ACS Energy Letters

http://pubs.acs.org/journal/aelccp

Women Scientists at the Forefront of Energy Research: A Virtual Issue, Part 2

Cite This: *ACS Energy Lett.* 2020, 5, 623−633

Read Online

ACCESS | Metrics & More | Article Recommendations

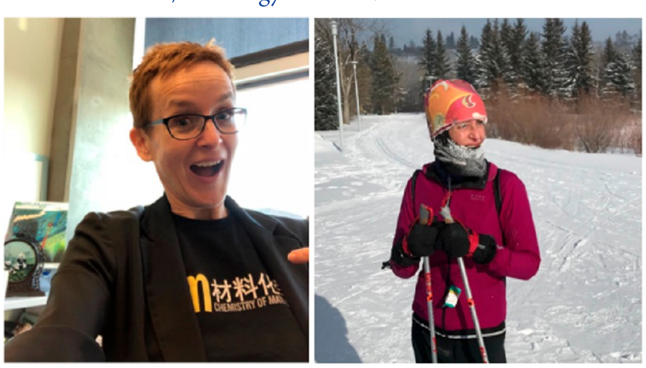
As the second part of the series celebrating the contributions of female energy researchers who have published new advances from their laboratories in *ACS Energy Letters*, we present their inspirational stories here. As in the previous part published in the January issue (https://pubs.acs.org/doi/10.1021/acsenergylett.9b02695), these personal stories of scientists around the globe (#WomenInEnergy, #WomenInStem, and #WomenInScience) reflect their passion and motivation to engage in energy research. It is our hope that new researchers will seek inspiration from these personal reflections and join the effort to tackle the clean energy challenge.

This virtual issue is a compilation of one representative paper from each of these scientists. We would like to thank Jillian M. Buriak, Shirley Meng, Jillian Dempsey, Natalia B. Shustova, Beatriz Roldán Cuenya, Hemamala Karunadasa, Lydia Helena Wong, Ming Lee Tang, Michelle Vaisman, Paulina Plochocka, Ranjani Viswanatha, Reshma R. Rao, Kelsey B. Hatzell, Giulia Grancini, Bettina Lotsch, Ann Greenaway, Eva M. García-Frutos, Marina Leite, Libai Huang, Lin X. Chen, Kara L. Bren, and María Escudero-Escribano for their contributions to this virtual issue. We also would like to thank Dr. Christina McLaughlin for her assistance in initiating this project.

β-SnSb FOR SODIUM ION BATTERY ANODES: PHASE TRANSFORMATIONS RESPONSIBLE FOR ENHANCED CYCLING STABILITY REVEALED BY IN SITU TEM

Hezhen Xie, Xuehai Tan, Erik J. Luber, Brian C. Olsen, W. Peter Kalisvaart, Katherine L. Jungjohann, David Mitlin, Jillian M. Buriak

ACS Energy Letters, **2018**, 3 (7), 1670−1676 (Letter)
DOI: 10.1021/acsenergylett.8b00762



Jillian Buriak at work and at play. Photos courtesy of Jillian Buriak

It was in 2006 that I noticed the many young students, both undergrads and new graduate students, literally banging on my door with an almost desperate drive to work on one specific area of research—solar energy conversion. Alberta has an enormous petroleum industry, but it was specifically solar energy that these bright and highly motivated students wanted to work on. It was a pleasant surprise to see such drive and focus, but also a little disconcerting: these young people were turning their backs on well-paying chemistry and engineering jobs in oil and gas and were powered by a deep concern for the future of the planet and addressing climate change. We had been working on nanoscale materials and surface chemistry of semiconductors, and so together we decided that we could learn on the fly and jump into organic photovoltaics and earth-abundant inorganic materials for solar energy conversion, and later electrochemical energy storage as well. We have not looked back, thanks to these concerned young scientists.

Now, 14 years later, I think back to that an enormous debt of gratitude I owe to these students for giving me a shake and launching us into research in renewable energy. We learned the ropes together, and they have gone off to do remarkable things, with one of the Ph.D. graduates even briefly holding the world record for OPV power conversion efficiency at Phillips 66. So, the message is this: students can profoundly effect change through a desire to improve the world; if you feel the drive to work on something, go knock on doors until you find what you are looking for—the world needs you!

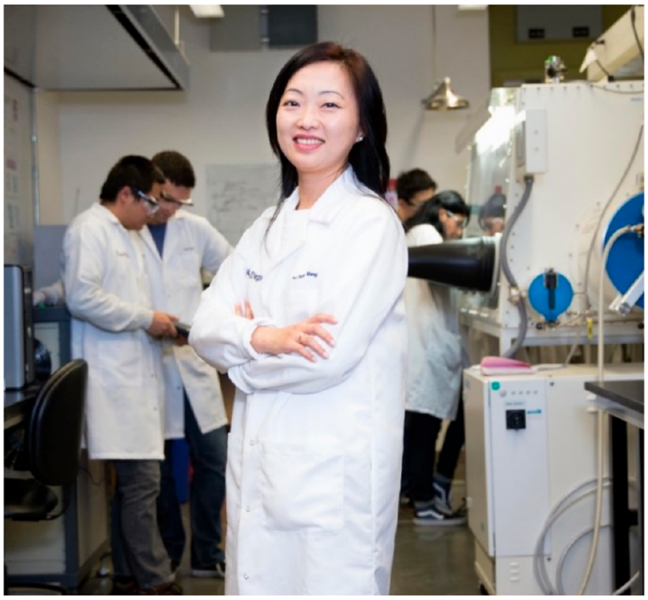
Jillian M. Buriak Editor-in-Chief, *Chemistry of Materials*; Professor of Chemistry

ELUCIDATING REVERSIBLE ELECTROCHEMICAL REDOX OF Li6PS5Cl SOLID ELECTROLYTE

Darren H. S. Tan, Erik A. Wu, Han Nguyen, Zheng Chen, Maxwell A. T. Marple, Jean-Marie Doux, Xuefeng Wang, Hedi Yang, Abhik Banerjee,Ying Shirley Meng

ACS Energy Letters, **2019**, *4* (10), 2418−2427 (Letter)
DOI: 10.1021/acsenergylett.9b01693

Received: January 13, 2020
Accepted: January 13, 2020
Published: January 30, 2020



Shirley Meng in the laboratory with group members. Photo courtesy: David Baillot

There are three things in my career I truly value: (1) Learn something NEW every day. (2) Surround myself with the best minds. (3) Be able to implement my own ideas. Being a professor in the field of energy materials design, discovery and diagnosis makes my dream come true. Science, technology, and engineering, if deployed properly, are the key drivers for improving people's lives, particularly today while climate changes are threatening the wellbeing of humankind; my work to enable better energy storage materials and devices seems relevant, and I think it is our duty to help the public understand we can provide meaningful solutions to combat climate change. I imagine a world where the majority of the population can access cheap, abundant, clean water and energy—this vision is my inspiration to engage in energy research (http://smeng.ucsd.edu/). Besides being a scientist and an engineer in the energy field, I am also an educator; I feel privileged that I can teach, advise, and mentor the young brilliant minds who are going to make a difference in the world. At the moment, my solid-state battery research team consisting of Ph.D. students and postdocs from France, India, Singapore, United States, and China works tirelessly with me to make some of the most exciting breakthroughs in battery technology, so we can provide the world a truly safe, low-cost, high-performance, and sustainable energy storage solution (http://smeng.ucsd.edu/publications/).

Shirley Meng Editor-in-Chief, *MRS Energy & Sustainability*; Zable Endowed Chair Professor in Energy Technologies and Professor of Materials Science and Nano Engineering

■ EXCITED-STATE PROTON-COUPLED ELECTRON TRANSFER: DIFFERENT AVENUES FOR PROMOTING PROTON/ELECTRON MOVEMENT WITH SOLAR PHOTONS

J. Christian Lennox, Daniel A. Kurtz, Tao Huang, Jillian L. Dempsey

ACS Energy Letters, **2017**, 2 (5), 1246−1256 (Review)

DOI: 10.1021/acsenergylett.7b00063

Jillian Dempsey. Photo courtesy: Lars Sahl

My entry into energy research was not deliberate. As an undergraduate chemistry major at MIT, I initially envisioned pursuing a career as a chemist in the pharmaceutical industry, but I was much more energized by my coursework in inorganic and physical chemistry than pharma-relevant courses like organic. When it came time to get started in research, I was propelled toward Dan Nocera's lab because I saw any opportunity to synergize my interest in these two areas. But what sort of problems could I solve with physical inorganic chemistry? The Nocera lab opened my eyes to our global energy challenges and showed me how creative and fundamental science could be a game changer. Later, as a graduate student, I had the opportunity to work as part of the NSF Center for Chemical Innovation in Solar Fuels which taught me that effectively harnessing sustainable energy resources requires researchers with different expertise to work together as a team. Over the last 15 years, I've witnessed tremendous changes in the energy research landscape, with an ever-expanding number of scientists bringing their unique perspectives to help solve outstanding challenges and a surge of effective collaborations between scientists from traditionally disparate subdisciplines tackling problems in new ways. The resulting global efforts to develop the fundamental science underpinning sustainable energy has led to tremendous technological advances during this time. Ultimately, while I stumbled into energy research, I've found my scientific home and been empowered to apply science that I'm deeply passionate about to address serious global challenges.

Jillian Dempsey Associate Professor of Chemistry

■ HETEROMETALLIC METAL−ORGANIC FRAMEWORKS (MOFs): THE ADVENT OF IMPROVING THE ENERGY LANDSCAPE

Allison M. Rice, Gabrielle A. Leith, Otega A. Ejegbavwo, Ekaterina A. Dolgopolova, Natalia B. Shustova

ACS Energy Letters, **2019**, *4* (8), 1938−1946 (Perspective)

DOI: 10.1021/acsenergylett.9b00874

Natalia B. Shustova (middle) with graduate students. Photo courtesy: USC

Solving emerging scientific problems in order to benefit society has long fascinated me, and I believe it is essential to train a new generation of talented scientists who possess the skills necessary to overcome not only these challenges but also those our society has yet to encounter. In my group, we strive to address current challenges in energy and nuclear waste administration sectors using a porous, modular, and tunable class of materials, metal–organic frameworks (MOFs). We are looking to utilize MOFs as a versatile platform for more efficient ways to reprocess or safely contain nuclear waste. This quest stems from events that happened in the last 50 years such as nuclear plant development resulting in the greatest tragedies faced by humanity: Fukushima or Chernobyl catastrophes. We believe that synergy between experiments and theory/modeling is still necessary to delineate the energetically favorable actinide-containing structural motifs, thereby allowing for identification of further MOF candidates as platforms for improved nuclear waste forms. This avenue is one of our main future directions for in-depth exploration.

I encourage my student co-workers to do things which they are passion about, even if no one believes it is possible. I want them to think about research as an adventure, and once they climb to the top of the mountain, they will see that their efforts were all worth it. I certainly have.

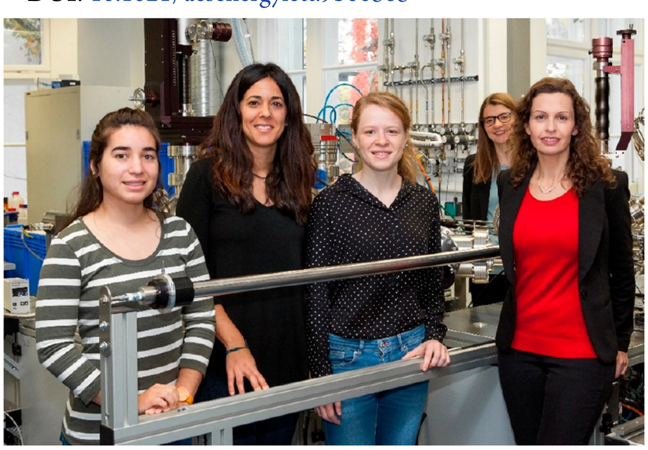
Natalia B. Shustova Associate Professor of Chemistry and Biochemistry

SHAPE-CONTROLLED NANOPARTICLES AS ANODIC CATALYSTS IN LOW-TEMPERATURE FUEL CELLS

Rubén Rizo, Beatriz Roldán Cuenya

ACS Energy Letters, **2019**, *4* (6), 1484–1495 (Perspective)

DOI: 10.1021/acsenergylett.9b00565



Prof. Dr. Beatriz Roldán Cuenya (far right) together with four of her female scientists. Photo Courtesy: Christian Tessmar, FHI Berlin

During my undergraduate and graduate studies in physics, I became conscious about the energy problem, in particular, the lack of fossil fuels for the next generations and the tremendous environmental impact that modern industrialization is having. By the time I had to choose a postdoctoral position, I wanted to become a part of the solution and decided to move to a chemical engineering department and start applying my surface science expertise to catalysis projects.

I especially enjoyed my time working at different synchrotron facilities with my students and other colleagues in the field, including long nights of measurements after countless hours of system alignment and optimization. In particular, I have fond memories of the first time I was able to follow structural and chemical transformations of one of our nanoparticle catalysts in real time under operando reaction conditions via X-ray absorption spectroscopy.

The most rewarding component of being in this field is its intrinsic interdisciplinary nature, which gives you the chance to interact with scientists in a variety of research fields, from chemical engineering to chemistry, physics, materials science, and biology. One of the challenges I experienced 15 years ago when I was an Assistant Professor in Physics in the United States was the struggle to convince editors in chemistry-related fields to send out my physical chemistry work for external peer-review in top chemistry journals.

I am very involved in the reutilization of carbon dioxide for the production of chemical and fuels through sustainable electrochemical routes driven by renewable energy sources (solar and wind). More specifically, in order to be able to rationally design more efficient catalysts, in depth insight into their structure and surface composition under reaction conditions is needed. This is currently being accomplished within my group via a synergistic combination of in situ and operando microscopy and spectroscopy methods. An example of ongoing research involves the direct visualization of the dynamic nature of copper nanoparticles during electrochemical processes (e.g., CO_2 electroreduction) via transmission electron microscopy, X-ray absorption spectroscopy, X-ray photoelectron spectroscopy, and X-ray diffraction.

Here is my advice to younger researchers in the field. You should not hesitate to speak to senior scientists and ask for mentorship.

Beatriz Roldán Cuenya Professor of Physics; Chair of Solid State Physics/Surface Physics; Associate Editor, *ACS Catalysis*

HALIDE PEROVSKITES UNDER PRESSURE: ACCESSING NEW PROPERTIES THROUGH LATTICE COMPRESSION

Adam Jaffe, Yu Lin, Hemamala I. Karunadasa

ACS Energy Letters, **2017**, 2 (7), 1549–1555 (Perspective)

DOI: 10.1021/acsenergylett.7b00284

Hema Karunadasa (middle) with co-workers Alex Su (left) and Ethan Crace (right). Photo Courtesy: H. Karunadasa

Here is my advice to younger researchers. *Define a research area, no matter how small, where you have a unique voice*: If you think about your research experiences as an undergraduate, graduate, and postdoctoral researcher, including the people you have met and the papers you have read, you have a unique combination of skills, knowledge, and ideas. Instead of following a research topic that is currently experiencing a surge of interest, define a research program that speaks to your distinct strengths. Even if you jump into a new field where you have little or no prior experience, you could bring this field new perspectives and ideas based on your experiences. It is never too early to think about what you could do as an independent scientist.

A paper is forever: There is considerable pressure to publish frequently and to publish quickly, especially as a young faculty member. But the papers that stand the test of time and define new research pathways are those that are written with great care and deliberation. As a part of your scientific legacy, improving your papers by refining a figure or researching prior work in the field is well worth the time. I believe that establishing a reputation for writing good papers is the most important part of starting your new group.

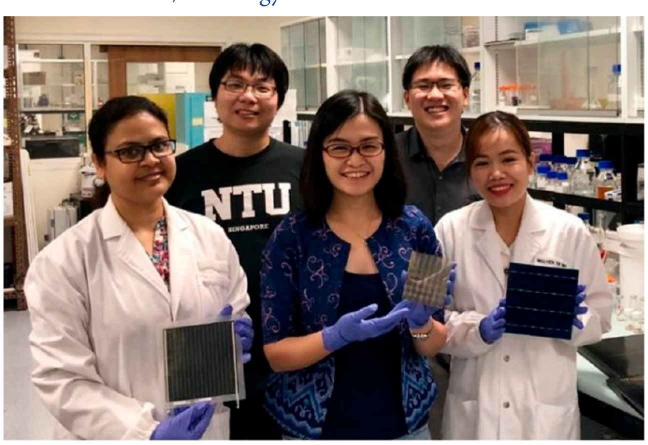
Hemamala Karunadasa Associate Professor of Chemistry

■ OVER 20% EFFICIENT CIGS–PEROVSKITE TANDEM SOLAR CELLS

Asim Guchhait, Herlina Arianita Dewi, Shin Woei Leow, Hao Wang, Guifang Han, Firdaus Bin Suhaimi, Subodh Mhaisalkar, Lydia Helena Wong, Nripan Mathews

ACS Energy Letters, **2017**, *2* (4), 807−812 (Letter)

DOI: 10.1021/acsenergylett.7b00187



Lydia with a few of her group members (left to right): Monika Rai, Mengyuan Zhang, Lydia Wong, Ying Fan Tay, and Hiep Nguyen. Photo Courtesy: Lydia Helena Wong

When I was starting my group in 2010, Professor James Barber (Imperial College) visited us at NTU and spoke about the artificial leaf, which inspired me to start research in this area. Nature has provided one of the most remarkably efficient clean energy sources in the form of plants, which efficiently convert CO_2 and water into O_2 and hydrocarbons. Unfortunately, none of the existing technology comes close to this.

I believe that a truly efficient artificial leaf concept will be realized only by the discovery of new materials. One project that my group is currently working on is accelerating the discovery of new materials by using high throughput/combinatorial synthesis and characterizations assisted by machine learning algorithms. New materials will enable new applications which expand beyond our current technology.

I hope more young people will be inspired to pursue research in renewable energy and do our small part in preserving the earth for our children and their grandchildren. Borrowing a phrase that Prof Barber often uses, “If the leaf can do it, so can we!”

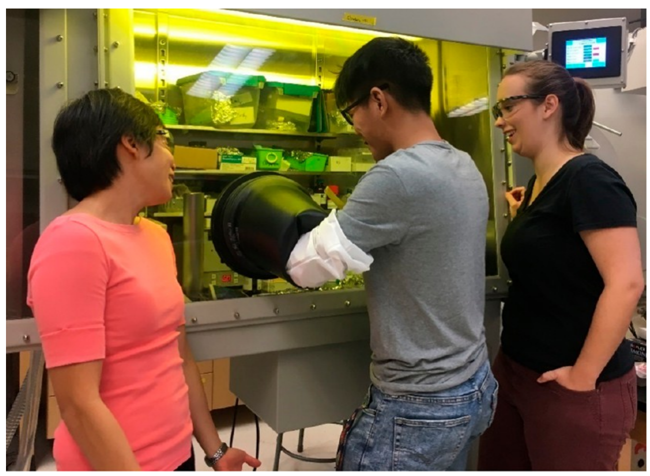
Lydia Helena Wong Associate Professor of Materials Science and Engineering

■ MIDGAP STATES IN PbS QUANTUM DOTS INDUCED BY Cd AND Zn ENHANCE PHOTON UPCONVERSION

Melika Mahboub, Pan Xia, Jeremiah Van Baren, Xin Li, Chun Hung Lui, Ming Lee Tang

ACS Energy Letters, **2018**, 3 (4), 767−772 (Letter)

DOI: 10.1021/acsenergylett.8b00122



Ming Lee Tang (left) with undergraduate student Lloyd Kao and graduate student Emily Moses. Photo courtesy: M. L. Tang

I’m most excited about our current work showing for the first time the ability to engage silicon with spin-triplet excitons in molecules. The power to use silicon, a ubiquitous, earth-abundant, environmentally benign material has important implications for in vivo applications harnessing photon upconversion in neuroscience, pain mitigation, body clock realignment, and preclinical research. Previously, we had performed photon upconversion only with toxic nanoparticle light absorbers that contain heavy metals. It was not clear before our results that silicon nanocrystals can efficiently absorb light and transfer energy to molecular acceptors, given the well-established indirect gap nature in bulk and the lack of any precedents. This exciting result is testimony to the fact that I’m very fortunate to be working with a group of talented and dedicated students.

Ming Lee Tang Associate Professor of Chemistry

■ 15.3%-EFFICIENT GaAsP SOLAR CELLS ON GaP/Si TEMPLATES

Michelle Vaisman, Shizhao Fan, Kevin Nay Yaung, Emmett Perl, Diego Martín-Martín, Zhengshan J. Yu, Mehdi Leilaeioun, Zachary C. Holman, Minjoo L. Lee

ACS Energy Letters, **2017**, *2* (8), 1911−1918 (Letter)
DOI: 10.1021/acsenergylett.7b00538

Michelle Vaisman. Photo Courtesy: Michelle Vaisman

Throughout my undergraduate education, I explored a myriad of research fields, and quickly came to understand my inspiration and passion were driven not by the theoretical or fundamental, but by the experimental fields with real-world applications. Solar quenched my thirst for a challenging problem that will meaningfully impact the world we live in today. My first opportunity to explore this field was by way of PbS quantum dot solar cells, and I was hooked. Starting with just a piece of glass and a few solutions, I was able to create a device that actually produced electricity before my eyes, and it would do so in a sustainable way! After further exploring this area, I discovered the field of III−V solar cells on silicon—an approach that holds the promise to enable high-efficiency devices at a low cost for both terrestrial and space applications. It was incredible to be a part of this research where I was able to grow these record-efficiency devices from their constituent elements. Renewable energy is critical for our planet, and it is inspiring to know that I am helping to push the envelope in what we can achieve. Furthermore, producing tangible solar cells that others can see in action allows me to more readily share my passion for research with the next generation of scientists.

Michelle Vaisman Engineer

■ EXCITONIC PROPERTIES OF LOW-BAND-GAP LEAD−TIN HALIDE PEROVSKITES

Krzysztof Galkowski, Alessandro Surrente, Michal Baranowski, Baodan Zhao, Zhuo Yang, Aditya Sadhanala, Sebastian Mackowski, Samuel D. Stranks, Paulina Plochocka

ACS Energy Letters, **2019**, *4* (3), 615−621 (Letter)
DOI: 10.1021/acsenergylett.8b02243

Paulina Plochocka. Photo courtesy: Paulina Plochocka

My adventure with organic−inorganic perovskites for energy-harvesting applications started in 2014. At the time the great excitement was driven by their skyrocketing power conversion efficiency. Perovskites exhibit phenomenal performance despite the cheap and cheerful bucket chemistry used in their fabrication. At first, I thought of perovskites as classical semiconductors with sample quality being the Holy Grail for optimizing device performance. This is really the paradox of perovskite spin-coated polycrystalline thin films, which are literally stuffed full of defects, but nevertheless are so great for many different applications.

Gradually, we began to understand that the secret of perovskites actually lies in their softness with a mixed crystal/glass-like behavior—they have even been described as a "phonon soup". In fact, perovskites are so soft that the harmonic approximation, the basic starting point for all solid-state textbooks when describing phonons, simply goes out the window and we have to rethink everything we know about phonons. This was the starting point of my fascination with these materials. The interplay between the charge carriers and the soft ionic lattice leads to the formation of polarons, a quasi-particle made up of a charge carrier dressed by the lattice vibrations. We are only beginning to understand perovskites physics and there remain many open questions concerning their fundamental properties. And maybe we could even go one step further: If we could tune on demand the electron phonon coupling, could we think then about perovskites-based "polarontronics"?

Paulina Plochocka Scientist

■ TRANSIENT SPECIES MEDIATING ENERGY TRANSFER TO SPIN-FORBIDDEN Mn d STATES IN II−VI SEMICONDUCTOR QUANTUM DOTS

Kushagra Gahlot, Pradeep K.R., Andrea Camellini, Gianluca Sirigu, Giulio Cerullo, Margherita Zavelani-Rossi, Anjali Singh, Umesh V. Waghmare, Ranjani Viswanatha

ACS Energy Letters, **2019**, *4* (3), 729−735 (Letter)
DOI: 10.1021/acsenergylett.9b00064

Quantum Dot Lab group discussion at JNCASR Foyer. Photo Courtesy: Pradeep K. R.

One day, one of my students walked over to me and said that he wanted to work in energy-related research. We discussed the challenges it would involve, and he was ready. So, we started to carve a niche for ourselves where we knew that we could make a positive impact. Here I believe it is very important for a researcher to take the time to figure out a suitable problem based on the scientific problem as well as your strengths. Over a period of the next few years we addressed the problem of energy efficiency by reducing energy loss pathways in several unconventional methods. For example, extended defects within the crystal were causing one of the major loss mechanisms, and we strategically solved this problem by using a counterintuitive pathway to get rid of these extended defects. However, during this study, we realized that these defects were different than other surface defects as they were strongly coupled to the host. Slowly, studies led to the constructive use of nonradiative/absorptive losses by making use of selective coupling of these defects or other energy loss paths to the energetically useful pathways, substantially increasing the efficiency. Currently, we are working on the slow feeding of excited electrons over extended periods to increase energy efficiency, which is very exciting. From these studies, it has been a revelation that it is always more efficient if we can find a pathway that is in the direction of thermodynamic equilibrium rather than trying to oppose it.

Ranjani Viswanatha Associate Professor

■ TRENDS IN ACTIVITY AND DISSOLUTION ON RuO_2 UNDER OXYGEN EVOLUTION CONDITIONS: PARTICLES VERSUS WELL-DEFINED EXTENDED SURFACES

Claudie Roy, Reshma R. Rao, Kelsey A. Stoerzinger, Jonathan Hwang, Jan Rossmeisl, Ib Chorkendorff, Yang Shao-Horn, Ifan E. L. Stephens

ACS Energy Letters, 2018, 3 (9), 2045−2051 (Letter)
DOI: 10.1021/acsenergylett.8b01178

Electrochemical Energy Laboratory in the Summer of 2019 (PI: Professor Yang Shao-Horn). Photo Courtesy: Yu Katayama

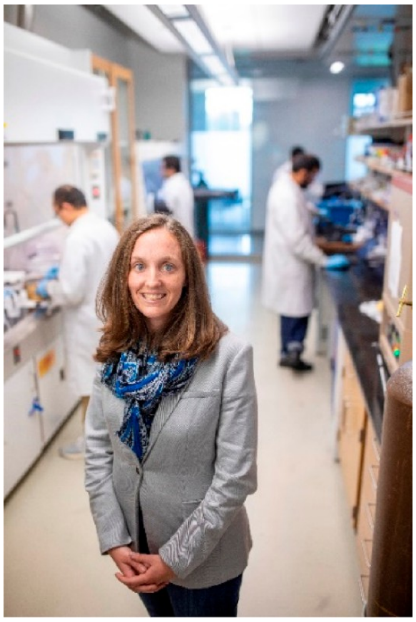
As a child, I spent a considerable amount of time around the lakes and penstocks of hydro power plants as my father worked for a company that generated and supplied electrical power to the city of Mumbai, India. Thus, energy, as a subject, was always central to my being. During my undergraduate years, I explored research opportunities in solar, wind, and fusion energy, and while at the World Renewable Energy Congress in 2013, I realized the importance of storage of clean energy to bridge the temporal and geographic gap between production and use. With a background in mechanical engineering that involved the study of turbines and engines, I took on the challenge of working in the field of electrochemical energy conversion and storage in Professor Yang Shao-Horn's group at MIT. Although the learning curve was steep, I persevered and found myself consumed with trying to understand the atomic level details of electrocatalytic reactions. We are specifically very excited about aqueous electrochemical reactions to produce energy carriers such as hydrogen from water, which is an Earth-abundant resource. Using a range of experimental and theoretical tools, we have attempted to break down every fundamental aspect of the reaction mechanisms occurring at the electrified solid−liquid interface and then design catalysts that can increase the kinetics of these reactions. Chemical reactions often dictate the way life progresses in the universe. All the complexities that we experience in the universe can be fundamentally understood by deciphering reactions at the atomic level. It is thus my belief that we can also solve the mammoth terawatt-scale energy challenge by controlling chemical reactions at the atomic scale.

Reshma R. Rao Postdoctoral Researcher

■ EFFECT OF PORE CONNECTIVITY ON Li DENDRITE PROPAGATION WITHIN LLZO ELECTROLYTES OBSERVED WITH SYNCHROTRON X-RAY TOMOGRAPHY

Fengyu Shen, Marm B. Dixit, Xianghui Xiao, Kelsey B. Hatzell

ACS Energy Letters, **2018**, 3 (4), 1056−1061 (Letter)
DOI: 10.1021/acsenergylett.8b00249



Kelsey B. Hatzell, group leader of inks and interfaces research group at Vanderbilt University. Photo courtesy: Kelsey Hatzell

As an undergraduate I studied engineering and economics and was fascinated by how we price natural resources, electricity markets, and sustainability. Thus, when I was pursuing a Ph.D.

program, electrochemical energy storage was a topic that combined all of my interests. Between my masters and Ph.D. I switched from mechanical engineering (control theory) to material science (energy storage materials). This required learning a whole new field. At the time it was challenging, but my current research approach draws upon my collective experiences; thus, I think it ended up providing me with an interesting viewon the energy sciences.

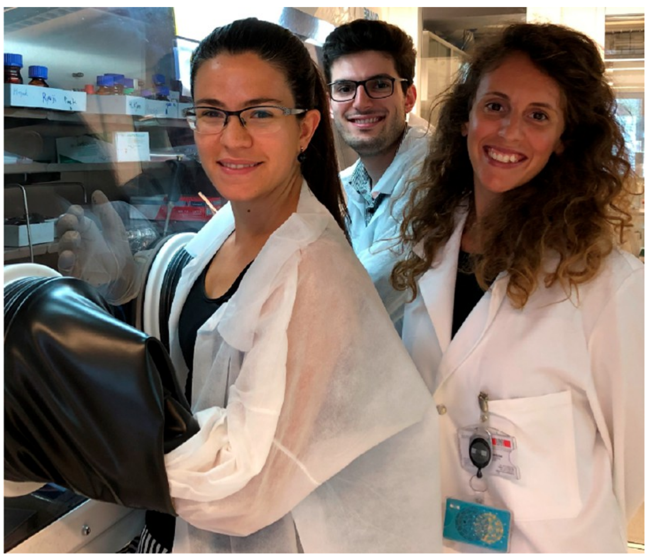
When I started my independent research group three years, I got really excited about the challenges and opportunities with solid-state batteries. Now, my group has a fairly large focus on addressing both fundamental and applied challenges associated with solid-state batteries. My research group does a lot of experimentation at synchrotrons, and no matter how much you prepare, you almost always have to change things up at the beamline. So I'd say we have had a lot of aha(!) moments at 2 am at the beamline! My simple advice is to be optimistic; research progress is built on a lot of failure, and if you never give up, you will always succeed.

Kelsey B. Hatzell Assistant Professor of Mechanical Engineering and Chemical and Biomolecular Engineering

HYSTERESIS-FREE LEAD-FREE DOUBLE-PEROVSKITE SOLAR CELLS BY INTERFACE ENGINEERING

Martina Pantaler, Kyung Taek Cho, Valentin I. E. Queloz, Inés García Benito, Christian Fettkenhauer, Irina Anusca, Mohammad Khaja Nazeeruddin, Doru C. Lupascu, Giulia Grancini

ACS Energy Letters, **2018**, 3 (8), 1781−1786 (Letter)
DOI: 10.1021/acsenergylett.8b00871



Drs. Ines Garcia Benito, Valentino Romano, Giulia Grancini (left to right). Photo courtesy: Giulia Grancini

It was back in the *before-Perovskite age*, early 2010, when I was a vising Ph.D. student in the Henry Snaith Lab in Oxford where I discovered the beauty behind the art of making solar cells. I was amazed when I realized the world record for hybrid polymer/oxide solar cells—at that time, that was the main research topic of the lab—of 1.2%! The satisfaction in making a working device with a real impact, while discovering the fascinated dynamics behind the light to current conversion mechanism, was simply great. I felt there was an opportunity to do more! The interest in the energy field completely overtook me, providing a clear direction on what I wanted to do in my research. That was only the start. Then, the *Perovskite age* came and thrilled me. I still remember the first time I made my perovskite film with my friend Mike Lee and his words: "*This material is crazy, turning black from yellow...*". From that time my passion for solar energy boomed; I worked with the top-notch world leaders in the perovskite field, from IIT, to EPFL, and now back to Italy with my *PVsquared2* team at UniPV. With my *ERC project HYNANO* I aim to develop a new understanding behind new hybrid perovskites materials and tackle the actual challenge to boost solar cell stability. The field is amazing, and the enthusiasm for it that I transfer to my students (as they tell me) is vital. But science is much more than this. It is meeting incredible female scientists who inspired me, building strong relations, pushing myself beyond my comfort zone (it is a struggle, but it is also the best place to learn), and transferring the knowledge to young people. I'm indeed most proud of my work when I see my students shining. To them I keep saying: stay strong and use your voice, build your network of supportive people and find examples, embrace your passion, be fully human, love what you do and be happy!

Giulia Grancini Associate Professor in Physical Chemistry

H_2 EVOLUTION WITH COVALENT ORGANIC FRAMEWORK PHOTOCATALYSTS

Tanmay Banerjee, Kerstin Gottschling, Gökcen Savasci, Christian Ochsenfeld, Bettina V. Lotsch

ACS Energy Letters, **2018**, 3 (2), 400−409 (Perspective)
DOI: 10.1021/acsenergylett.7b01123

Bettina Lotsch. Photo courtesy: Bettina Lotsch

My entry into energy research goes hand in hand with my fascination for materials and the perspective to rationally design them, atom by atom.

If we can design materials with such a level of perfection, why cannot we teach them new tricks that can really make a difference, all the way to saving the planet? Energy research provides an exceptionally fertile ground for bringing together fundamental materials research and potentially game-changing applications, without having to sacrifice either of the two.

A major challenge in some of the rapidly evolving fields of energy research is the fact that material performance indicators are often reported without standardization, and documented best practice approaches are scarce. As a community, we need to work hard on further improving our measurement and reporting standards to make energy science more robust and reliable.

I am excited by our recent progress in merging different fields of energy research to stimulate hybrid concepts like "dark photocatalysis" and solar batteries. Intriguingly, earth-abundant materials such as covalent organic frameworks and carbon nitrides are ideal platforms to study such concepts, which in the long run could help transform them into economically viable energy technologies.

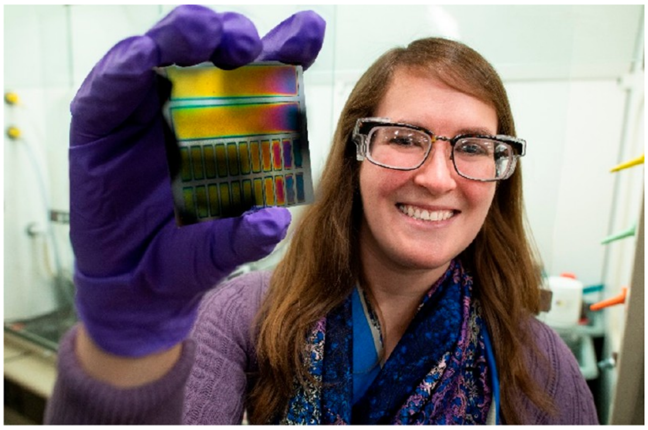
Finally, here's my advice to young researchers: Max Planckwas convinced that "Insight must precede application". This is a statement that today is more important than ever. Young scientists should be encouraged to follow this path and at the same time be receptive to societal needs and innovation.

Bettina Lotsch Professor of Chemistry

■ LOW-COST APPROACHES TO III–V SEMICONDUCTOR GROWTH FOR PHOTOVOLTAIC APPLICATIONS

Ann L. Greenaway, Jason W. Boucher, Sebastian Z. Oener, Christopher J. Funch, Shannon W. Boettcher

ACS Energy Letters, **2017**, 2 (10), 2270–2282 (Review)
DOI: 10.1021/acsenergylett.7b00633



Ann Greenaway holds a combinatorial nitride sample at NREL. Photo courtesy: NREL (https://images.nrel.gov)

I always loved science, but as I started college and realized I cared deeply about public service, I was not sure how to make a difference in people's lives as a scientist. Then I spent a summer at the National Renewable Energy Laboratory as a Science Undergraduate Laboratory Intern. Learning about the lab and seeing other scientists' shared passion for the work showed me I could definitely make a difference pushing renewable energy forward. My experience during that internship is what made me want to go to graduate school and eventually brought me full circle to a postdoc at NREL.

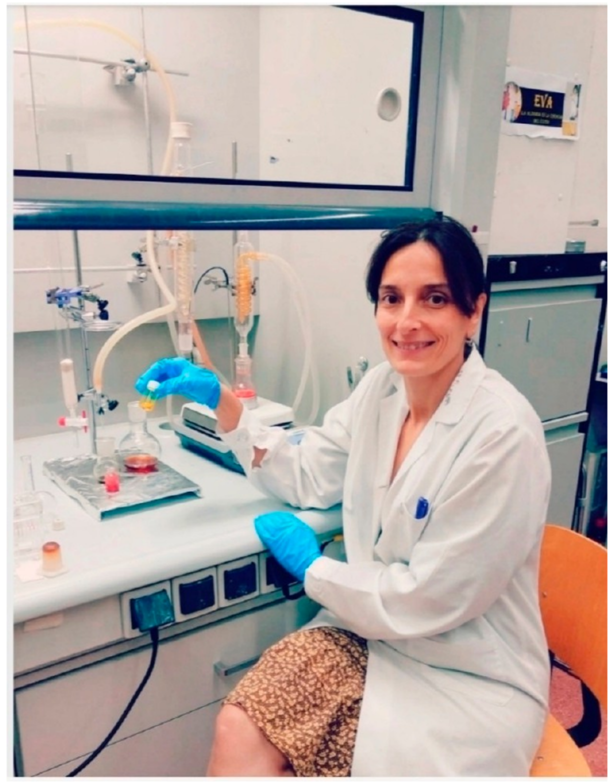
There is a huge world of scientific opportunity out there, and what I most want younger researchers to know is that they can make a contribution in a million different ways. In college and graduate school it can feel like you are aiming at a very narrow definition of success, but there are numerous ways to contribute to the advancement of energy research. If there is a scientific problem that you feel needs to be answered, do not be afraid to dig into it—we need all the help we can get finding new sources of energy and methods for storage and improving energy efficiency.

Ann Greenaway Director's Postdoctoral Research Fellow

■ SIMPLE DONOR–ACCEPTOR LUMINOGEN BASED ON AN AZAINDOLE DERIVATIVE AS SOLID-STATE EMITTER FOR ORGANIC LIGHT-EMITTING DEVICES

Cristina Martin, Carlos Borreguero, Koen Kennes, Mark Van der Auweraer, J. Hofkens. Gustavo de Miguel, Eva M. García-Frutos

ACS Energy Letters, **2017**, 2 (12), 2653–2658 (Letter)
DOI: 10.1021/acsenergylett.7b00910



Woman researcher working toward the future of organic electronic devices. Photo courtesy: Natalia de la Torre Gordo

I got my position as a Tenured Scientist at the Institute of Materials Science of Aragon (ICMA) CSIC in 2009. To get to Zaragoza from Madrid, where the ICMA is located, you have to pass through "La Muela", a small town full of windmills for electric power production. At that time, a great idea emerged in my mind: to develop devices with a less rigid structure and that were biodegradable, in order to have renewable energy in our houses, with less visual impact on the landscape. This was the beginning of the idea for the first project I was granted, framed in the preparation of new materials for flexible organic electronic devices. Some years later, I wondered why we were working on such complicated materials and molecules, when these could be simpler and, therefore, possess easier transferability. Thus, I began to design simple organic molecules to be applied to my research line. Nevertheless, it was not until one afternoon in July, when I was removing solvent from a vial with one of those simplified compounds, when my lab partner told me "it looks like a gel", that was indeed the beginning of a whole line of research focused on OLEDs, which resulted in several scientific papers (*Langmuir* **2015**, *31*, 8697; *ACS Energy Lett.* **2017**, *2*, 2653; *Adv. Funct. Mater.* **2017**, 1702176). Now, and since 2014, I am in a research group that works on biodegradable materials at the Institute of Materials Science of Madrid (ICMM) CSIC, working with great enthusiasm on new eco-friendly and flexible materials in the area of organic electronics, which will take us closer to a more sustainable energy future.

Eva M. García-Frutos Tenured Scientist

■ IMAGING ENERGY HARVESTING AND STORAGE SYSTEMS AT THE NANOSCALE

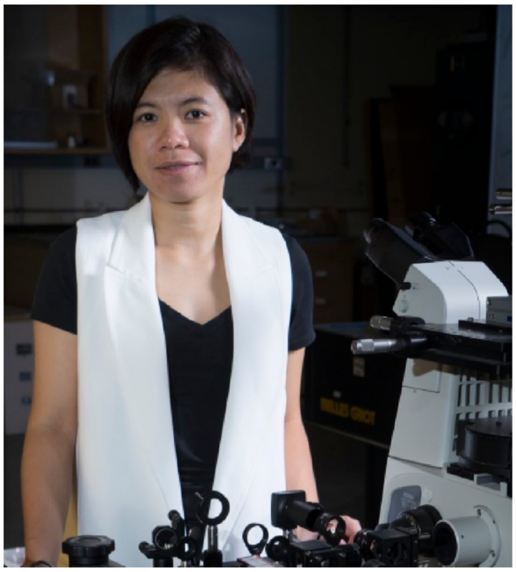
Elizabeth M. Tennyson, Chen Gong, Marina S. Leite

ACS Energy Letters, **2017**, 2 (12), 2761–2777 (Review)
DOI: 10.1021/acsenergylett.7b00944

Marina Leite. Photo courtesy: Reeta Asmai, UC Davis

I started working with functional materials for renewable energy in 2008, when I joined Harry Atwater's group at Caltech as a post-doctoral scholar. Since then, I have worked with a variety of systems, ranging from perovskite and multijunction solar cells to all-solid-state batteries (*ACS Appl. Materials & Interfaces* and *Nano Letters*) and metallic alloys for electrocatalysis (*Accounts of Chemical Research*, *ACS Photonics*, and *ACS Appl. Materials & Interfaces*). In my first year as an assistant professor I realized that the scientific community working with inhomogeneous materials for photovoltaics needed a tool to spatially resolve the open-circuit voltage (V_{oc}) of devices, which is known for being the primary limiting factor for high-efficiency solar cells. Thus, my group implemented an atomic force microscopy universal method to locally map V_{oc}, enabling the visualization of physical processes at the nanoscale. For halide perovskite devices for light-absorbing and -emitting applications, we have been able to track, in real-time and at the nanoscale, ion motion within these materials (*ACS Energy Letters*, *Nano Letters*, and *ACS Nano*). We have recently expanded our expertise in scanning probe microscopy to tackle the dynamic electrical/optical behavior of perovskites that can lead to device degradation (*J. Physical Chemical Letters* and *Chemistry of Materials*). Now, we are eager to apply machine learning methods to help elucidate device "rest" conditions needed to achieve material "recovery", critical for reliable power generation conversion. Overall, I cannot wait to see the additional progress that will take place in the next 10 years concerning advanced materials for renewable energy!

Marina Leite Associate Professor of Materials Science and Engineering; EAB, *ACS Energy Letters*; Associate Professor



Libai Huang. Photo courtesy: Purdue

I remember distinctly how inspiring it was to see the atomic force microscopy images of the purple bacterial photosynthetic membranes for the first time. The light-harvesting complexes 1 and 2 form rings of around 10 nm in diameter and arrange in beautiful patterns in the natural membranes. The spatial arrangement of these light-harvesting complexes was thought to be critical for the remarkably efficient energy flow in photosynthesis; however, fundamental understanding has been hindered by the lack of spatial resolution in energy-transfer measurements. Seeing these images has inspired me to develop ultrafast microscopy to visualize how energy migrates in space and in time. We discovered quite a few surprises when we started to exam the motion of charge carriers and excitons with femtosecond time resolution and nanometer spatial resolution. One such surprise is that triplet excitons move orders of magnitude faster than they should in singlet fission materials. We finally were able to conclude that the enhanced transport was due to the interconversion between singlet and triplet population that allowed triplets to migrate as a singlet for a certain period of time. A question driving a lot our thinking currently is the competition between quantum coherence and disorder and how such competition can be utilized to control energy transport. Finally, I would like to relay advice that I got from Santiago Ramón y Cajal in his book *Advice for a Young Investigator*, "Problems that appear small are large problems that are not understood."

Libai Huang Senior Editor, *Journal of Physical Chemistry A/B/C*; Associate Professor of Chemistry

■ ULTRAFAST IMAGING OF CARRIER TRANSPORT ACROSS GRAIN BOUNDARIES IN HYBRID PEROVSKITE THIN FILMS

Jordan M. Snaider, Zhi Guo, Ti Wang, Mengjin Yang, Long Yuan, Kai Zhu, Libai Huang

ACS Energy Letters, **2018**, 3 (6), 1402−1408 (Letter)

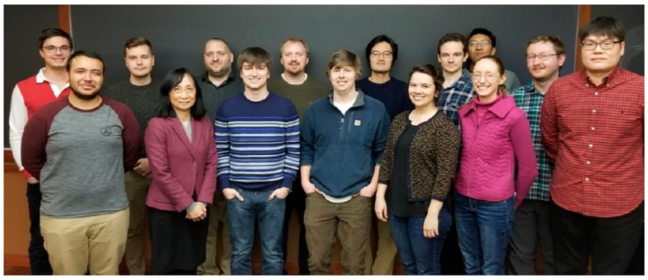
DOI: 10.1021/acsenergylett.8b00560

■ ENHANCED LIGHT ABSORPTION IN FLUORINATED TERNARY SMALL-MOLECULE PHOTOVOLTAICS

Nicholas D. Eastham, Alexander S. Dudnik, Boris Harutyunyan, Thomas J. Aldrich, Matthew J. Leonardi, Eric F. Manley, Melanie R. Butler, Tobias Harschneck, Mark A. Ratner, Lin X. Chen, Michael J. Bedzyk, Ferdinand S. Melkonyan, Antonio Facchetti, Robert P. H. Chang, Tobin J. Marks

ACS Energy Letters, **2017**, 2 (7), 1690−1697 (Letter)

DOI: 10.1021/acsenergylett.7b00486



Lin Chen with group members (from left: Adam Nijhawan, Waleed Helweh, Denis Leshchev, Lin Chen, Michael Mara, Nick Weingartz, Austin Spencer, Nate Flanders, Pyosang Kim, Emily Sprague-Klein, Bros Kramer, Ariel Leonard, Darren Hsu, Dillon Edwards, and Tae Wu Kim (Courtesy of Jonathan Maendel, Northwestern University).

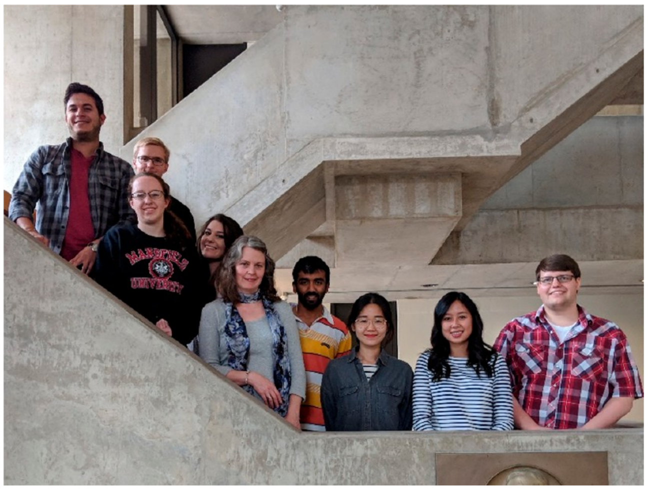
Light−matter interactions are always fascinating topics to me as someone who is interested in studying chemical systems with advanced physical methods. On one hand, the response of matter to light, from THz to X-ray, the range that I have dealt with in my career, enables numerous ways to detect physical and chemical phenomena through various spectroscopic measurements. On the other hand, these responses also indicate light energy conversion for other useful energy sources. I have been inspired by the opportunities emerging from both aspects. One of the eureka moments from the first aspect was the time when I first observed the evidence of molecular structural changes in the excited-state transition metal complexes directly measured by the extended X-ray absorption fine structure (EXAFS) via a laser-pulse pump and X-ray-pulse probe method at the Advanced Photon Source more than two decades ago. Since then, the ultrafast X-ray structural methods advanced significantly with the efforts of many scientists and engineers who build advanced light sources around the world. The other exciting aspect of my research is applying what we have learned in fundamental photophysics of conjugated polymers to interpret phenomena in organic photovoltaics using ultrafast optical spectroscopy and in situ grazing incident X-ray scattering, which consequently provides feedback to materials synthesis. The work to some extent fills a gap of knowledge between materials synthesis and device fabrication. It is important and rewarding to connect solar energy conversion processes in various media, such as photocatalysis and photovoltaics, with fundamental knowledge in light−matter interactions. Laser spectroscopies are perfect means to enhance our understanding of physical phenomena as well as finding solutions for practical issues in the light conversion. I am grateful for years of collaboration with my colleagues, postdocs, and students (the current research group in Northwestern University is featured in the photo) who have made significant contributions in energy research.

Lin X. Chen Senior Editor, *ACS Energy Letters*; Professor of Chemistry

■ ENGINEERED ENZYMES AND BIOINSPIRED CATALYSTS FOR ENERGY CONVERSION

Jennifer M. Le, Kara L. Bren

ACS Energy Letters, **2019**, *4* (9), 2168−2180 (Perspective)
DOI: 10.1021/acsenergylett.9b01308



Bren group at the University of Rochester. Photo courtesy: Georgios Alachouzos

I've focused my career in the areas of bioinorganic and biophysical chemistry of metalloproteins. The proteins we have worked with the most are cytochromes, which perform a range of functions, but much of our early work focused on gaining a fundamental understanding of relationships between molecular structure and dynamics, electronic structure, and electron transfer function. As these proteins participate in biological energy conversion, there was a natural progression toward thinking about engineering them to play alternative roles in energy conversion. I have been fortunate to interact with colleagues at Rochester with interests in energy science, especially Rich Eisenberg. In learning about the kinds of systems that Rich worked with for photochemical hydrogen production, we came to realize that the active sites of the proteins that we study, as well as other bioinorganic metal-binding motifs, have metal coordination environments closely resembling those of known hydrogen evolution catalysts. At the same time, these metallobiomolecules have additional attractive features, including water solubility and the provision of a tunable active-site microenvironment, that may affect activity. We were delighted to find that these systems derived from and inspired by cytochromes as well as other metalloproteins were active as artificial hydrogenases in electrochemical and photochemical systems. We have identified other energy-related catalytic activities of these systems such as nitrate reduction to hydroxylamine and ammonium. What I learned through this experience is that taking a leap into a new area is possible with brave, talented, and motivated students and postdocs and supportive colleagues.

Kara L. Bren Associate Editor, *Journal of the American Chemical Society*; Professor of Chemistry

■ ADDRESSING THE INTERFACIAL PROPERTIES FOR CO ELECTROREDUCTION ON CU WITH CYCLIC VOLTAMMETRY

Paula Sebastián-Pascual, María Escudero-Escribano

ACS Energy Letters, **2020**, *5* (1), 130−135 (Viewpoint)
DOI: 10.1021/acsenergylett.9b02456

Left to right: Kim D. Jensen, Inês J. Pereira, María Escudero-Escribano, Bethan J.V. Davies, José Alejandro Arminio-Ravelo, Paula Sebastián-Pascual, and Anders W. Jensen during 2019's group retreat in Padua (Italy). Photo courtesy: María Escudero-Escribano

When I was a chemical engineering undergraduate student, my dream was to become a scientist. I was inspired to engage in energy research when, during my Ph.D., I did a research stay at Argonne National Laboratory; I then got more familiar with energy conversion and, in particular, with a reaction that is now very close to my heart: the oxygen reduction reaction. As a postdoctoral researcher at the Technical University of Denmark and Stanford University, I investigated novel electrocatalysts for renewable energy conversion devices such as fuel cells and water electrolyzers. Given the urgent need to replace fossil fuels by renewable sources, electrochemistry is expected to play an essential role in decarbonizing the transportation, electricity, and industrial sectors in the next couple of decades. Currently, my research group investigates tailored electrochemical interfaces for energy and sustainability, aiming to help accelerate this decarbonization. Having built this international, multidisciplinary, and diverse group of highly motivated researchers who support each other greatly cannot be more rewarding. Our main projects aim to investigate electrocatalysts for renewable energy, conversion of greenhouse gases into green fuels and chemicals, as well as developing electrosynthesis routes to produce value-added chemicals. These routes could allow us to transition toward a sustainable chemical industry based on renewable electricity. I am particularly interested in getting a mechanistic understanding and tuning the selectivity of "dream" electrochemical reactions by tailoring the structure of the electrocatalyst at the atomic and molecular levels. My advice to newcomers in the field, including the next generation of women in energy, is do not fear the journey, do not be discouraged by anyone who tells you that your dreams are not possible, and pursue your passion regardless of the obstacles that you will find along the way.

María Escudero-Escribano Assistant Professor of Chemistry

Constance M. Biegel, Coordinating Editor, *ACS Energy Letters*
Prashant V. Kamat, Editor-in-Chief, *ACS Energy Letters* orcid.org/0000-0002-2465-6819

AUTHOR INFORMATION

Complete contact information is available at:
https://pubs.acs.org/10.1021/acsenergylett.0c00083

Notes

Views expressed in this Energy Focus are those of the authors and not necessarily the views of the ACS.

The authors declare no competing financial interest.