support women in computing, the chapter organized events including a roundtable discussion and dinner with the current ACM-W chair, Valerie Barr, a Toastmasters event with the New York Independent System Operator, attendance at the one-day GHC/1 event, modeled after the national Grace Hopper Celebration of Women in Computing, and a “Dinner & Life After Graduate School” event with Rensseleaer School of Science professors Fran Berman and Stacy Patterson.
Why did the dinosaur cross the equator…and then keep going?

New research from an international team, including researchers at Rensselaer Polytechnic Institute (RPI), has uncovered the mystery of why large Triassic dinosaurs took more than 30 million years to populate the tropics.

For years, paleontologists have had different theories about why they could find no evidence of large, long-necked, herbivore dinosaurs (sauropodomorphs) living at low latitudes, until at least 30 million years after they first appeared on Earth, and 10 to 15 million years after they became abundant at higher latitudes (both north and south of the equator).

Published today in Proceedings of the National Academy of Sciences, the paper "Extreme ecosystem instability suppressed tropical dinosaur dominance for 30 million years" suggests a highly unpredictable hot and dry climate, linked with high atmospheric carbon dioxide (CO2) concentrations, prevented larger herbivore dinosaurs from inhabiting the area.

“This really is the first time we’ve been able to connect so many environmental dots from a single key region and time in the evolutionary history of early large dinosaurs,” said Morgan Schaller, an assistant professor in the Department of Earth and Environmental Sciences within the School of Science at Rensselaer. “These indicators paint a picture of relatively inhospitable conditions for herbivores at these low latitude locations – there’s no reason for them to remain during hot, very dry, periods when their food sources are unstable.”

Read more
Commencement 2015

Joshua McLane – Finding Work/Life Balance in Science

“A confluence of factors” drew doctoral candidate Joshua McLane to seek his degree in biological sciences at Rensselaer Polytechnic Institute. Among that confluence was a personal connection, hometown appeal, and “the name Rensselaer Polytechnic Institute.”

A Capital Region native, McLane earned an undergraduate degree from the University at Buffalo, State University of New York, and a master’s degree from Union College. His adviser at Union had a professional connection with Rensselaer professor Lee Ligon, who ultimately became McLane’s doctoral adviser.

“Although Rensselaer is not a large school, it is very well known and respected,” McLane said. “Where you decide to attend is something that will follow you for your entire life; having an established and respected name follow you is worth it.”

At Rensselaer, McLane researched how physical aspects of tissues, like structural arrangement or stiffness, influence the behavior of cancer and cancer-associated cells.

“So little is known about how cells respond to different physical cues in the ever-changing environment of a tumor,” said McLane. “At the same time, physical interactions can be manipulated without transporting something, like a drug, into a cell. If we find a major role of a certain physical aspect, in say the metastasis of cancer cells, we can manipulate the cell from the outside to control its behavior.”

McLane worked hard to arrive at Rensselaer, and he worked hard at Rensselaer – early in his doctoral work he once spent three months working without taking a day off — but along the way, McLane said he realized he had to learn to balance work and life.

“While at RPI, I finally had to realize that there’s more to life than work; that one can’t just put their head down, work hard, and everything else will be OK,” he said. “Further, not simply that you have to pop your head up once in a while, but that you have to live all the time, even at work, with your head up.”

Read more
Commencement Awards in Science

UNDERGRADUATE STUDENT AWARDS

G. Howard Carragan Award (1961)
An annual award based on the income from funds contributed by friends and former students of Professor Carragan, the prize is awarded to a senior in the Department of Physics, Applied Physics, and Astronomy for outstanding scholarship.

Jacob Leedom
Ryan McAvoy

Glenn Martin Mueller ‘64 Prize (2000)
An annual prize established to honor Glenn Martin Mueller, Rensselaer Trustee and Graduate, Class 1964. A leading venture capitalist in Silicon Valley, Glenn was a champion entrepreneur, funding many successful start-up companies. This prize is given to a computer science major who is deemed to be the most entrepreneurial.

Markus William Gaasedelen

Henry J. Nolte Memorial Prize (1978)
To a baccalaureate or master’s degree candidate in Electrical, Computer and Systems Engineering who has done an outstanding engineering research or design project.

Zacharie Cole Dugas, Computer Science/Computer & Systems Engineering

J. Erik Jonsson Prize (1960)
To a senior who has spent at least three years at Rensselaer and has achieved the highest academic record in the class. This prize, established by J. Erik Jonsson, Class of 1922, consists of a cash award and special medal, which will be presented during the Commencement exercises.

Ryan Louis McAvoy, Physics, Applied Physics and Astronomy

J. Lawrence and Gertrude Katz (2001)
The J. Lawrence and Gertrude Katz award in Physics was established in 2001. This award is presented to the student selected as the outstanding graduating senior receiving a Bachelor of Science in Physics.

Josue San Emeterio

John and Mary Cloke Prize (1964)
Awarded to a graduating senior in the Department of Chemistry and Chemical Biology who is continuing in a graduate school of chemistry, medicine, or biological science, and who has made a distinguished record, especially in the department.

Jonathan Fine
Joseph L. Rosenholtz Prize (1963)
An annual award based on the income from funds contributed by friends and former students of Professor Rosenholtz, the prize is awarded to a senior in the Department of Earth and Environmental Sciences for outstanding work in earth sciences. Joseph Rosenholtz was Professor of Geology from 1924 into the 1960s and this award is given in his honor.

Jon Van Deusen
Vincent Riggi

Max Hirsch Prize (1972)
Established by Professor Edith H. Luchins in memory of her father, is awarded to a senior in the Department of Mathematical Sciences who has demonstrated outstanding ability in academic work and gives promise of outstanding success in a career in mathematical sciences.

Christopher Browne
Anthony Trubiano

Nadia Trinkala Service Award (2012)
Established by Diane and Michael Trinkala in memory of their daughter, is given to a Physics or Applied Physics student who has made significant contributions to the community and quality of life at Rensselaer and in City of Troy.

Eric Deutsch

Paul A. McGloin Prize (1989)
An annual prize established in honor of Professor Paul McGloin, scholar and teacher in the computer science and mathematical sciences departments from 1955 to 1989. The prize is given to an outstanding senior in computer science.

Daniel Patrick Bulger

Rensselaer Class of 1902 Research Prize (1927)
The Class of 1902 Research Prize, established by the Class of 1902. It is awarded at Commencement to the senior in the School of Science or Engineering who has completed two semesters of undergraduate research and who presents the best research results culminating in a written report, submitted paper, or thesis.

Monica Patel, Biological Sciences

Robert G. LaFleur Award (2011)
An award established by the friends of Professor Robert G. LaFleur for students in the Department of Earth and Environmental Sciences demonstrating an excellent record in, commitment to, and promise in the field of environmental geosciences.

Alexandra Evans
Roland Walker Prize (1989)
Established by friends and former students of Roland Walker, Professor Emeritus of Biology. The prize is awarded to a senior in the Department of Biology for outstanding scholarship.

*Monica Patel, Biological Sciences*
*Nathan James, Biological Sciences*
*Lauren Olinski, Biological Sciences*
*Ashley Mathew, Biological Sciences*

Severino Center Award in Entrepreneurship (2000)
An annual prize given to an outstanding undergraduate computer science student with a concentration in technological entrepreneurship.

*Kevin Lyman*

Stanley I. Landgraf Prize ’46 (1998)
An annual prize established to honor Stanley Landgraf, Rensselaer trustee, Acting President, and friend of the Computer Science Department. The prize is given to a computer science major who excels in leadership skills and academic achievement.

*Joshua Kevin Goldberg*

W. A. Tarr Award
The Society of Sigma Gamma Epsilon, National Earth Sciences Honor Society, presents the W. A. Tarr Award annually to each society chapter. Scholarship, leadership, and contribution to the school provide the primary basis for the award. RPI’s Delta Theta Chapter 2011 recipient in the Department of Earth and Environmental Sciences is

*William Skorski*

William Pitt Mason Prize (1939)
This prize goes to the senior in the Chemistry and Chemical Biology Department who has demonstrated outstanding academic work and gives promise of outstanding success in his or her professional chemistry career. Research is a major criterion for this award.

*Jessica Krause*

Science Ambassadors
The Science Ambassadors (SAs), in collaboration with the Engineering Ambassadors, is a group comprised of select undergraduate students who work as teams to develop engaging and interactive engineering-related presentations geared toward K-12 students. As our new SAs prepare to inspire the next generation of scientists by sharing their own enthusiasm for the field we want to say thank you to our two seniors that helped make our first year a successful one.

*Josue San Emeterio, Physics*
4.0 AWARDS

*Ashley Mathew (BIAM)*
*Daniel Bulger (Computer Science)*
*Benjamin Ciummo (Computer Science)*
*Jacob Leedom (Physics, Applied Physics, and Astronomy)*
*Ryan McAvoy (Physics, Applied Physics, and Astronomy)*

GRADUATE STUDENT AWARDS

**Bill and Nancy Siegmann Applied Mathematical Modeling Prize (2014)**
An award established by John G. Watson ’71 in honor of his Ph.D. advisor, Professor Bill Siegmann, and his wife Nancy. This prize is awarded to an undergraduate and/or graduate student whose work best exemplifies elegance in any or all of the three pillars of Applied Mathematics, namely, problem formulation, problem solution, and solution interpretation.

*Pamela Fuller Pyzza*
*Lei Yao*

**Henry Ehrlich Prize in Microbiology and Environmental Sciences (2012)**
The Henry Ehrlich Prize in Microbiology and Environmental Sciences is awarded for excellence in scholarship to either a graduating senior or graduate student (MS, PhD) in the Department of Biology who plans to pursue a career in microbiology and/or environmental sciences.

*Bianca Pier*

**Hillard B. Huntington Award (1976)**
Friends and former students of the late Hillard B. Huntington, professor emeritus of Physics, established the prize. It is awarded at Commencement to an outstanding graduate student in the Department of Physics, Applied Physics, and Astronomy.

*Anqing Liu*

**Jack Hollingsworth Prize (1999)**
An annual prize given to honor Jack Hollingsworth, Professor of Mathematics. This prize is awarded to a computer science student who made a major contribution to the educational program at Rensselaer.

*Simon Richard Ellis*

**Joaquin B. Diaz Prize (1978)**
Established by friends, family and colleagues in memory of Dr. Joaquin B. Diaz, the Albert Einstein Professor of Science at Rensselaer in the Department of Mathematical Sciences. This award is presented to a graduate student in the Department of Mathematical Sciences who shows ability and enthusiasm for research in mathematics.

*He Yang*
Dr. Johanna Maas Chemistry Teaching Assistant Award (2000)
This award is presented to one or more graduate students for outstanding service in the teaching program of the Chemistry and Chemical Biology Department. Established by Sonja Krause, Class of 1954, and others in memory of Dr. Johanna Zelie Maas, chemist, physician, Holocaust survivor, and humanitarian.

James Buchwald
Anthony Maiorana
Jennifer Wilcox

Karen & Lester Gerhardt Prize in Science (1982)
This prize was established to honor a full-time engineering or science doctoral candidate, who by the originality and insight of his her work emphasizes the tradition of excellence that is Rensselaer.

Joshua McLane, Department of Biological Sciences

Paul S. Ho (2010)
Established in 2010, by Dr. Paul S. Ho, is awarded to an outstanding graduate student enrolled in the Department of Physics

Ryan Krafnick

Ralph Ernest Huston Prize (1973)
Established by Antoinette K. Huston and sons, Peter, Kenneth, Richard and T. Michael, in memory of Dr. Ralph Huston, Professor of Mathematics from 1934–1969. This prize is to be awarded to the first or second year graduate student in the Department of Mathematical Sciences who has demonstrated unusual promise and ability as a teacher.

Joanna Sutton

Robert McNaughton Prize (1989)
An annual prize established in honor of Professor Robert McNaughton, scholar and teacher in the computer science and mathematical sciences departments from 1967 to 1989. The prize is given to an outstanding graduate student in computer science.

Lily Ann Briggs

Walter H. Bauer Doctoral Prize in Chemistry (1981)
This prize goes to a doctoral candidate who has an exceptional graduate record in the Department of Chemistry and Chemical Biology, has carried out meritorious doctoral thesis research, and shows outstanding promise in the field of chemistry.

Michael Topka
Walter Eppenstein '52 Graduate Teaching Assistant Award (1991)
Established by friends and colleagues of Walter Eppenstein, Professor Emeritus of Physics, to honor his many contributions to education at Rensselaer. It is awarded to one or two graduate students for outstanding contribution to our teaching program in the Department of Physics, Applied Physics, and Astronomy.

Georges Jaar
Anthony Post

FACULTY RECOGNITION – INSTITUTE AWARDS

Sibel Adali, associate professor in the Department of Computer Science, has been awarded the 2015 Trustees’ Outstanding Teacher Award. This award recognizes outstanding accomplishments in classroom instruction.

Jim Hendler, director of the Rensselaer Institute for Data Exploration and Applications (IDEA) and Tetherless World Constellation Professor of Computer Science, Web, and Cognitive Sciences, has been awarded the William H. Wiley 1866 Distinguished Faculty Award which honors those who have won the respect of their students and their colleagues through demonstrated excellence in teaching, research and scholarship – and through service to Rensselaer as evidenced by their contributions to local, regional and national professional organizations and community involvement.

FACULTY and STAFF RECOGNITION – SCIENCE AWARDS

Outstanding Early Research Award
The Early Research Award recognizes a faculty or staff member for accomplishments in research during the past three-years. The winner demonstrates excellence in research innovation and accomplishments; has produced research results viewed as significant by others in the field; and excels in at least one of the following: interdisciplinary collaboration, involving students in research, or involving members of underrepresented groups in research.

Vincent Meunier

Outstanding Teaching Award
The Outstanding Teaching Award recognizes a faculty or staff member for excellence in classroom instruction and other educational activities during the past three-year period. The winner demonstrates excellence in classroom instruction; is regarded highly by students for teaching accomplishments; and excels in at least one of the following: student mentoring, integrating research into the teaching program, course and curricular innovation, and service in introductory or required courses with large enrollments.

Wayne Roberge
Outstanding Staff Award

The Outstanding Staff Award recognizes a staff member for dedication, accomplishments, and contributions to the School of Science. The winner demonstrates excellent performance well beyond what the position requires; makes contributions that allow the department or unit to function effectively and efficiently; and exhibits special qualities such as: innovation, initiative, confidence, enthusiasm, the ability to meet challenges, and a cooperative attitude.

Alexander Ma

Science Degrees Awarded at Commencement – Troy Campus

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## DUAL BACHELOR’S DEGREES AWARDED AT COMMENCEMENT
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* Not official degree statistics
Rensselaer Appoints Rongjie Lai Assistant Professor of Mathematical Sciences

Rongjie Lai, an expert in three-dimensional object recognition, has been appointed assistant professor in the Department of Mathematical Sciences within the School of Science at Rensselaer Polytechnic Institute. Lai joins Rensselaer from the University of California, Irvine.

Researching in the field of numerical partial differential equations and computational differential geometry, Lai uses mathematical techniques to develop global tools for extracting information from discrete data points representing nonlinear objects.

“The tools that Dr. Lai is developing will enable us to recognize and compare three-dimensional objects ranging from organs of the body to structures in the universe,” said Curt Breneman, dean of the School of Science at Rensselaer. “This is a generation of analysis that we are just beginning to realize, and it will revolutionize our ability to gain insights from high-dimensional datasets. We welcome Rongjie to Rensselaer.”

As Lai explains, data points in two-dimensional objects like photographs share a common domain – in this case the x/y coordinates of information within the image – making it relatively easy to reach common ground for comparisons between those two objects. However, among high-dimensional objects (in one example, Lai uses convoluted 3-D outlines of the human hippocampus) there is no straightforward way to know how a data point on one object corresponds to a data point on another high-dimensional object. Or in Lai’s terminology, there is no “canonical domain” for datasets of high-dimensional objects.

“Visually we can tell they are the same shape, but absent a canonical domain, a computer cannot distinguish between them,” said Lai. “Fortunately, mathematics offers a path.”

Read more

Science Faculty Promotions and Retirements

Sibel Adali has been promoted to Full Professor in the Department of Computer Science.

Mark Goldberg, associate department head and professor of computer science, and George Edick, laboratory supervisor in biological sciences, will retire effective June 30, 2015. Mark Wentland,
professor of chemistry and chemical biology, has announced he will retire at the end of the year. We are greatly appreciative of their service to the School of Science and Rensselaer community.

**Spring 2015 SuperTeachers**

Each semester faculty and staff in the School of Science are recognized for their dedication to teaching. These “SuperTeachers” have achieved teaching evaluation scores higher than 4.75 out of 5 with class size of at least eight students (graduate) or ten students (undergraduate) with a response rate of at least 50 percent. This semester a new category recognizing large format classes (>100 students) was added. Faculty in this category earned scores greater than 4 out of 5 with at least a 40 percent response rate. Congratulations to the Spring 2015 SuperTeachers!

**Spring 2015 “Classical SuperTeachers”**

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Spring 2015 “Large Format SuperTeachers”

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Faculty News Briefs

Sibel Adali, professor in the Department of Computer Science, gave an invited talk at an invite-only seminar conference, organized by the Social Epistemology group at the Philosophy Department in Northwestern University on the "Nature of Trust". As one of the seven invited talks that made up this conference, Adali’s talk titled "Trust in Socio-Technological Networks: Why Context Matters" concentrated on the how the different situational considerations determine to which degree a person will rely on the competence or the trustworthiness of the sources and the credibility of information in trust decisions. The talk and the conference were attended by an interdisciplinary group of researchers from fields that included philosophy, psychology, sociology, history and computer science. The conference was the third in a series of four funded by a grant from the Mellon Foundation on topics within Social Epistemology. See more at: http://www.philosophy.northwestern.edu/community/sawyer-seminar/events.html.

K. V. Lakshmi, associate professor in the Department of Chemistry and Chemical Biology and scientific lead at the Baruch ’60 Center for Biochemical Solar Energy Research, presented an invited lecture at the Second International Conference on Proton-Coupled Electron Transfer (PCET) that was held in
Skokloster Wärdshus, Sweden. Lakshmi’s presentation was titled "Elucidating the Principles that Control Proton-coupled Electron Transfer Reactions in Solar Water Oxidation." The lecture was focused on recent breakthroughs in the Lakshmi laboratory on the structure of key photochemical intermediates of the solar water oxidation reaction. PCET is an important fundamental reaction that has sparked the interest of the chemical, biological, and physical scientific communities for its ubiquity in natural and artificial photosynthetic systems for the production of solar fuels. The Second International Conference on PCET brought together leading researchers in the areas of enzymatic, catalytic, surface, and computational frontiers for discussions on contemporary issues in the field of coupled charge transfer. The conference was chaired by Professor Leif Hammarström at Uppsala University, Sweden.

**K. V. Lakshmi** presented an invited lecture titled, “Characterization of Defects in Semiconductors by Electron Paramagnetic Resonance and Two-dimensional Hyperfine Sublevel Correlation Spectroscopy” at the Gordon Conference on Defects in Semiconductors that was held in Waltham, MA.

**K. V. Lakshmi** presented research titled, “The Tuning and Activation of Substrate Water Molecules in Photosystem II: 2D \(^1\)H HYSCORE Spectroscopy of the S\(_2\) State of the Oxygen-Evolving Complex of Sr\(^{2+}\)-Substituted Photosystem II” at the Gordon Conference on Photosynthesis that was held in Mount Snow, Vermont.

**K. V. Lakshmi** chaired a Scientific Session at the 32\(^{nd}\) Eastern Regional Photosynthesis Conference at the Marine Biological Laboratory in Woods Hole, MA.
In the News: Better Understanding Phosphorene

Researchers in the US have furthered our understanding of a promising new semiconductor called black phosphorus by studying low-frequency interlayer “breathing” Raman modes in this material for the first time. These modes can be used to determine how crystals are oriented in the 2D layered structure and calculate its thickness.

2D materials have dramatically different electronic and mechanical properties from their 3D counterparts and so may find use in a host of novel device applications. Until now, however, most research in this field has focused on the most famous of all 2D materials, graphene, but the fact that this material lacks a direct electronic bandgap between its valence and conduction bands means that scientists are now starting to look at other 2D candidates too. A bandgap is essential for electronics applications because it allows a material to switch the flow of electrons on and off.

Among the promising newcomers are the transition metal dichalcogenides (TMDCs), which have the chemical formula MX$_2$ (where M is a transition metal, such as Mo or W, and X is a chalcogen, such as S, Se and Te. These materials go from being indirect bandgap semiconductors in the bulk to direct bandgap semiconductors when scaled down to monolayers. The monolayers also efficiently absorb and emit light and so could be ideal for making a variety of optoelectronics devices such as light-emitting diodes and solar cells.

Small, direct bandgap and fast photoresponse

There is a problem, however, in that TMDCs respond to light relatively slowly. They also have a large bandgap of between roughly 1.5 to 2 eV and so are only suitable for device applications that work in the visible part of the electromagnetic spectrum. A material with a direct and small bandgap, as well as a fast photoresponse, could thus bridge the gap between graphene (a zero-gap semiconductor) and TMDCs with their large bandgaps.

Few-layer black phosphorus, which can be obtained by mechanically cleaving black phosphorus crystals (in the same way that graphene layers are mechanically exfoliated from bulk graphite), could fit the bill here.

Although researchers have known about bulk black phosphorus (one of the allotropes of the element phosphorus) since 1914, it is only very recently that they have tried to isolate single layers of the material. Just as in graphene, phosphorene atoms are arranged in a hexagonal lattice but with its direct and small bandgap (of 0.3 eV for the bulk material and 0.2 eV for a monolayer), phosphorene can quickly switch between insulating and conducting states. The material is still thin enough to confine electrons
though so that charge flows quickly through the structure, something that leads to high charge mobilities – needed for making ultrafast photodetectors and other electronics devices.

When exposed to visible and near-infrared light, FETs made from phosphorene show a photoresponse that reaches 4.8 mA/W. This is faster than both MoS$_2$ and WS$_2$-based photodetectors. Importantly (and unlike MoS$_2$ and WS$_2$), the material is also “ambipolar”, which allows it to conduct with both electrons and holes. This property means that it can be used to construct p-n junctions (the building blocks of modern electronics and photovoltaics). Finally, phosphorene’s hole mobility can reach nearly 300 cm$^2$/Vs, which is about three to five times that of MoS$_2$. To compare, silicon’s hole mobility is just 100 cm$^2$/Vs.

**Raman spectrometry**

With all these good properties to its name, researchers would like to better understand this promising material. To do this, they need to be able to measure its thickness and determine how the crystals in the 2D structure are oriented. A team of researchers led by Mildred Dresselhaus of the Massachusetts Institute of Technology (MIT) and Vincent Meunier of Rensselaer Polytechnic Institute (RPI) has now found that the so-called interlayer “breathing” Raman modes in black phosphorus are very sensitive to the coupling between its layers. This is important for when it comes to identifying both its thickness and the orientation of crystals in the layers.

Raman spectrometry can be used to observe the vibrations and rotation of molecules in materials. These low-frequency modes of vibration provide a “fingerprint” whereby molecules can be identified. The technique works by inelastic, or Raman, scattering of monochromatic light – usually from a laser working in the visible, near infrared or near ultraviolet wavelengths. The laser light interacts with molecular vibrations or vibrations of the crystal lattice (phonons), which shifts the energy of the laser photons up or down. The size of this shift provides information about the vibrational modes in the sample.
Student News and Notes

Rensselaer Polytechnic Institute Hosts 12th Annual GameFest Weekend

Katherine Mezic received the 2015-2016 Chateaubriand Fellowship in Science, Technology, Engineering, and Mathematics. The Chateaubriand Fellowship supports Ph.D. students registered in an American university who wish to conduct part of their doctoral research in a French laboratory. This fellowship is offered by the Office for Science & Technology (OST) of the Embassy of France in Washington in partnership with American universities and French research organizations such as Inserm and Inria. It is a partner of the National Science Foundation’s GROW program. Mezic will travel to Strasbourg, France for the spring and fall 2016 semesters and work with Dr. Petra Hellwig in the Department of Chemistry at the University of Strasbourg. She will be doing Fourier-transform infrared (FTIR) and attenuated total reflectance spectroscopic studies on an enzyme as part of her Ph.D. thesis.

Mezic graduated from Rensselaer as a Chemistry major doing significant research with professor of Biological Sciences Blanca Barquera. She began as a graduate student in biochemistry and biophysics in Fall 2015.

Students Attend Conference on Natural and Artificial Photosynthesis

Students at the Baruch ’60 Center for Biochemical Solar Energy Research in the School of Science at Rensselaer participated in the 32nd Eastern Regional Photosynthesis Conference at the Marine Biological Laboratory (Woods Hole, MA). The conference was focused on understanding of the molecular mechanisms of natural and artificial photosynthesis for the development of cutting-edge chemical and biological approaches for renewable energy. Stuart Smith, a graduate student in Professor K. V. Lakshmi’s laboratory, presented an invited lecture titled, “Two-dimensional 1H and 14N HYSCORE Spectroscopy and DFT Analysis of the A0 Cofactor of Photosystem I.” Greg Theophall, also a graduate student in the same lab, presented a poster on his research on electrochemical, optical and quantum mechanical studies of the electronic structure of porphyrins in solar energy conversion. Professor Yiyang Sun presented research on pure quantum-mechanical studies of proton-coupled electron transfer reactions in energy transduction that is a collaboration between the Baruch ’60 Center, the Kodosky constellation and the Center for Computational Innovations to develop state-of-the-art methods for pure quantum mechanical treatment of large-scale systems.
Chemistry Undergraduate Receives Research Award

Suttipong (Jay) Suttapitugsakul, student in Chemistry and Chemical Biology, has been selected as one of four winners of the Eastern Analytical Symposium Student Research Awards. He has received this award based on the description of his research ability as described by Linda McGown, professor in the department of Chemistry and Chemical Biology, and was selected from many highly qualified nominees.

The Baruch ’60 Center Hosts High School Students in New York State

The Baruch ’60 Center for Biochemical Solar Energy Research in the School of Science at Rensselaer hosted high school students from Amsterdam and Bronx (New York). The students explored the basics of solar energy conversion through the light-driven reactions of natural photosynthesis and the design of artificial solar energy devices at the Baruch ’60 Center.

Student News and Notes

Stuart Smith, a graduate student in Professor K. V. Lakshmi’s laboratory in the Baruch ’60 Center for Biochemical Solar Energy Research in the School of Science, presented a poster titled, “High-resolution Electronic Structure of the Primary Electron Acceptor A0 of Photosystem I” at the 59th Annual Biophysical Society Conference that was held in Baltimore, Maryland.

Alexander Bruening, an undergraduate student in Professor K. V. Lakshmi’s laboratory in the Department of Chemistry and Chemical Biology and the Baruch ’60 Center for Biochemical Solar Energy Research in the School of Science, presented a poster titled, “The Structure and Function of Supramolecular Self-assembling Binary Guanosine Gels” at the 59th Annual Biophysical Society Conference that was held in Baltimore, Maryland. This research was conducted in collaboration with Professor Linda B. McGown in the Department of Chemistry and Chemical Biology.
Alumni News and Notes

School of Science Alumni Elected to Hall of Fame

MRI Prototype Developer

John Schenck ’61 (physics), PhD ’65 (Solid State Physics with Professor Roger W. Shaw) was recently elected to the Rensselaer Alumni Hall of Fame. Schenck was a key member of the research team at GE that developed the first clinically viable high-field MRI scanner in the early 1980s. An emergency room physician as well as a research scientist, he became the first researcher at GE to work full time with magnetic resonance imaging. He served as a principal leader on the team that proposed using a magnet rated at 1.5 tesla, more than five times as high as had previously been used for whole-body human imaging. In 1982 his team produced the first MRI prototype and Schenck, himself, became the subject of the first magnetic resonance scan of the brain. The initial test was a success, and the 1.5 tesla magnet subsequently became the industry standard for MRI. Today MRI is a vital tool used for medical diagnosis in hospitals around the world. Schenck is an authority on MRI safety whose published works have served as a guide to the industry in how it is regulated and managed. He will be officially inducted into the Hall of Fame in October 2015.
Upcoming School of Science Events

School of Science Graduate Student Happy Hour
Wednesday, June 24 • 4:30-6:30 p.m. • CBIS Terrace

The School of Science Graduate Student Council will be holding a summer Happy Hour for all School of Science graduate students. Drinks and snacks will be available on the CBIS Terrace from 4:30 to 6:30 while supplies last. Make this a summer to remember!

Catch more School of Science updates on social media!