

2021 Materials science And engineering

Prof. Edwin Fohtung



Pawel Keblinski

Professor and Department Head, Department of Materials Science and Engineering (MSE)

WELCOME

Greetings to our MSE alumni and friends,

Our last academic year continued to be dominated by the ongoing COVID-19 epidemic. While we transitioned from online course instruction to almost exclusive in-person learning, we still had occasional on-line episodes when the next wave of the epidemic was intensifying. Furthermore, throughout the academic year we faced limitations in in-person extracurricular activities, undergraduate research, and research related travel.

I am happy to report that despite all the challenges, the Materials Science and Engineering department, including faculty, staff and students continues to perform at the highest professional level.



mse.rpi.edu

WELCOME [CONT.]

With sadness, I want report on passing of two of our former faculty, Dr. Shyam Murarka and D. Sanford Sternstein. They both had distinguished careers at RPI in the field of electronic materials, and polymer science, respectively. On a personal note I will miss the tremendously sarcastic humor of Dr. Sternstein, and his immortal battles of words with Dr. Wright about superiority of metal over polymers We highlight some of their achievements in this issue.

On a joyful side, I am happy to share with you that our glass and computational mechanics of materials expert, Prof. Yunfeng Shi was promoted to full professor level, and our electronic structure theory and modeling expert, Prof. Ravishankar Sundararaman was promoted to the level of associate professor with tenure. Also Professor Edmund Palermo, a bio-polymer expert, was promoted to associate professor with tenure.

In this installment of the MSE News, you will find highlights of our recent achievements and new developments within MSE community at RPI. One of the highlights are several recognitions of our faculty, most prominently Prof. Ravishankar Sundararaman concurrent with his promotion received \$2.6 million from the Department of Energy to lead an effort towards development of advanced computational tools to model full complexity of electrochemical systems. Another highlight is on Prof. Edwin Fohtung led effort based on coherent X-ray imaging that enabled to reveal defects and map local strain in nanostructured vanadium oxide.

In this issue of the MSE News, you will also find other compelling stories, including one on our continuum excellence and prominence in glass science and a portrait of our Department Administrative Coordinator, Tess Lecuyer, ensures that staff shortages, both in our department and across the institute, have minimal negative impact on our students and faculty.

As always you will find numerous highlights on the achievements of our undergraduate and graduate students and a larger feature on Fin Donachie illustrating the possibilities offered to our undergraduates with respect of research, community involvement and development of leadership skills.

Please enjoy the stories we report to you and please share any thoughst, ideas and your own successes with us.

Thank you,

Pawel Keblinski Professor and Department Head Materials Science and Engineering Department Rensselaer Polytechnic Institute

GRADUATING 2021

Congratulations and best of luck!

Our 215th Commencement Welcomed Materials BA/BS Graduates: Ryan Albrecht, Shawn E. Andrews, Luke Barba, Alex Brodsky, Ben Ertel, Ryan Hawks, Bradley Hovan, Fanyue Kong, Ky Lamarca, Zoe Li, Dan Louks Baer, Zachary Lueders, Alajandro Matos, Miranda Mudlark, Collin Nagle, Vincent Paglia, Sumati Rangaraj, Sarah Sickels, Anqiun Sun, Xiaolin Tang, Gia Trzaska, Peter Wang, Samantha Wiegand, Ziyi Wu, and Xiaofei Zeng.



On the Cover: This is a SEM image of a polymerized drug material scaffold after 5 weeks of biodegradation. These materials are being used as part of a collaboration between Palermo lab and Gilbert lab in BME.



ADVANCED DEGREES AWARDED IN 2021

Congratulations and best of luck!

Congratulations to our newly minted Ph.D.s and Masters in Materials Science & Engineering!

Our Fall 2021 Ph.D.s: Dr. Peijiao Fang, Dr. Scott Peters, Dr. Prachi Pragnbya, and Dr Abhishek Shandilya!

Earning a Master's in Engineering: Dante Boyd, Bradley Hovan, Allison Martin, and Alexander Yepikhin!

We are so proud of our newest Materials Science & Engineering Masters and Ph.D graduates! Someday you'll look back and think, Wow, I graduated at the strangest time ever... Until then, we'll be here for you, cheering you on, looking forward to wherever life takes you next, and feeling so proud of you. Hard work, talent, drive and vision will always outlast tough times. That's how we know you're going to make the world what you want it to be.



Tess Lecuyer

Tess Lecuyer, our Administrative Coordinator, is from the Capital District, and joined RPI in the Fall of 2019. In addition to coordinating the department processes and course scheduling, she assists and supports the Department Head and supervises the administrative staff. She also admins the Department Facebook page, helps create the department Newsletter, coordinates and facilitates faculty promotion, tenure, evaluations and recruitment. She was previously employed for over a decade at Borders Books & Music. Tess enjoys hiking and snowshoeing in the Adirondacks, is an avid photographer, and is a published poet who has often performed at area Poetry Open Mics.



Prof. Ravishankar Sundararaman, Prof. Yunfeng Shi, and Prof. Edmund Palermo Granted Promotions

We are happy to inform you that RPI Board of Trustees granted promotions to three of our faculty, Prof. Edmund Palermo, Prof. Ravishankar Sundararaman and Prof. Yunfeng Shi.

Congratulations to **Prof Edmund Palermo** on his promotion to Associate Professor with Tenure in the Department of Materials Science and Engineering. We appreciate his contributions to the School of Engineering as a teacher, scholar and mentor!

Ed is from Bay Shore, NY. He began his adventures in polymer science as a high school student under Prof. Miriam Rafailovich at SUNY Stony Brook. After completing a bachelor's degree in Mechanical Engineering at Cornell in 2006, he moved to The University of Michigan and earned a Ph.D. in Macromolecular Science & Engineering, under the mentorship of Kenichi Kuroda, in 2011. Ed was also an NSF/JSPS visiting scholar at Nagoya University under Prof. Masami Kamigaito in 2010. Following a postdoc with Anne McNeil in Chemistry at Michigan, Ed joined the faculty at RPI in 2014. His focus areas are Polymer Synthesis, Materials-Biology Interface, and Antibacterial Materials.

Prof. Sundararaman, known as Shankar, was promoted to the level of Associate Professor with Tenure and Prof. Prof Yunfeng Shi to the level of Full Professor.

Dr Sundararaman's research group develops computational

techniques to predict nanoscale phenomena from electronic structure calculations, with applications in energy conversion & storage, electronics and photonics, and leads the open-source JDFTx software project. Prior to RPI, he did a postdoc at Caltech and did graduate work at Cornell.

Dr. Shi received his Ph.D. degree in Materials Science from the University of Michigan, Ann Arbor, in 2006. Prior to joining Rensselaer, he spent two years in North Carolina State University as a Postdoctoral Research Associate. Dr. Shi aims to understand complex material behaviors and design better materials using simulation and modeling. His research include many material systems: metallic/silica/polymeric glasses/composites, nanostructured carbon, on material behaviors such as fracture, self-assembly, wetting and friction/wear. He was selected as one of the inaugural Gordon S. Fulcher Distinguished Researchers by Corning Inc, where he spent sabbatical in 2015.

Both Prof. Sundararaman and Prof. Shi specialize in computational materials science and use models and computer simulations to understand, design and predict materials structure and properties and associated processes to guide, inspire and provide an understanding of experimental work.

Please join us in congratulating Profs. Sundararaman and Shi.



Photo of Sundararaman research



Prof. Yunfeng Shi



Prof. Edmund Palermo

STUDENT NEWS



Genevieve Kane



Gopal Kenath

2021 Norman S. Stoloff Research Excellence Award

The Norman S. Stoloff Research Excellence Award is to recognize MSE graduate students for their outstanding research accomplishments, as evidenced by a submitted or published journal article in the past 12 months.

Genevieve Kane and **Gopal Kenath** are the winners of the 2021 Norman S. Stoloff Research Excellence Award. The award which is given annually to two senior graduate students, recognizes the students for their outstanding research accomplishments, as evidenced by a submitted or published journal article in the past 12 months. Each received a cash prize and an award certificate following their presentation as part of the department seminar series.

This year our award winning presentations are Genevieve Kane, "The effect of cooling conditions on Ti 6%Al 4%V microstructure observed using high-temperature in-situ scanning electron microscopy" and Gopal Sankar Kenath, "Super resolution imaging of spatial heterogeneities in model thermosensitive hydrogels with implications for their origins"!

Congratulations!

Diwali Celebration

The Materials Science and Engineering Department hosted a Diwali Party with our Faculty and students. The gathering included delicious Indian food, a presentation on the history and meaning of Diwali, and Professor Ramanath performed a song.

Diwali is the five-day Festival of Lights, celebrated by millions of Hindus, Sikhs and Jains across the world. Diwali, which for some also coincides with harvest and new year celebrations, is a festival of new beginnings and the triumph of good over evil and light over darkness.

It was the Department's first gathering since the Covid shutdowns started, and care was taken to insure distancing and safety. But a joyous light-filled time was had by all!



Imaging Technique Reveals Strains and Defects in Vanadium Oxide

Researchers led by **Edwin Fohtung**, an associate professor of materials science and engineering at Rensselaer Polytechnic Institute, have developed a new technique for revealing defects in nanostructured vanadium oxide, a widely used transition metal with many potential applications including electrochemical anodes, optical applications, and supercapacitors. In the research — which was published in an article in the Royal Chemical Society journal, CrystEngComm, and also featured on the cover of the edition — the team detailed a lens-less microscopy technique to capture individual defects embedded in vanadium oxide nanoflakes.

"These observations could help explain the origin of defects in structure, crystallinity, or composition gradients observed near grain boundaries in other thin-film or flake technologies," said Fohtung, an expert in novel synchrotron scattering and imaging techniques. "We believe that our work has the potential to change how we view the growth and non-destructive three-dimensional imaging of nanomaterials."

Vanadium oxide is currently used in many technological fields such as energy storage, and can also be used in constructing field-effect transistors owing to metal insulating transition behavior that can be adjusted with an electric field. However, strain and defects in the material can alter its functionality, creating the need for nondestructive techniques to detect those potential flaws.

The team developed a technique based on coherent X-ray diffraction imaging. This technique relies on a type of circular particle accelerator known as a synchrotron. Synchrotrons work by accelerating electrons through sequences of magnets until they reach almost the speed of light. These fast-moving electrons produce very bright



intense light, predominantly in the X-ray region. This synchrotron light, as it is named, is millions of times brighter than light produced from conventional sources and 10 billion times brighter than the sun. Fohtung and his students have successfully used this light to develop techniques and capture minute matter such as atoms and molecules and now defects. When used to probe crystalline materials, this technique is known as Bragg coherent diffraction imaging (BCDI). In their research, the team used a BCDI approach to reveal nanoscale properties of electron densities in crystals, including strain and lattice defects.

Fohtung worked closely with Jian Shi, a Rensselaer associate professor of materials science and engineering. They were joined in the research on "Imaging defects in vanadium(III) oxide nanocrystals using Bragg coherent diffractive imaging" by Zachary Barringer, Jie Jiang, Xiaowen Shi, and Elijah Schold at Rensselaer, as well as researchers at Carnegie Mellon University.

STUDENT AWARDS & HONORS

Ryan Hawks and **Luke E. Barba** share the 2021 annual award based on the income from funds contributed by former students of Dr. Hunter, the prize is awarded annually to the senior in materials engineering who has demonstrated outstanding ability in academic work leading to a career in that field.



Ryan Hawks



Luke E. Barba

Genevieve Kane and **Gopal Kenath** are the winners of the 2021 Norman S. Stoloff Research Excellence Award. The award which is given annually to two senior graduate students, recognizes the students for their outstanding research accomplishments, as evidenced by a submitted or published journal article in the past 12 months. Each received a cash prize and an award certificate following their presentation as part of the department seminar series.



Genevieve Kane





Spencer L. Davis,

Spencer L. Davis, An annual award based on funds contributed by Meeli Leith, Rahmi Ozisik, and Moritz family; the award is made to a senior or co-terminal student in materials science and engineering who has demonstrated a keen interest in materials field and shows further growth in their future career.



Sumati Rangaraj

Sumati Rangaraj is the 2021 recipient of the Materials Design Award. This award is made to a senior student in materials science and engineering based on their Materials Selection and/or Capstone performance.

She also won the The MS&E Graduate Studies Award: This award is given to a graduating senior, who has exhibited outstanding academic performance and leadership abilities, and goes on to pursue graduate studies.



Cataldo W. Lamarca

Cataldo W. Lamarca won the annual award based on the income from funds contributed by former students of Prof. Mackay, the award is made to a senior in materials engineering who has given time and effort to the service of others without seeking recognition or acclaim, and who has completed the academic program at Rensselaer creditably.



Giovanna G. Trzaska

Giovanna G. Trzaska received the Doreen Ball-DiFazio Award in 2021. This award is given to given to a female senior with outstanding academic achievements and service to the community.

RESEARCH FOCUS

Raise a Glass ... to Glass Untangling the mysteries of this amazing material.

Shekhar Garde, Dean of the School of Engineering

At Rensselaer, a lot of imagination, thinking, and highperformance computing are being applied to understand glass. We know that glass breaks on strong impact. Glass can also get tired and break after a long time under a static or cyclic mechanical load or in the presence of water or water vapor. Professors Liping Huang, Minoru Tomozawa, and Yunfeng Shi in the Department of Materials Science and Engineering are advancing fundamental knowledge of how a crack initiates and propagates in glass through laboratory experiments and large-scale atomic simulations (i.e., molecular scale movies) on supercomputers in the Center for Computational Innovations to understand how a crack develops in glass at the microscopic scale, so we can make glass tougher and stronger.

As COVID-19 spread throughout the U.S. and the world last year, universities faced a serious challenge. I am proud of how quickly our faculty, staff, and students transitioned to online and hybrid learning. We developed innovative pedagogies, and imagined and implemented new ways to engage students, to assess them, and to provide them meaningful laboratory experiences. As professors delivered lectures behind Plexiglass shields to hybrid classrooms, glass lenses of cameras recorded them. Images were passed at high speeds over fiber optic cables to students from California to China, who in turn watched them on the glass screens of their computers, I could not help but marvel at the role of this invisible material that made it possible.

With the inventions of the microprocessor, the digital camera, and the graphics processor, Rensselaer alumni helped launch the digital or silicon revolution over the past many decades. Kurt Van Wagenen '85, president and CEO at FirstLight, a fiber-optics communication and data company, or Thomas G. Capek '86, senior vice president and chief engineer at Corning, might tell you that we are entering another Silicon Age, the age of glass. The UN has designated 2022 as the International Year of Glass. I will begin the celebrations by raising a glass to this amazing material. Will you join me?





Fin Donachie

Why did you choose RPI for your studies?

As a senior in high school, I knew that I wanted to study Materials Science & Engineering (MSE). Alumni from my high school came into my chemistry class and talked about their research with semiconductors and I was sold on the field that very instant. There are only so few universities that offer MSE as a major, so RPI caught my eye in that regard.

One of my close relatives, Matthew J. Donachie, Jr. graduated in 1954 from Rensselaer Polytechnic Institute with a BS in Metallurgical Engineering and attended Massachusetts Institute of Technology, where he earned his MS and ScD. When I discovered that Matthew not only studied at RPI but also specialized in metallurgy, I knew that RPI was the institute for me.

What RPI organizations are you a part of? (Polytechnic contributions, clubs, etc)

I am the President of Material Advantage (MA) for the Fall 2021 semester and I am a member of the RPI Crew team.

What aspect of Materials Science are you passionate about?

I am passionate about metallurgy more than any other aspect of materials science. I always imagined my dream job to be working at a hardware company such as Intel or AMD. I am also starting to develop an interest in glasses as of this semester. Dr. Tomozawa, my professor for Structures of Materials, is a glass expert and has shared multiple experiences from his professional career this semester. Hearing about the advancements and research in the past decades concerning glasses captivated me.

What research interests you?

I am looking into researching, possibly with Professor Tomozawa, during the Spring 2022 semester. When I was a freshman, I took Introduction to Materials Engineering and did my final project on three glass samples. My teammates and I were able to run X-ray diffraction as well as Raman spectroscopy on three glass samples in the Materials Research Center (MRC).

What career are you interested in?

I am interested in computer hardware and the automotive industry. I recently heard back from General Motors about an internship as a welding engineer for the Summer of 2022.

What is your favorite part of being at RPI?

RPI is full of incredible people. There are so many welcoming peers and professors who want me to reach my full potential. There is so much support offered through a variety of mediums on campus.

Furthermore, the campus at RPI is amazing. Everything is located in a



convenient spot for students to access. The walk to each one of my classrooms from my dorm is less than five minutes. What more could a college student ask for? The fall is a beautiful time of year in Troy. There are so many scenic spaces to study and take walks. It helps to have a scenic campus to clear one's mind when the inevitable stress from classes becomes too much.

What are your spare time hobbies?

I enjoy working out every morning at the Mueller Center and attending crew team practices during the evening. I find that I can focus more clearly when I have ample exercise throughout the day. Exercise in the morning helps wake me up and feel ready to start the day.

How do you want to change the world?

I want to see the world head in a more positive direction environmentally. When I graduate RPI and proceed into the engineering industry or graduate school, my goal is to contribute to this global effort as much as I possibly can. Perhaps I can focus on research related to sustainable material when I have the opportunity to do research.

Comments about your time at RPI

I am incredibly happy with my time spent at RPI thus far. Although I am a sophomore, this semester feels like my freshman year in a sense. Campus life completely turned around from last year and I could not be happier with how things are going right now. I am also looking forward to meeting more MSE staff and faculty as I take more classes and conduct outreach through MA.

FACULTY NEWS

Prof. Sundararaman – Advancing Future Energy Technologies

by Torie Wells



With the support of a \$2.6 million grant from the Department of Energy, **Ravishankar Sundararaman**, an associate professor of materials science and engineering at Rensselaer Polytechnic Institute, in collaboration with a multi-institution team of researchers, is taking on the challenge of developing accurate, cost-effective, and highly accessible computational electrochemistry tools.

Accurate predictive simulations of the electrochemical reactions that power solar fuel generators, fuel cells, and batteries could advance these technologies through improved material design, and by preventing detrimental electrochemical processes, such as corrosion. However, electrochemical reactions are so complex that current computational tools can only model a fraction of all relevant factors at one time — with limited accuracy. This leaves researchers reliant on the trial and error of significant and expensive experimentation.

"Our project aims to address the full complexity of electrochemical systems by combining quantum electronic simulations with classical electrolyte models," said Sundararaman. "Then, by using AI to learn from all previous simulations, we also hope to predict electrochemical processes quickly and accurately."

Prof. Daniel Gall Receives Bill Sproul Award and Honorary Lecture Recipient



The AVS Advanced Surface Engineering Division (ASED) Awards Committee has selected Materials Science & Engineering Department's **Professor Daniel Gall** as the recipient of the Bill Sproul Award and Honorary The International Conference on Metallurgical Coatings and Thin Films 2021 Lecture. The members of ASED Executive Committee were delighted to hear about the selection. The Bill Sproul Award and Honorary ICMCTF lectureship is to recognize the achievements of a mid-career researcher who has made outstanding scientific and/or technological contributions in areas of interest to the Advanced Surface Engineering Division (ASED) of the AVS, with emphasis in the fields of surface engineering, thin films, and related topics. The Bill Sproul Honorary Lecture will be scheduled at one of the regular ICMCTF2021 (April 25-30) sessions.

STUDENT ORGANIZATIONS

Material Advantage

RPI Material Advantage Student Chapter, a professional society housed by the MSE department, holds events focusing on professional development, educational outreach, and the student community. These events take place within the RPI community and surrounding communities, such as Troy, Niskayuna, and Albany. Listed below are some of the many events Material Advantage held this past year.

As the sole professional society specifically for materials engineering majors on campus, Material Advantage provides invaluable development opportunities to its members. These events allow students to connect with professionals in industry and academia, by learning about the decisions that developed their career paths and meeting new people to develop career networks. As they do each year, students attended the virtual Materials Science & Technology (MS&T) conference in 2020, where they took part in a design challenge competition, Speaking and Poster competitions, and professional development

panels Students also visited the materials testing lab in the Stratton Air National Guard Base and learned about failure analysis in materials exposed to extreme conditions The "MatChat" is a recurring series held over the academic year, where several professors in the MSE department are asked to hold career-oriented dialogues with students. During these hour-long talks, professors begin by sharing a summary of their previous experiences and open the floor to questions. This provides an informal environment to learn about the professors and pick up guidance.

Club members are to participate in Exploring Engineering Day in February 2022 where they will teach K-6 students about the buoyancy of materials using through hands-on activities. The demonstration will feature a brief lesson to highlight concepts such as density, hydrophobicity, as well as the engineering design process. The students are asked to "build a boat" using household materials such as aluminum foil and drinking



straws. In the end, students will reflect upon successes and failures

During the Fall 2021 semester, MA worked in conjunction with Engineering Ambassadors to help with outreach events at the Boys & Girls Club of Troy located on 7th Avenue in Downtown Troy During these outreach sessions, members of MA worked with students ages 5-12 by giving a new STEMrelated lecture every week accompanied with an activity for the after-school students to participate in. The most recent activity had students build the tallest and most stable structure possible from plastic bottles.

FACULTY AWARDS



Prof. Daniel Gall Receives Bill Sproul Award

Daniel Gall, Professor, Materials Science and Engineering (MSE) received the 2021 Bill Sproul Award and Honorary International Conference on Metallurgical Coatings and Thin Films (ICMCTF) Lectureship Award from the American Vacuum Society (AVS).



Prof. Liping Huang Elected Fellow of the American Ceramic Society

Liping Huang, Associate Dean for Research and Graduate Programs, Professor, Materials Science and Engineering, elected Fellow of the American Ceramic Society.

Assistant Prof. Edmund Palermo Receives \$1.2 Million Grant



With the support of a four-year \$1.2 million grant from The Department of Veterans Affairs, an interdisciplinary team of engineers from Rensselaer Polytechnic Institute aims to create a polymer coating that could potentially be capable of reducing the body's inflammatory response following the implantation of these electrodes.

Ryan Gilbert, a professor of biomedical engineering at Rensselaer, will work with Edmund Palermo, an assistant professor of materials science and engineering at Rensselaer, to develop a polymer coating out of curcumin, a chemical compound found in turmeric, which has both anti-inflammatory and antioxidant properties. But first, the researchers need to tackle the challenge of how to turn curcumin, a fairly unstable molecule, into a polymer material.

The Rensselaer team will also have an opportunity to work with the research division at the Albany Stratton VA Medical Center and in collaboration with Dr. Jeffrey Capadona's laboratory at the Louis Stokes Cleveland VA Medical Center.

For individuals with central nervous system paralysis, the effectiveness of neuroprosthetic technology — such as braincontrolled prosthetic limbs or muscle stimulation devices — makes a world of difference. If the process of implanting tiny electrodes in the brain were to be improved, allowing for stronger and longer lasting communication between neurons and external devices, it could significantly enhance quality of life.

"This is for veterans who have some sort of paralysis," said Ryan Gilbert. "The electrode would allow for the patient to communicate with external devices to power a robotic arm or to communicate with some sort of server to help the veteran live a better life."

"It needs to be a degradable coating that protects the implant on the way in, tamps down the injury, and then allows the neurons to establish a connection," Palermo said.

If the team's polymer could reduce scarring tissue that is formed, electrodes would continue to work for a longer period of time, therefore reducing the number of surgeries needed for electrodes to be replaced.

"What we're trying to do with this polymer is reduce that scarring so that we can have better communication between the electrode and the brain tissue for more chronic timeframes, so several months — if not years — after implantation," said Gilbert, who is also a member of the Center for Biotechnology and Interdisciplinary Studies (CBIS) at Rensselaer. In addition to its eventual use for neuroprosthetics, this new biomaterial coating could also potentially be used on things like catheters, sutures, or anything else that is introduced into the body to reduce the inflammatory response.

Rensselaer Department of Materials Science and Engineering

GRAD STUDENT SPOTLIGHT

Prachi Pragnya

Why did you choose RPI for your studies?

I Had heard about RPI's interdisciplinary approach to research from my professors and peers in my previous university. Most importantly, I found the work in Prof. Daniel Gall's group very exciting.

What RPI organizations are you a part of? (Polytechnic contributions, clubs, etc)

RPI-MSE Graduate Seminar, RPI Indian Students Association (Grad-ISA), American Vacuum society) RPI student chapter.

What aspect of Materials Science are you passionate about?

The generality in applications. The well-rounded and interdisciplinary approach. It lets us use physics, chemistry, and engineering to build something like a space rocket or something like a needle.

What research interests you?

Thin film deposition and characterization and in situ microscopy.

What career are you interested in?

Something that allows me to use Materials Science to help society grow.

What is your favorite part of being at RPI?



Doing research on two very exciting research topics with two world-class experts.

What are your spare time hobbies?

Cooking, Social Networking, Travelling to new places.

How do you want to change the world?

By doing impactful research that caters to the betterment of the human-race.

Comments about your time at RPI

Efficient work environment created by people from diverse educational background and diverse cultural backgrounds, who are very easy to get along with.

CURRICULUM CORNER

A New Python Based Programming Course

With an institute-wide push towards emphasizing data dexterity in the undergraduate curriculum, we have introduced a new Programming for Materials Engineers course intended for our freshmen and sophomores. This 1-credit course takes students with little or no prior programming experience through elementary programming concepts, basic data analysis and visualization using the Python programming language and the Jupyter interactive notebook environment. Code concepts are introduced with examples based in materials engineering, starting with evaluation of basic mathematical formulae in week 1 and reaching Monte Carlo simulations of diffusion by week 6. This lays the groundwork for using programming and simulation throughout the materials curriculum and serves as a common core for advanced elective courses including Applied Mathematical Methods and Material Informatics & Data Science that allows students to further leverage computation for materials engineering.

The department recently introduced a course on applied mathematics in materials engineering. The course seeks to help students develop an ability to conceptualize, formulate and solve mathematical problems in materials science and engineering through use of the techniques, skills and modern engineering tools necessary for engineering practice including symbolic computation tools and numerical solvers.

IN MEMORIUM



With **Shyam Murarka's** passing, RPI and the world of semiconductor processing science have lost a giant. Shyam came to RPI from industry, having been one of the pioneers in replacing aluminum with copper for interconnects on semiconductor wafers. There are even some technologists who believe that the entire concept can be attributed to Shyam's acumen. In any event the concept resulted in a true game changertechnical revolution in electronic materials process that essentially guaranteed the continuation of Moore's Law. At RPI, Shyam almost immediately established the Center for Advanced Interconnect Science and Technology (CAIST). Under his leadership a partnership was established between the

semiconductor industry and NY State that encompassed as many as a dozen universities, with RPI as the lead institution.

Shyam introduced me to CAIST by inviting me to use the concept of electrochemistry as a research tool for processing semiconductor wafers. That endeavor resulted in the production of more than a dozen PH.D. students in the areas of chemical mechanical planarization and ultrafine electrochemical deposition. I eventually joined him in the administration of CAIST by becoming its co-director.

Shyam was dedicated to RPI, the department and primarily to his students. I was Department Head when Shyam announced that he would be taking early retirement for health reasons.. With that announcement the department lost a valuable scientist, mentor and colleague. We are all poorer for his passing.

Dr. David Duquette



Dr. Sanford Samuel Sternstein, known as Sandy, passed away in September 2021 at the age of 85. He received a Doctor of Philosophy degree in chemical engineering from Rensselaer Polytechnic Institute (R.P.I.) in Troy in 1961. He then went on to work as a professor of engineering at R.P.I. for 46 years from 1961 to 2007. Sandy served in a chair professor role as the William Walker Weightman Professor of Polymer Engineering from 1972 to 2007 and director of Center for Composite Materials and Structures from the mid- 1990s to 2000. Sandy was world renowned and highly respected in his career field of study which included the following topics: polymer physics, mechanical properties of polymers and composites, and viscoelasticity and rheology. He was the author and co-author of more than 100 published journal articles. He also patented a

materials testing device and was the president and founder of the former Dynastatics Instruments Cooperation.

Those who worked with him at RPI said, "Professor Sternstein was a bright and outspoken professor."

"Sandy was one of the brightest and most inquisitive scientists/engineers with whom I have had the pleasure to work with. His mathematical prowess was well known and his attention to detail was unparalleled. He was a giant in the world of rheology. Sandy was devoted to the Department and to RPI. When I was Department Head I could always count on Sandy to take on otherwise unpopular courses. His retirement was a blow to the Department, and his occasional visits after retirement were always a pleasure. In addition to his academic pursuits, Sandy and his wife Gail were strong supporters of the arts and it was always pleasant to meet with them at the Troy Music Hall, at SPAC and at Proctor' theatre."

David J. Duquette

RESEARCH FOCUS

Changing a 2D Material's Symmetry Can Unlock Its Promise

Jian Shi Research Group engineers material into promising optoelectronic

Optoelectronic materials that are capable of converting the energy of light into electricity, and electricity into light, have promising applications as light-emitting, energy-harvesting, and sensing technologies. However, devices made of these materials are often plagued by inefficiency, losing significant useful energy as heat. To break the current limits of efficiency, new principles of light-electricity conversion are needed.

For instance, many materials that exhibit efficient optoelectronic properties are constrained by inversion symmetry, a physical property that limits engineers' control of electrons in the material and their options for designing novel or efficient devices. In research published today in Nature Nanotechnology, a team of materials scientists and engineers, led by Jian Shi, an associate professor of materials science and engineering at Rensselaer Polytechnic Institute, used a strain gradient in order to break that inversion symmetry, creating a novel optoelectronic phenomenon in the promising material molybdenum disulfide (MoS2) — for the first time.

To break the inversion symmetry, the team placed a vanadium oxide (VO2) wire underneath a sheet of MoS2. Molybdenum disulfide is a flexible material, Shi said, so it deformed its original shape to follow the curve of the VO2 wire, creating a gradient within its crystal lattice. Imagine what would happen if you placed a piece of paper over a pencil that was sitting on a table. The varied tension created in the paper is like the strain gradient formed in the MoS2 lattice.

That gradient, Shi said, breaks the material's inversion symmetry and allows electrons traveling within the crystal to be manipulated. The unique photo-response observed near the strain gradient allows a current to flow through the material. It's known as the flexo-photovoltaic effect, and it could be harnessed to design novel and/or high-efficiency optoelectronics.



"This is the first demonstration of such an effect in this material," Shi said. "If we have a solution that does not create heat during photon-electricity conversion, then the electronic devices or circuits could be improved."

Vanadium oxide is very sensitive to temperature, so the team was also able to demonstrate that the flexo-photovoltaic effect brought about temperature dependence at the site where the MoS2 and VO2 materials meet — changing the lattice's gradient accordingly.

"This discovery suggests a novel principle that could be used for remote thermal sensing," said Jie Jiang, a postdoctoral research fellow in Shi's lab and the first author on this paper.

What the team was able to demonstrate here, Shi said, not only shows great promise for this material, but also suggests the potential of using such an approach in engineering other materials with favorable optoelectronic properties that are plagued by inversion symmetry.



Rensselaer

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