Department of Chemistry

Fumes from the Hood

Summer 2016

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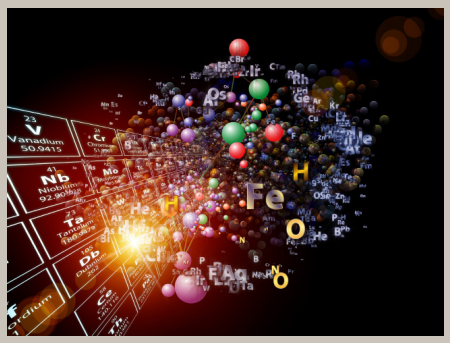


Visualization of Chemical Elements
by: agsandrew

Expanded stories available online:
blogs.oregonstate.edu/erlenmeyer

MESSAGE FROM THE CHAIR

Dear Alumni and Friends,

Summer 2016 is already here and OSU Chemistry continues to be full of energy and excitement. This past spring, we had our largest graduating class of undergraduates in our history – over 50 BS Chemistry degrees were awarded from our Department (Pg 23)! This is a testament to dedication of our amazing faculty and staff as well as the unique draw that our Department's mission has for students. Not surprisingly, our amazing Undergrads of the Quarter (Pg 6) and our other student awardees (Pg 17) continue to inspire us.

This Summer 2016 edition of Fumes from the Hood starts a thematic series of issues for our newsletter. The theme of this first newsletter is "Innovation" – a fitting focus area given our Department's long and successful track record in this area. OSU Chemistry impacts our daily lives from the microprocessors that run our devices (**Doug Keszler** & Inpria - pg 4) to medications you take (**Rich Carter** & Valliscor – Pg 8) and even the colors themselves (**Mas Subramanian** & YInMn Blue – Pg 12). Our history in innovation can be seen throughout the history of our Department from our most senior faculty member **Ken Hedberg** (Pg 5) to our NSF-supported Center for Substainable Materials Chemistry (CSMC - pg 9). Our faculty and students discover new elements (**Walt Loveland**), help protect our environment (**Staci Simonich**), develop new battery technology (**David Ji** – Pg 10), create low cost tools to test for disease (**Vince Remcho** – Page 9) and improve the nuclear fuel cycle (**May Nyman**). Our Department pioneered Chemistry online education nearly 15 years ago (Pg 18) and continues to innovate in developing new tools to educate the world including integrating innovation and professional development training into graduate education.

Thank you for your continued support of OSU Chemistry. We always want to hear from you and welcome you to return to visit our Department. It is always great to see our alumni on campus. During our annual Chemistry Is Awesome (CIA) event this past June, we were thrilled to have a very special alum join us – Dr. **John Stephensen** ('60). John came back to visit OSU for the CIA event because he actually worked for the real CIA (Pg 22). We hope to see you on campus or hear from you soon!

All the best,
Rich

WHERE ACADEMIA MEETS BUSINESS: START-UPS OF THE CHEM DEPARTMENT

Inpria - Doug Keszler

For decades the semiconductor industry has produced ever faster, smaller and cheaper chips to power the electronics that change our lives and world. Semiconductor chips are smaller and cheaper thanks to advances in photolithography or semiconductor patterning. These advances allow manufacturers to pack more transistors into a given area, a trend often referred to as Moore's Law. Inpria Corporation, a 2007 spin-out from the OSU Department of Chemistry, is developing inorganic photoresists to extend Moore's Law and support semiconductor chip manufacturers as they move to the next generation of patterning technology, known as Extreme Ultraviolet Lithography (EUV.)

Photoresists are photo-reactive chemicals that can turn a light image into a physical pattern on a silicon wafer. You can think of this process as similar to old-fashioned photography, except the pattern is recorded in a 3-d fashion, leaving behind a physical stencil.

Over the past few decades, many equipment and process advances have enabled manufactures to record and transfer these ever-smaller patterns. However, photoresist fundamentals have not changed very much in the past 25 years. They are still predominately based on the same class of organic (carbon-based) compounds known as Chemically Amplified Resists. This platform and approach has already been refined and optimized many, many times over the years, and these conventional photoresists are rapidly reaching fundamental limits; Their molecular building blocks are simply too big to meet upcoming the patterning requirements.

Using a unique inorganic (metals-based) approach, Inpria Corporation is developing photoresists based on much smaller molecular buildings blocks. While conventional material molecules average ~5nm in diameter, Inpria's molecular building blocks are merely 1nm wide. Furthermore, Inpria's materials are designed specifically to absorb the new 13.5nm wavelength of laser light, which is critical given the reduced number of available EUV photons as compared to 193nm (the most recent generation of lithography.) Inadequate photon capture leads to "grainy" patterns (similar to low-light photography) and insufficient and error –prone pattern transfer during the subsequent semiconductor manufacturing process steps.

While Inpria's headquarters is still based here in Corvallis - and quite close to it's OSU "birthplace" - the company is truly global in nature with active engagements on three continents. With strong investor and partner support across the semiconductor value chain, Inpria appears well positioned to leave a long-term impact and mark on the global semiconductor industry.

Lens of the Market - Judy Giordan

OSU Chemistry knows that for chemistry students to be successful chemists in the 21st century requires more than solely educating them in chemistry. 21st century chemistry and all scientific careers require both knowing chemistry and knowing how to ensure chemistry can address global challenges in health, food, energy and water. Led by the National Science Foundation Center for Sustainable Materials Chemistry Principal Investigator and Distinguished Professor **Douglas Keszler**, and now with the support of a National Science Foundation Innovations in Graduate Education grant, led by OSU Chemistry Chair Professor **Rich Carter**, noted organic chemist and successful venture founder, OSU Chemistry in conjunction with ecosVC, Inc and their the Lens of the Market (LoM) program is leading the nation in training chemistry – and other STEM graduate students and post docs – in the skills to link their research with market analytics, business acumen

Start-ups of the Chem Dept, continued on page 8

KEN HEDBERG: A Q&A WITH CHEMISTRY'S OLDEST INNOVATOR

by: Luanne Johnson

It's February 2, 1920; Walt Disney's career is just beginning to take off, Babe Ruth is setting world records, treaties are being signed in Russia and in Portland, OR, Ken Hedberg is making his first appearance into the world. 20 years later, he attended Southern Oregon Normal (now Southern Oregon University) for two whole terms before transfering to Oregon State College (now OSU) in the fall of 1939. He graduated with a Bachelor of Science degree in December 1943. He then attended the California Institute of Technology (Caltech) where he obtained his PhD in Chemistry and Physics in June 1948.

I recently sat down with Dr. Hedberg to ask him some questions about what it's like to be a scientist at the ripe old age of 96, how he got started, and what wisdom he'd like to pass to students and junior faculty.

LJ: How long have you been practicing chemistry, Ken?

KH: As a professional, i.e. non-student, since January 1943.

LJ: You built your own scientific apparatus. When did you decide that was something you needed to do?

KH: When I accepted the job at Oregon State in the summer of 1955. I arrived to begin teaching in January of 1956. I began construction almost immediately.

LJ: And how long did it take you to build it?

KH: Too damned long. I started in Jan. 1956 and it must have been 1962 when I first got usable data.

LJ: What exactly does the apparatus do? In layman's terms for us non-scientists.

KH: When one tosses a stone into a pond, waves originate from the impact point. These die out, of course, but if one tossed a series of stone into the pond such that they all entered at the same spot, one would get a series of waves. If one were to take a picture the resulting waves would be frozen in time. My apparatus does something similar. The stones are a beam of electrons and the pond is a small cloud of molecules in the gaseous state. The electrons bounce off the molecules in such a manner to form waves. The apparatus makes a photograph of the wave pattern, a pattern which can be analyzed to reveal how the atoms in the molecule are put together—a three-dimensional structure of the molecule, that is.

LJ: I heard yours was the first such apparatus. Is this true? And how many others are there like it in the world?

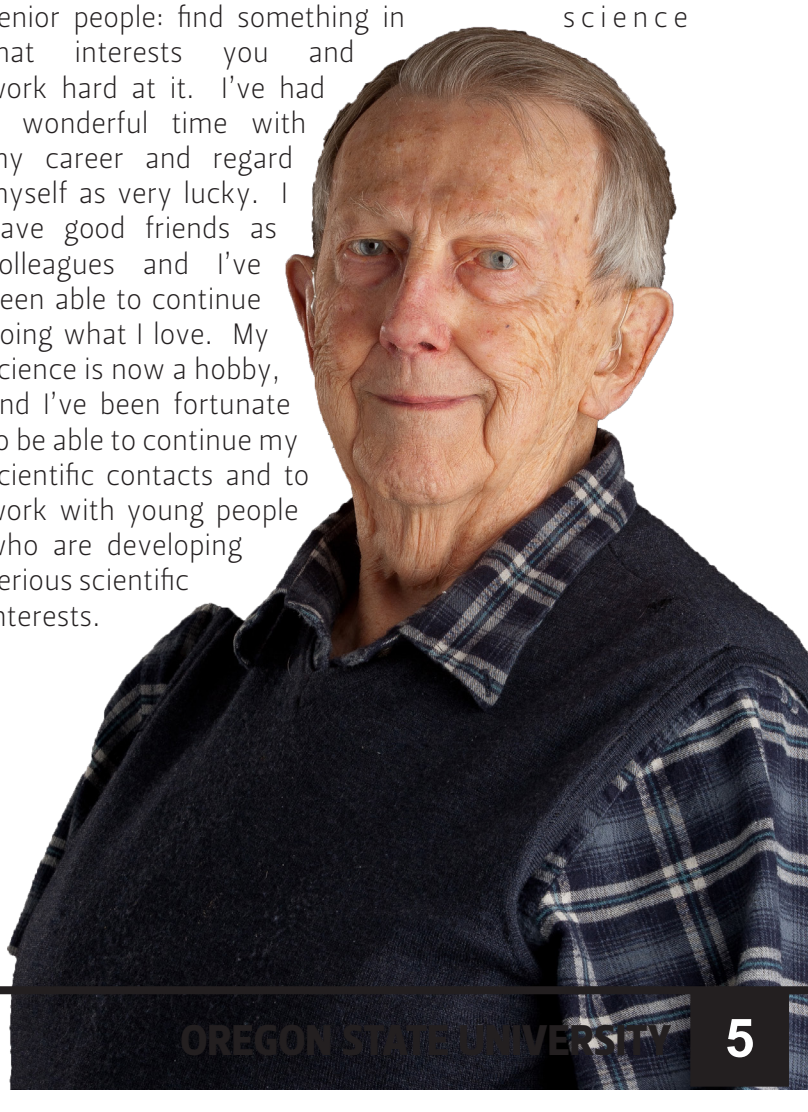
KH: No, my apparatus was not the first. The first photograph was made by a German named Wierl in the early 1930's. At one time there were perhaps a dozen apparatuses, all but a few are now gone. The remaining ones are in Russia and Kazakhstan. Mine is the only one left in the United States dedicated to molecular structure determination. At one time there were 4-5 in the U.S. Also, there was at least one apparatus in Scotland, Germany, Holland, and Japan.

LJ: Do you consider what you did (i.e. building your own device, etc) innovative?

KH: If there is any innovation to what I do, it is the types of molecules (i.e., problems) that I tackle.

LJ: Do you have any advice for young scientists looking to be as innovative as you?

KH: Luanne, if I have any advice for young scientists, it is surely similar to what I've read from other senior people: find something in science that interests you and work hard at it. I've had a wonderful time with my career and regard myself as very lucky. I have good friends as colleagues and I've been able to continue doing what I love. My science is now a hobby, and I've been fortunate to be able to continue my scientific contacts and to work with young people who are developing serious scientific interests.



Johnny Hergert - Fall 2015 Undergraduate of the Quarter

"I like the details and problem solving, particularly on the small scale. And how applicable to daily life it is," he replied when asked why he chose chemistry. He also stated that CH 361 and 362 were his favorite classes because, "the integrated labs are so hands on, and I really liked that." His favorite instructor so far has been Dr. **Christine Pastorek**, the integrated lab instructor.

Since Johnny is on the Materials Science track of the Chemistry program, it was only natural he started doing research in Prof. **John Simonsen**'s lab. During the spring of 2014, Johnny started working on cellulose nanocrystals and polymer composites. More recently, he's begun 3D printing objects to help with the experiments. He says his favorite research topic, though, is renewable materials.

Upon graduation, Johnny will attend graduate school at the University of Colorado, Boulder where he plans to obtain a PhD in Materials Science. He hasn't decided yet whether that PhD will take him to academia or industry, but we wish him the best of luck either way.

In his spare time, Johnny is a member of Sigma Phi Epsilon, an experience has says has had a huge impact on his life. He also enjoys hiking, mountain biking and intramural sports.

It is students like Johnny who make us proud to be teaching the next generation of chemists.

Kenneth Stout - Fall 2015 Undergraduate of the Quarter

Kenneth's decision to attend OSU was partially based on cost, but he was also swayed by the fact that he had family in Washington and Oregon and that OSU accepted his high school AP credits.

Kenneth is currently a junior, dual majoring in Chemistry and Chemical Engineering. He finds both of these complementary subjects to be interesting and enjoys the academic challenges they pose.

His favorite class at OSU has been CH 471 – Advanced Organic Chemistry with Prof. **Chris Beaudry**. It was this class that made him get involved with research and he's been working in Dr. Beaudry's lab ever since. He says, "taking this class got me really interested in Organic Chemistry. It's motivated me to take more Organic classes."

Outside academics, Kenneth says he's been inundated with opportunities to get involved with campus life. He says his favorite memories are working for a year as a Resident Assistant and spending time in the campus craft center. He says he appreciates that everything at OSU is so accessible.

Upon graduation, Kenneth plans on attending Graduate School and studying more Organic Chemistry. He's considering post graduate work in either academia or a biotech company, but he says, "it's early and I'm keeping my options open."

Blake Erickson - Winter 2016 Undergraduate of the Quarter

Blake said he didn't even consider an out-of-state school because it would have been too costly, but was lucky to have such a great research university here in the state of Oregon. Upon arriving at OSU, Blake cycled through Biology and then Biochemistry/Biophysics before deciding on Chemistry as his major. Blake commented how much he enjoyed the organic chemistry sequence with Profs. **Chris Beaudry**, **Kevin Gable** and **Dwight Weller**, but it was the experimental labs with Dr. **Christine Pastorek** and **Emile Firpo** that really sealed his decision to be a Chem major.

Blake has shown tremendous breadth in chemical interest. His favorite course so far was the second term of Physical Chemistry with Prof. **Chong Fang** where they studied Quantum Chemistry. He liked it so much he took it twice, once as a student and once as an undergraduate teaching assistant.

He is currently doing undergraduate research with Prof. **Joe Nibler** exploring the vibrational/rotational structure of perdeutero-spiropentane. They have just submitted earlier this year their first paper specifically on the ground vib/rot structure of the molecule and are currently working on analysis of some more of the upper states.

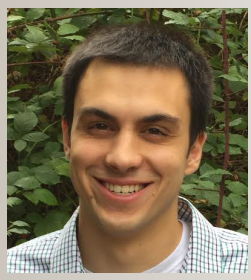
Graduate School is definitely in Blake's future, as he's already been accepted to UC Berkeley's Chemistry graduate program. He's leaning toward academia upon getting his PhD because he loves research, but also has enjoyed teaching others about chemistry, so it will be a good balance for him.

In his spare time at OSU, Blake was also a member of the OSU Marching Band where he got to perform at a variety of sports events.

Students like Blake are the

reason the Chemistry Department is so successful in educating future scientists. Congratulations, Blake!

Marshall Allen - Winter 2016 Undergraduate of the Quarter



Marshall reported that he debated between OSU and Cal-Tech. However when OSU offered him the Presidential Scholarship as well as his admittance to the Honors College, he decision became pretty clear. When Marshall arrived at OSU, he was originally a chemical engineering major. After speaking with Chief Chemistry Advisor, Dr. **Christine Pastorek** at a START session, he shifted his focus to a dual degree in Chemical Engineering and Chemistry.

Marshall took Organic Chemistry as a freshman which he loved. He remembers his other classes being mainly filler; leaving a greater amount of time to focus on chemistry. Then, his sophomore year, he took Advanced Organic Chemistry (CH 471) from Prof. **Chris Beaudry**. The next year, Marshall also took Spectroscopy (CH 435) from Prof. **Sandra Loesgen** - a class he says was hands down, his favorite.

When asked about his favorite teacher, Marshall replied that it had to be Prof. Chris Beaudry. Since attending his class freshman year and well as performing undergraduate research in his lab, Prof. Beaudry has become as much a mentor as a teacher to him.

Marshall is currently completing an internship at Maxim Integrated in Portland.

After his internship and completing his BS degree from OSU in chemistry, his plan is definitely to continue on to graduate school. Prior to his internship, his focus was on obtaining a job in academia, but his internship experience has opened him up to new horizons.

We're so proud to have students like Marshall Allen in our department and are looking forward to seeing all he will accomplish.

Shannon Davis - Spring 2016 Undergraduate of the Quarter

Shannon came to OSU because she wanted to attend a PAC-12 school, and with her choices being OSU and UW. She wanted something a little smaller and a little farther from home, so OSU was the obvious choice. "Plus," she said, "my dad went here." She originally matriculated into Chemistry with a chemical engineering option, but quickly discovered she liked the general chemistry sequence and switched to the advanced chemistry option.

Shannon says her favorite class has been the Experimental Chemistry series with Dr. **Christine Pastorek** and **Emile Firpo**. She also stated that they quickly became her favorite instructors.

Shannon has been doing Undergraduate Research for Prof. **Jennifer Field** since just after fall term of her junior year. She said she trained for a whole year before she was able to do actual research. Now, she's using liquid chromatography and mass spectrometry to close mass balance in soil extractions. She says it's been challenging and slower going than she thought originally.

When asked about extra-curricular activities, Shannon indicated that what she really enjoyed were the Family Science and Engineering Nights and Discovery Days. The outreach and chemistry volunteer work were a lot of fun.

Upon graduation, Shannon will be attending U Mass Boston to study marine science. She's currently unsure of what she wants to do post-PhD, but is leaning toward teaching. She does know, she's excited about moving cross-country.

Congratulations, Shannon! It is talented students like you that make OSU Chemistry such as special place.

Dang Nguyen - Spring 2016 Undergraduate of the Quarter

Dang was born in Colorado, but his parents moved to Portland when he was three-years-old, so he considers himself an Oregonian.

Being one of the best engineering schools in the country and fairly close to home, OSU quickly became the clear choice for him however, during his freshman year, everything changed. Dang commented on one of the turning points in his life, speaking of Dr. **Richard Nafshun**. "He has a teaching style that made me want to learn more about chemistry. The more chemistry I took, the more I enjoyed it; so, I switched."

Dang has been doing undergraduate research with **Maduka Ogba** in Prof. **Paul Cheong**'s lab for almost two years. He said they were working on non-classical hydrogen bonding research using computational chemistry. At the end of the academic year, they were working on a manuscript that Dang is

Undergraduate of the Quarter, continued on page 17

Start-ups of the Chem Dept, continued from page 4

and leadership skills.

LoM is a three stage training program that is demonstrated to aid in transforming excellent researchers into successful innovators: LoM helps students build skills to analyze market requirements and build innovations based on research plans that simultaneously develop transformative research while delivering potential solutions to global challenges. Student response to date has been strongly positive with students saying how they have walked in with knowledge about science and walked out with relevant and important information to become innovators who can address opportunities and societal need with their research.

Developed by Dr. **Judith Giordan**, founder of ecosVC and OSU Professor of Practice in Chemistry, LoM has trained over 500+ students in universities across the country. OSU chemistry's goal is to work with Giordan to demonstrate the power of Lens of the Market as a platform for an alternate doctoral degree program in chemistry and STEM by expanding adoption of the work within OSU and contributing to the development of OSU as the PNW's leading innovation university.

Valliscor

Founded in 2012 by Professor **Rich Carter** and Dr. **Mike Standen**, Valliscor is a smart chemical manufacturing company based in Corvallis. They make fluorinated chemicals for the pharmaceutical industry. Their lead product bromofluoromethane is the final ingredient in the manufacture of fluticasone propionate - the active ingredient in Flonase and Advair. They are now one of the world's largest manufacturer of this material - shipping to companies all over the world.

Professor **Rich Carter** has stated that he had wanted to start a chemical manufacturing business since 1991 when he was an undergraduate summer researcher at Stanford. He remembers the first time he actually verbalized the idea - the people he was talking to smiled and chuckled a bit as if saying, "Good luck, but that isn't very realistic." Turns out, they weren't far off; as people don't normal just "start" chemical manufacturing companies anymore. It is a field largely dominated by established companies.

In 2011, a local entrepreneur named Dan Whitaker gave a talk at the Chemistry Department Faculty Retreat and Rich remembers thinking to himself, "I think I can actually do it." He remembers calling Dr. **Mike Standen** whom he had known for almost a decade at that point and saying that they should start a company together. They had worked together on several projects over the years and he knew he would be a great person to do this with. They had both tossed around ideas for what would be good areas. In fact, the idea that ultimately was their bi ggest success came from Mike originally. They also couldn't have done it with their team of amazing employees - including former OSU Chemistry Postdoctoral Scholar and employee #1 **Raj Lingampally**.

Starting a business can be incredibly expensive, especially a chemical manufacturing business. The founders put some cash into Valliscor initially and they received a very helpful GAP grant from ONAMI. After that, Valliscor is what is called a "cockroach startup" which means that it is largely "self funded" by the revenues it generates. OSU has been incredibly supportive - both OCCD and the Accelerator.

Rich says he has been thrilled and amazed with how successful they have been. To go from zero to basically the leading supplier of a key ingredient in a $20B a year drug globally (fluticasone propionate) in less than 3 years of active manufacturing is not something he would have guessed they could do. They have now branched into additional products and he is so excited for our future!

When asked if he would start another business if given the chance, Rich responded, "One at a time! That said, starting a company has been one of the most amazing and rewarding experiences of my life. I am very grateful that I did it."

He had the following advice for people looking to start their own business. "Opportunity does not wait for a time that is convenient. I started Valliscor while I was Department Chair and maintaining an active research group as Professor. I would have preferred not to do that - but you can't wait around. You have to be absolutely committed to the goal. We have poured our hearts and souls (not to mention multiple all nighters) in order to get Valliscor to be successful."

"Also, nobody cares about your neat idea - the question you must answer is what problem are you solving for your customer. All too often people talk about the cool invention or their amazing idea. Yes, it is cool. Yes, it is amazing. That said, nobody is going to buy it if it is not solving a problem for them. You have to solve a problem."

Trillium Fiber Fuels, Cascade Analytical Reagents & Biochemicals, and Lasso Metrics – Vince Remcho

Trillium FiberFuels (TFF) was a cellulosic ethanol startup company. They began operations during the alternative energy craze about 8-10 years ago, and focused on feedstocks from the Willamette Valley - largely ryegrass straw. As the price of crude oil fell, the value of their products to the fuels industry dropped. The silver lining was the value of these technologies in other areas, such as production of specialty sugars for laboratory research and ethanol for human consumption, increased. Recognizing that, TFF spun off another company focused on specialty chemicals (Cascade Analytical Reagents and Biochemicals, CARB). CARB and TFF employed more than 20 different people over their existence. Both of these companies sold off their intellectual property and closed their doors about a year ago.

Professor **Vince Remcho** has since moved on to a new startup in collaboration with friends and colleagues from Veterinary Medicine and Mathematics, called Lasso Metrics. Lasso is a biodata company that focuses on devices that enable rapid, widely deployed biomarker analysis in blood and urine. These devices generate large datasets for families of biomarkers that are indicative of various cancers, infections, and other health conditions in animals.

Lasso Metrics is a much more direct fit with Dr. Remcho's long-held research interests. His spouse, Candace is a Vet, and the fit between veterinary medicine and analytical diagnostics is a personal interest for sure. There is a need for low-cost, widely applicable, reliable diagnostic tools in both veterinary medicine and human medicine. The barrier to market entry in VetMed is much lower than in human med, which makes the veterinary field of application quite attractive too. In addition, once good veterinary data is available, the case for bringing these new methods to bear on human medical diagnostics is more easily made.

Right now Dr. Remcho is really enjoying being focused primarily on his OSU teaching, research and service, with secondary attention to business development. "I think this focus has helped me grow as a teacher, mentor, and scientist."

As for advice on getting your own start-up off the ground, "Be prepared to burn the midnight oil - or ethanol, if you prefer."

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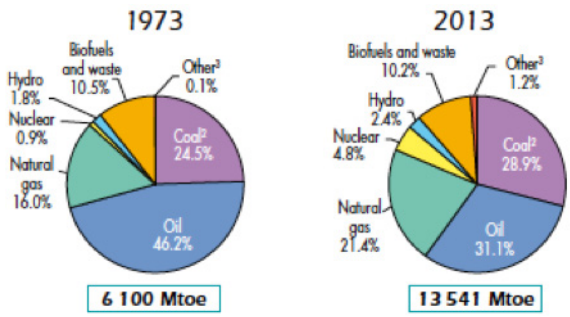
center for sustainable materials chemistry

The Center for Sustainable Materials Chemistry (CSMC) is an NSF funded center for chemical innovation (CHE-1102637). They focus on fundamental aspects of the aqueous chemistry of inorganic nanoclusters and their transformation to solids. They explore new approaches to synthesizing inorganic clusters, and how to tune their reactivity by coupling theory with experimentation. The CSMC prepares thin solid films with minimal energy input emphasizing the so-called green elements in the periodic table. The chemical transformations leading to these high-quality films is then investigated using various techniques; offering near-atomic resolution capabilities. By applying the film chemistry to lamination, the center studies and tunes reactions -neutralization, metathesis, interdiffusion, and redox - providing insights on basic chemistry processes involving these materials. By pushing the film chemistry to ultra-thin limits (< 1 nm), the center will open new opportunities to synthesize targeted compositions and structures Beyond the Molecular Frontier. This research holds the promise of transforming current technologies to produce high performance materials at dimensions < 10 nm with potential broad applications from electronic device fabrication to optical coatings and use in energy storage materials and applications using environmentally benign methods.

The center was initially created because there was a huge knowledge-gap in this area of science. The CSMC is committed to closing this knowledge-gap and to education at all levels. There were a lot of questions that needed to be answered so the center could actually utilize the solution methods in printing to produce the high quality films necessary for real world applications. Distinguished Professor **Douglas Keszler**, Director of the CSMC stated that the Center has been more successful than he had initially hoped, but that he honestly wasn't surprised at the level of success. "We have spun out three companies through this process (Inpria, Amorphyx and Beet) and answered a lot of questions that we had; but many more challenges lay in front of us. We've done some great science." The CSMC is hoping, in the next few years, to continue making breakthroughs in science, start up additional new businesses and to keep making solid contributions in their field.

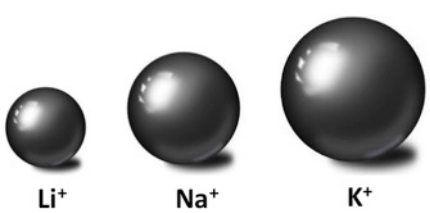
Dr. Keszler did have some advice to anyone looking to follow his path: "Surround yourself with good people." He gave credit to all the students, post-docs, and colleagues saying, that they are the ones that really make these big efforts happen. "So make sure you have good people around you and really go for the knowledge-gaps, try to make the breakthroughs in science that lead to inventions because that's what spawns innovation and the other opportunities beyond academics."

ENERGY MATERIALS CHEMISTRY: CHALLENGES AND OPPORTUNITIES



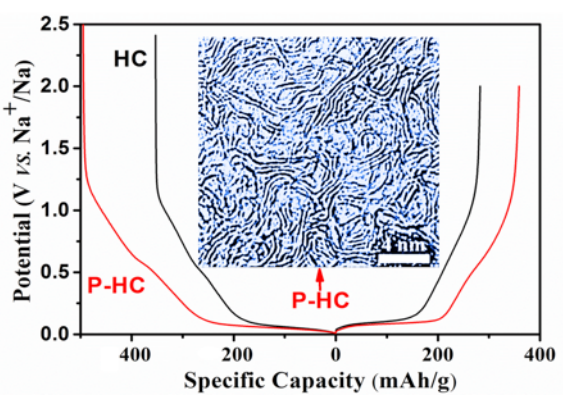
by: David Ji

From 1973 the year of the oil crisis to most recently, global energy usage has been more than doubled, but the percentage of fossil fuels in the pattern of all energy sources stays nearly the same < above 80%. It is not a question that heavy reliance on fossil fuels is detrimental to the environment and futuristic prosperity of the global economy. What is blocking countries from using more renewable energy, like solar and wind? In fact, to date, the cost for solar panels has dropped by 80% in the last five years, where it is cheap enough to be comparable to fossil fuels. It seems that massive deployment of more solar energy will solve all our problems. However, solar energy as an intermittent source has to be stored and used when the sun does not shine to maintain a constant power supply. Large solar farms, e.g., Topaz Solar Farm in California with 9 million solar panels, can provide electricity for over 160,000 homes. Yet, where is the electricity from during the nights? Now, it is either nuclear or fire power plants. The bottleneck and the missing enabler for renewable solar energy are large-scale stationary energy storage solutions. Well, pump hydro (taking up 99% of the whole global storage) and compressed air can provide tremendous amounts of storage capacity; however, such storage sites are not modular and thus cannot be used for metropolitan areas and neighborhood communities. It is the electrochemical cells that are modular, i.e., to be installed in a garage or mounted on the walls, and some of them can be cost effective when scaling up. Li-ion batteries (LIBs) will be impossible to undertake the task of large-scale storage for load leveling. Earth simply does not have that much lithium, despite the fact that we also hope to power millions of automobiles by LIBs and we still have not figured out how to recycle lithium. This is why researchers are competing in the arena of alternative batteries that are hopefully as functional as LIBs but at a smaller cost and with better technological sustainability.



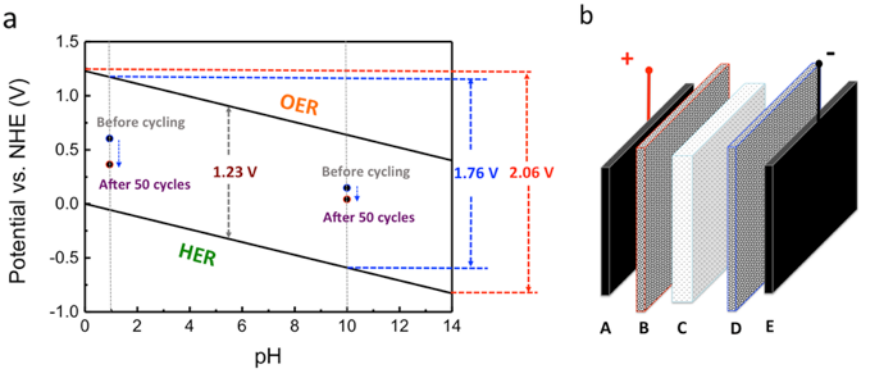
For stationary battery applications, energy density, i.e., how small or how light the devices are to store the same amount of energy, is not the first priority to worry about. The various properties of these batteries would be boiled down to two key metrics: cost and cycling life, where the latter also points to low cost with minimal maintenance. Of course, a higher capacity or energy density is always welcome. Along this line, it is a must to move beyond lithium to Earth-abundant elements, such as Na, K, Mg, Al and carbon, just to name a few. In my group, we target on the chemistry for energy storage devices based on these elements. Compared to Li-ion, the ions of the above elements, also known as charge carriers for the battery operation, are either very large or of multi-valance (electrostatically sticky). To borrow electrode materials from LIBs would not be helpful in most cases for these emerging batteries. In fact, this challenge offers battery scientists and engineers a new round of opportunities to make a large impact to the society by innovations of materials chemistry.

For example, graphite is THE anode for LIBs, but it cannot provide any meaningful capacity in Na-ion batteries (NIBs). However, even charcoal can do a better job than high purity and expensive graphite as an NIB anode. Well, there could be thousands of different charcoals, or hereafter we refer to this type of carbons as non-graphitic carbon, depending on the choice of some unique biomasses as precursors for pyrolysis. Certainly, it is not going to be efficient to "burn" all the biomasses into carbon as electrodes for NIBs so as to find which one is the best. The question is whether one can design such carbons to maximize its functionality, i.e., capacity or

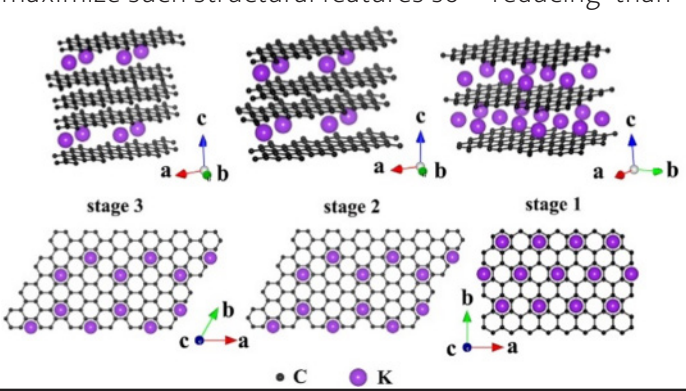


charge stored per unit mass or volume in this case. As you know, non-graphitic carbon is also known by other names, such as amorphous carbon, or disordered carbon. Now, how could someone design a material that is of a disordered structure? Scientists have been working on crystalline materials for a long time, where advanced properties have been exploited for many purposes related to our everyday life from single crystal silicon in electronics to future resistance-free electrical wires of superconductivity. Yet, people still know very little about short-range ordered materials or amorphous materials and how to tune their functionality. Just to characterize the structures of these materials can already be challenging. Designing such structures will be more difficult but highly rewarding.

In fact, designing such materials is exactly our major interest, which we attempt to impose "order" to disordered materials at local structures: atomic or nanometric. We do this based on our expertise in tuning materials' properties, particularly, the local structures of disordered materials, e.g., by doping, as well as our capability in characterizing the structures as well as the corresponding functionality. In our research, we often focus on one metric of materials, e.g., capacity, and we identify the key features of the structures that provide the largest impact on capacity. By knowing such a basic correlation, we can rationally design the materials to maximize such structural features so that a more desirable performance, particularly in batteries or capacitors, can be realized. For example, recently, we discovered that tuning the population of defects and domains sizes in disordered carbon materials can enlarge the capacity in NIBs. The project is currently funded by a NSF grant (2015 to 2018).



Besides addressing the needs to provide an intermediate-term impact to the society, our interests extend to realms of basic materials chemistry, syntheses of novel materials as electrodes as well as new charge storage principles. For example, we recently first discovered that K-ions can be reversibly intercalated into major types of bulk carbon materials in nonaqueous electrolyte at room temperature, where such carbons include graphite and disordered carbon (Patent pending). Funded by NSF CAREER award, we will employ large K-ions as a probe to fully explore the unknown features of disordered carbon, and for sure, such carbon can be used as an anode material for future K-ion batteries (KIBs). Here, just one hint about the advantages of KIBs: in nonaqueous electrolyte, potassium metal is more reducing than lithium, namely, the K+/K couple is lower in potential by 0.1 to 0.15 V than Li+/Li, despite our common sense about the standard potentials of different redox couples in an aqueous electrolyte.



We explore solutions "out of the box" for charge storage. As one example, we recently invented a bipolar tri-layer membrane that can be used a separator for different electrochemical devices. The function of such membrane assembly is such that it effectively enlarges the voltage window of water electrolyte from 1.23 V to 2.06 V, which can be translated to a much larger energy in many devices, where this is a patent pending technology.

It is certainly exciting working on new solutions for energy storage by novel materials chemistry, where our team of beavers will continue to push the frontier for a cleaner and more sustainable future.

FOCUS ON #YINMN BLUE: WE'VE GONE VIRAL!

by: Kayla Shearer

How long does it take for a piece of news to go viral? Well, in the case of YInMn blue, it took about seven years. And let's not forget all of the haters who didn't believe the news when it finally did break, seven years later. Nevertheless, chemist **Mas Subramanian**'s discovery of YInMn blue nearly broke the internet on Tuesday, June 26 when the news of the discovery fled academia straight into the arms of pop culture.

The Department of Chemistry's Milton Harris Chair Professor of Materials has been featured in numerous media outlets, including: Cosmopolitan, Teen Vogue, Seventeen, even the Huffington post, just to name a few. From our tally, there have been over 25 articles breaking the news within the span of a single week. And that number is still climbing.

In case you happen to live under a rock and have no clue what this "news" is, we are referring to the ground-breaking discovery of a new blue pigment by one of our very own faculty members here at OSU.

Don't fret, fellow alumni, faculty, and affiliates, the Department of Chemistry has the inside scoop, literally. Inside these pages, you will find the timeline illustrating the development of the pigment over the past seven years. In addition, we have the latest, greatest, and most accurate information on the subject. So stay tuned.

Mas Subramanian, the chemist credited with the discovery, describes this experience as "one of the most amazing and exciting journeys." He goes on to point out that most scientists working in labs would never expect so much attention, across so many industries and disciplines; and that, if it does happen, "it happens once in a blue moon." Good one, Dr. Subramanian.

Let's start with the basics. How does one "discover" a new blue pigment in the first place? We sat down with some of the students working in Subramanian's lab to figure out what actually goes into creating a pigment.

First, we spoke with **Madelaine Corban**, an undergraduate senior at OSU majoring in Art and Art History. Madelaine got involved in the Subramanian Research Group after listening to a talk presented by Subramanian to the art department at OSU. She says she's not usually interested in science but that Subramanian's talk as had "an artist's lens attached to it," describing the idea of color and where it comes from, and she was hooked.

We went to Madelaine to hopefully get a non-scientific description of what goes on in the Subramanian lab: "I'm just cooking, cooking in the lab." Did we catch that right – cooking? Indeed, Madelaine compares the process of creating pigments to that of baking a cake. After receiving a formula for a pigment, Madelaine collects the proper amount of each ingredient, mixes those ingredients using a mortar and pestle, and then bakes the mixture at an extremely high temperature (think +2000 degrees F) for a long time (think 12 – 24 hours). Ironically, the finished product looks a little like a mini cake.

Bella Giampaoli, a graduate student who also works in Subramanian's lab, goes on to describe what can be done with those "cakes." But first, let's get the terminology correct.

"Those are called ceramic pellets and you can leave them in that form; but you can also grind them back down into powders ... You can also take that powder and ball-mill it to make a finer particle size and you can put that in pretty much any solvent or base."

Those solvents and bases can be a multitude of things, from molten plastic to oil, acrylic, or water bases to create paints. This is where the pigment goes from a powder to a YInMn blue oil paint, a blue plastic toy, or to a state of the art blue coating for a US Navy ship that reflects infrared rays.

Yes, the United States Navy is very interested in the new pigment and its reflective properties. By reflecting a greater amount of infrared rays, US Naval ships coated in YInMn blue will be harder to detect

Graduate Student, Bella Giampaoli shows off YINMN Blue at the CIA Party

April 2009

Mas Subramanian suggeststothen,Graduate Students, **Andrew Smith** to synthesize a series of compounds, Yttrium Manganese Indium oxide ($YMn_xIn_{1-x}O_3$) to study their properties for electronic applications. this project was funded by the National Science Foundation.

May 2009

When Andrew was taking samples from the furnace Mas was in the lab and noticed the samples were an intense blue. He was surprised as manganse oxides normally turn a black or gray and don't form blue oxides. Maybe something was wrong. Mas asked Andrew to repeat the experiments again, the oxides continued to come our an intense blue.

June 2009

Having reproduced the blue color several times, it was concluded the shade was probably due to the new chromophore based on manganese in trigonal pibyramidal coordination and these compounds show properties for a good blue pigment.

Sept-Nov 2009

A publication based on our blue pigment was submitted to Journal of American Chemical Society on September 30 and the paper appeared in November, 2009 issue of the journal.

November 2009

Nov 16 - Chemical and Engineering News published a "News of the Week" column, "A New Blue: Mn-based chromophore points to more planet-friendly pigments" about the discovery.

Nov 26 - The New York Times covered our discovery in its Science section, "By Happy Accident, Chemists Produce a New Blue," which generated lots of interest among pigment companies and the public.

TIMELINE

December 2009

Dr. Jeff Peak of Shepherd Color Company called to inquire about samples to do initial evaluations of the pigment. A Non-Disclosure Agreement was signed between OSU and Shepherd Color and samples were sent.

Shepherd Color Company makes blue pigments based on Cobalt Blue.

Shepherd
The Shepherd Color Company
We Brighten Lives

February 2010

Dr. Jeff Peake of Shepherd Color Company visited OSU on Feb 1st with an initial report. This report showed that our blue pigment was superior to currently known blue pigments. However, he cautioned more work to be needed to fully characterize the pigment for commercialization.

December 2010

On Dec 7th, Shepherd Color Company finished the first phase of the testing and came to the following conclusions:

- OSU pigment is superior
- Higher IR reflectance than current pigments
- Could be useful as "Cool" coatings for roof and auto applications

May 2011

Subramanian group has discovered other colors by replacing Manganese with"

- Iron (Orange)
- Copper and Titanium (Green), and
- Zinc and Titanium (Purple)

July 2011

Corvallis Gazette-Times published a Front page Headline article on July 29th titled, "Indelible discovery: OSU team is creating vibrant pigments that endure, safely: Shades of luck and science."

Corvallis Gazette-Times

OF YINMN BLUE: A

October 2012

A patent covering the pigments US 8282728 was issued on October 9th, 2012. The patent covers all pigments with trigonal puramidal coordination of elements which can give color.

http://www.google.com/patents/US8282728

December 2012

Shepherd Color Company finished the long term evaluation and came to the conclusion that OSU Blue pigments are:

- Very Durable
- Reflects heat
- No sign of fading

They start sending samples to customers for testing in various applications.

February 2013

February Issue of National Geographic Magazine published full page article on the discovery of OSU's heat reflecting blue pigments in the section, "Next," titled "Coat d' Azure."

NATIONAL GEOGRAPHIC

January 2014

A new class of purple pigments was discovered adding Zinc and Titanium for Indiom in the same structure as the blue pigment.

Septembe

Shepherd Color Com
the purple pigments
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contains toxic coba
carginogen.

TRIP DOWN DISCOV

ber 2014

Company tested
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ate which also
cobalt, a known

May 2015

After a few months of negotiation, Shepherd Color Company signed an agreement with OSU to license the patent for commercialization.

January 2016

Shepherd Color Company started making commercial size quantities for customers for large scale testing.

February 2016

National Public Radio selected the discovery of YInMn Blue as one of the top 10 happy accidental discoveries in recent years.

npr

July 2016

News of the pigment's pending public release has gone viral in pop culture media. News broadcasts from Cosmopolitan, Tech Insider, Teen Vogue and IFL Science, just to name a few have made #YInMnBlue a worldwide hastag and Dr. Mas Subramanian a nationally recognized name.

http://blogs.oregonstate.edu/erlenmeyer/2016/06/30/ylnmn-blue-goes-viral/

VERY LANE

on infrared cameras, protecting them from enemy attacks.

But how exactly does a pigment go from the lab to a coating on a Naval ship?

Well the pigment had to be discovered, first. **Andrew Smith**, a graduate student working under Dr. Subramanian in 2009, was performing a similar procedure to the one described by Madelaine Corban when he noticed a brilliant blue coming from the furnace.

Subramanian's first thought was that something was wrong with the reaction set-up, but had an inkling that this was something new - something big. After repeating the process multiple times and getting the same brilliant blue as a result, Subramanian's instincts proved to be correct. Serendipitously, what's been labeled as "the most beautiful shade of blue" was born.

So why the sudden interest in this seven-year-old discovery? Perhaps because the new pigment is finally ready for commercial use. This commercialization process began when Andrew Smith took the pigment to the Sheperd Color Company. The Sheperd Color Company specializes in producing complex inorganic color pigments. YInMn blue fits that description and more. With its non-toxic, incredibly stable composition, YInMn blue is the best reflector of heat on Earth, next to white. And, as Subramanian says, "Blue just looks so much nicer."

So, Smith brought the pigment to the Sheperd Color Company where they are continuing to study the pigment on properties not studied while at Oregon State University. At this point, Sheperd Color Company has begun to produce and sell samples of the pigment, mostly to artists.

Subramanian says Sheperd is hoping to transition from the art industry to larger scale projects within the construction and automotive industries, where the pigment can be used as a reflective, energy-saving coating in cars, ships, and industrial and office buildings.

The cosmetics industry has also shown significant interest in the pigment for its applications in nail polishes, eye shadows, hair dyes, and so on. However, FDA approval for YInMn pigment use in cosmetics has not yet come through.

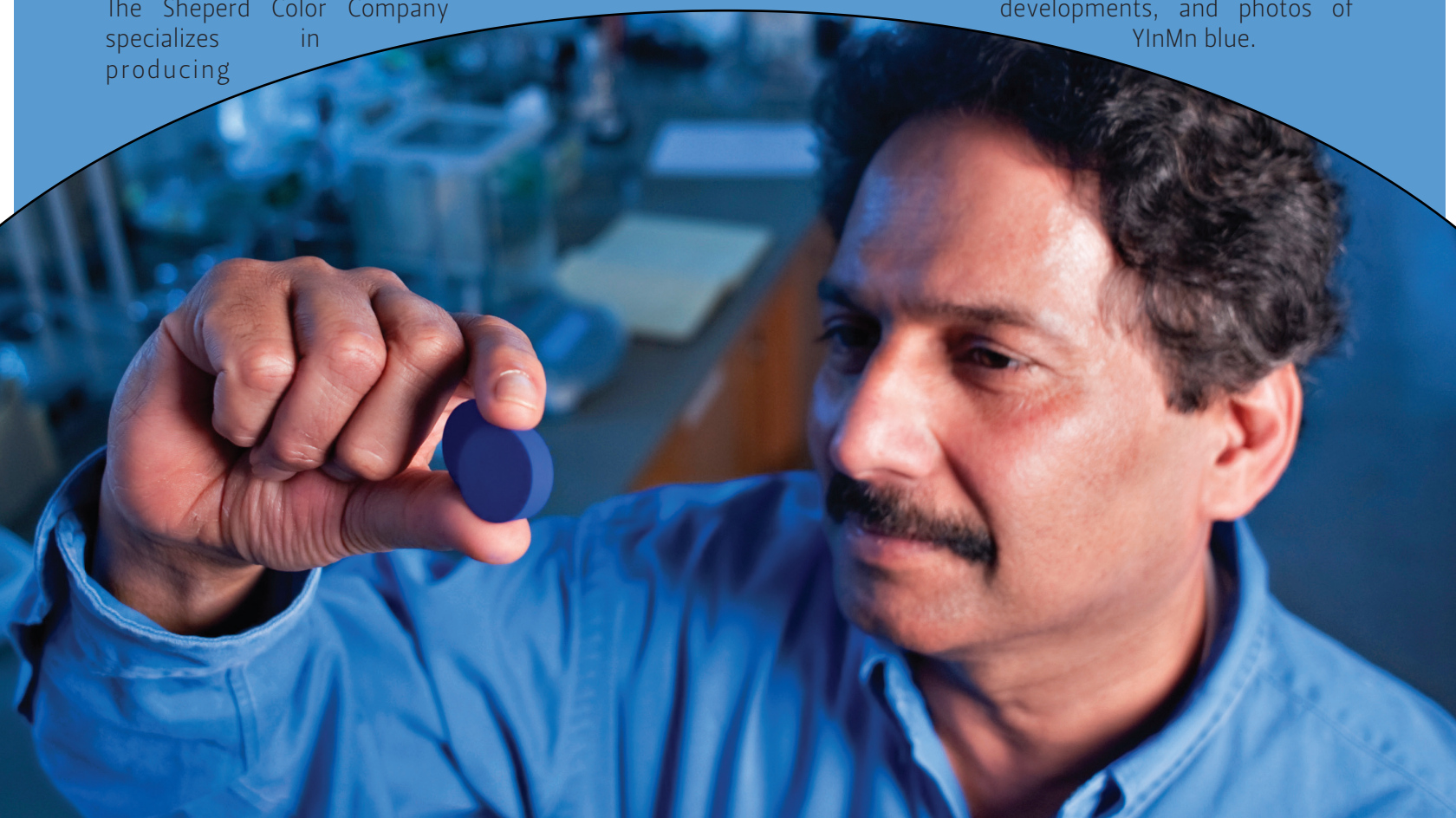
So what do you do after you discover a new inorganic blue pigment for the first time in over two centuries?

"Well we are now looking for a red pigment ... We are trying to come up with a red that is more environmentally friendly, more user friendly, easier to be made, and is non-toxic ... But, who knows?"

Subramanian makes a good point. Given the fact that his last discovery was not a planned one, he plans to keep an open mind and enjoy the journey, wherever it might take him.

"It's not the destination that is important in this journey. The journey itself is important because you see so many things on the way." And one final piece of advice from Subramanian: "it's a famous saying, 'In the fields of observation, chance favors only the prepared mind.' Because it's not simply luck. You also have to be prepared for it."

Want the latest news on the YInMn blue frenzy? Keep an eye out on our blog, The Erlenmeyer Flask for links to recent articles, developments, and photos of YInMn blue.



NEW FACES
IN THE CHEMISTRY DEPARTMENT

Steven Nguyen
Instructor

Steven Nguyen is from Irvine, CA. As a student, he dreaded his chemistry courses and found an interest in studying biology. He was particularly fascinated with human physiology and aspired to one day work in the health sciences field. As a result, Steven graduated from UC San Diego in 2010 with a BS in Biochemistry & Cell Biology.

During his undergraduate, Steven had a change of heart and found himself enamored with organic chemistry. He especially enjoyed providing synthetic schemes and proposing reaction mechanisms as he views it as piecing together jigsaw puzzles. With encouragement from Dr. Christina Johnson, his undergraduate chemistry professor, Steven switched fields.

In 2012, Steven earned an MS in Chemistry at UCSD. Upon completion of his MS, Steven immediately continued on to his doctoral work and completed his studies June 2016. We were lucky enough to hire him starting August, 2016.

Steven also has a plethora of teaching experience, and will be teaching our Integrated Labs and General Chemistry Series. He worked as both an undergraduate and graduate TA for 8 years, where he received the UCSD Department of Chemistry Excellence in Teaching Award in 2010. In addition, Steven was awarded the NIH Socrates Fellow in STEM education where he developed an inquiry-based high school curriculum and taught alongside chemistry high school teacher, Autumn Ross at Patrick Henry High School (Del Cerro, CA). As an adjunct faculty, Steven taught chemistry to both non-science and science majors at Southwestern College (Chula Vista, CA).

Outside of the academic setting, Steven enjoys spending his free time playing sports and exploring nature. He is enjoys an active lifestyle and looks forward to going on outdoor adventures during his spare time.

Riley Evans
Lab Assistant

Riley was born here in Corvallis. She grew up in Kings Valley, about thirty minutes west of Oregon State University. Throughout her K-12 education, a handful of wonderful teachers sparked and helped maintain her love of science; chemistry in particular.

After high school, she attended Hawai'i Pacific University and studied abroad at Deakin University in Geelong, Victoria, Australia. She eventually transferred to Oregon State University where she became a member of Sigma Delta Omega and graduated with a B.S. in Microbiology ('14). From there, she moved to Manhattan, Kansas where she started a graduate program in Biochemistry and Molecular Biophysics at Kansas State University. When health and family circumstances required her to withdraw from the program and return to Oregon, she was hired on as one of the new Laboratory Assistants.

While she would like to return to graduate school in the future, she is happy to be back in Beaver Nation. When she's not helping maintain the Chemistry teaching labs, she enjoy spending time with her family and pets, reading comic books, and hiking the Pacific Northwest. She and her friends attended Emerald City Comic Con in full cosplay and had a BLAST!

David Kuczek
Warehouse Worker

David Kuzcek II was born in Auburn, NY. He attended Paradise Valley High School and graduated in 2005. He moved to Phoenix, AZ because his parents didn't like the weather in NY, but moved to Oregon last year so his girlfriend, Lillie could work on her PhD in Biochemistry.

Before coming to Oregon State, David worked in a series of record stores. He says these jobs contributed greatly to his highly eclectic musical taste.

David and Lillie have a 7-year-old daughter that take up a lot of their spare time, but with what's left, he likes to play computer games and watch television. He says he's obsessed with Doctor Who, and also enjoys The Walking Dead and Seinfeld.

Undergraduate of the Quarter, continued from page 7

hoping will reach publication.

He was unable to list just one favorite instructor, but was pretty adamant that his favorite class was experimental chemistry. "Experimental chemistry is more of an application and hands-on experience. I like this class because it's a bridge between the two core concepts; theory and implementation."

During his spare time, Dang is the president of the Chemistry Club. He also is an undergraduate TA for the general chemistry 12x and 23x sections and worked in the Mole Hole tutoring students. Upon graduation, he will be attending graduate school here at OSU, in the College of Education in the hopes of getting his Masters. He plans on teaching high school chemistry and math in the future; saying his teaching style is to use a lot of demos and applications. He feels like high school is the best place to do that.

Rusty Root

Coordinator of Building Services & Support

Rusty is a native Oregonian, born in The Dalles. He grew up on a dry land wheat farm in eastern Oregon. His family moved around for few years and ended up in Yakima WA, where he graduated high school. After short stint at Western Washington University, he found he was not ready for college. After kicking around for a few months trying to find a job; he ended up enlisting in the Navy as an Aviation Electrician. After five years enlisted, marriage and a son, he left the Navy and took a job installing, servicing, and repairing electronic office machines back in Yakima. While attending night school at Yakima Valley Community College, he and his wife had a second son.

Rusty attended OSU from 1987-1992 in the Engineering Department. After a long and colorful career, Rusty took a job here in Chemistry, as the Coordinator of Building Services and Support. Being a 4th generation Beaver (his son graduated from OSU too [5th generation]), he jumped at the chance to come work for an institution that has been such a big part of his life, and apply all the skills he has learned in his education and life experiences.

In his personal associations, he's been an Assistant and Scout Master for the Philomath Boy Scout Troop. He's volunteered with the Philomath Frolic & Rodeo Association holding several Chair positions and even a short stint as their President. He's played softball for decades in the Corvallis Parks and Rec; Men's, Wood Bat, and Coed leagues, attended Grant Avenue Baptist Church, participated in several bowling leagues, and, he's a Mason with Corvallis Lodge #14 AF&AM.

Sarah Leon

Lab Assistant

Sarah was born in Virginia, but she grew up and graduated high school in Ohio. She moved around a lot after high school, living in South Carolina, Georgia, and Utah. She eventually found herself in Oregon. She instantly fell in love with all the green and decided to make her life here despite the rain! Here is also where she met her wonderful husband, Brian Leon, and they have just celebrated their fourth wedding anniversary. They currently reside in Salem.

She began her studies at Chemeketa Community College before transferring to Oregon State University to finish up her degree. In addition to taking classes at Chemeketa, she also worked as an Instructional Assistant in their Math learning Center for the past 3.5 years. Last June, she graduated with a BS in Zoology and a chemistry minor. Sarah has loved science ever since she was a little girl, so the only hard part about choosing a major was deciding on just one area to focus on. She ultimately loves chemistry because of its pervasive presence in the world and strong math component.

Her extracurricular activities include cooking, watching movies, and napping. She also spends Saturdays volunteering at Chintimini Wildlife Center here in Corvallis. Currently, she is trying to convince her husband that he is not allergic to cats so they can get one, which takes up a lot of her time.

IN MEMORIUM: DR. GERALD JAY GLEICHER

January 31, 1939 – August 4, 2016

Breaking curfew was never a good idea for Gerald Gleicher's children. From the end of the cul-de-sac, one could see the porch light, the living room light and the chandelier in the stairwell from beyond the open front door. Drawing nearer, a figure could be seen sitting calmly on the front steps. Finally, upon stepping quickly from the friend's car, the late child heard the unmistakable sounds of a loud aria or overture. The stage was set for the master to pass judgment, although he never spoke harshly. He always claimed he simply couldn't sleep until we were all home safe and sound. Not one of his three children willingly broke curfew more than once, although he continued his vigil throughout the rest of his life, ending finally on Aug. 4, 2016.

Dr. **Gerald Jay Gleicher** was born on Jan. 31, 1939 in Brooklyn, New York to his parents David and Sadie (Mayer) Gleicher. He lived in Brooklyn during his youth, but commuted via subway to Manhattan to attend Stuyvesant High School. Perhaps his favorite teachers grew weary of his frequent pranks and elaborate lines of questioning; he graduated at the age of 16 in 1955. He earned his bachelor's degree from Brooklyn College in 1959. His masters and doctoral (1963) degrees in chemistry were awarded from the University of Michigan. He did postdoctoral work at the University of Texas at Austin and Princeton University.

In 1966 he married the love of his life, Mary Katharine Schmidt, and they spent the next 45 years together raising their family until her death in 2011.

Jerry and Mary Kay headed to Oregon on their honeymoon where Jerry had accepted a faculty position in the Oregon State Chemistry Department. The couple settled in Corvallis and welcomed the arrival of Abby, Tom, and finally, James. The children were raised listening to creative stories, going to the beach for impromptu picnics, and gathering knowledge from his virtually inexhaustible stores of facts. Jerry loved to plan intricate gourmet dinners and the menus would span the globe, feasts pulled together from his large collection of cookbooks. Family, friends and many wayward graduate students were the grateful beneficiaries of his culinary genius.

Read the entire obituary on: http://www.gazettetimes.com/news/local/obituaries/dr-gerald-jay-gleicher/article_914199bd-ba55-5e5c-9cb4-7cd589367bb6.html

FACULTY HONORS AND AWARDS

May Nyman was promoted to Professor with indefinite tenure.

Chong Fang was promoted to Associate Professor with indefinite tenure.

Marita Barth was promoted to Senior Instructor 1.

Mas Subramanian was awarded one of the 2016 Outstanding Scientist Awards from the OR Academy of Science.

Mike Lerner was inducted into the OSU 25 Year Club, Class of 2016.

David Ji received a NSF CAREER Award.

Paul Cheong was named the Bert and Emelyn Christensen Endowed Professor.

Chris Knutson and **Daniel Myles** were both named Professors of the Term by the Panhellenic Executive Council.

Walt Loveland was elected a 2016 Fellow for the American Association for the Advancement of Science.

Mas Subramanian was selected as a finalist for NPR's Golden Mole Award for Accidental Brilliance in Science.

Vince Remcho was named the 2016 Honors College Eminent Professor.

Paula Christie received the "Our Hero" Award.

Chris Pastorek was inducted into the OSU 35 Year Club

STUDENT HONORS AND AWARDS

Peter B. Culter Memorial Scholarship winners were: **Stephen Duda**, **Eaton Fong**, **Aimee Schacher**, & **Anastasiya Prymolenna**.

Carroll DeKock Scholarship winners were: **Jocelyn Conroy** & **Nathan Coddington**.

Linda May Oleson Scholarship for Excellence in Chemistry winners were: **Jason Sandwisch** & **Cassandra Lew**.

Colleen Spurgeon Scholarship winner was: **Amy Albrecht**.

ACS-Hach Land Grant Teacher Scholarship winners were: **Dang Nguyen**, **Alexandra Malone**, & **Taylor Lee-Rouille**.

Keith McKennon Undergraduate Research Scholarship recipients were: **James Palmiter** & **Colin Muniz**.

James D. Ingle Chemistry Scholarship winners were: **Kayla Naas**, & **Nicholas Diaz-Hui**.

CRC Award winners were: **Annie Cao**, & **Kyle Olsen**.

PLU Award winner was: **Nathan Coddington**.

Analytical Chemistry Award winner was: **Jacob Ramsey**.

Inorganic Chemistry Award winner was **Trevor Shear**.

Organic Chemistry Award winner was **Kenneth Stout**.

American Institute of Chemists Award winner was: **Blake Erickson**.

Hypercube Award winner was: **John Hergert**.

Merck Award winner was **Reid Kinser**.

WIC Culture of Writing Award winner was: **Jason Sandwisch**.

Yunteng He was a finalist at the Oregon Statewide Three Minute Thesis (3MT) Competition.

Pieter Waldenmaier was featured in the "Speak Simply About Science" challenge at ACS.

A publication by **Krista Barzen-Hanson** was selected as an ESTL Best of the Best.

Cassie Lew was awarded a prestigious DAAD RISE Fellowship to conduct research in Germany this summer.

Kyle Almlie & **Drew Ferreira** were selected to receive Graduate Student Travel Awards from the Graduate School.

Ivan Titaly won a 2016 Graduate Student Paper Award from the Environmental Chemistry Division of the ACS.

Bella Giampaoli & **Elizabeth Kaweesa** were featured in the Career Development Center's newest ad campaign.

Maduka Ogba participated in the new Beavs Recycling ad campaign.

NL Tartar Summer Research Project winners were: **Donovon Adpressa**, **Drew Ferreira**, **Nick Larkey**, & **Xin Li**.

Milton Harris Summer Fellowship winners were: **Cheng Chen**, **Ankan Ghosh**, **Bella Giampaoli**, **Karoly Kozma**, **Jinming Li**, & **Wesley Surta**.

Dorothy & Ramon Barnes Graduate Fellowship winners were: **Alexander Brueckner**, **Camille Richardson**, **Dylan Sures**, & **Ivan Titaley**.

Bruce Graham Memorial Scholarship winners were: **Daniel McCauley-Walden**, **Ganesh Ummadi**, **Hanyang Zhang**, & **Lulu Zhang**.

Arnold Johnson Jr. Graduate Fellowship winner was: **Ismael Rodriguez Perez**.

Dandeneau Family Graduate Fellowship winner: **Ismael Ridriguez Perez**.

Ken and Lise Hedberg Graduate Fellowship winner: **Ismael Rodriguez Perez**.

Benedict Fellowship winner: **Ismael Rodriguez Perez**.

Ingram Award winner: **George Neuhaus**.

Benedict Award winner: **Krista Barzen-Hansen**.

Whiteley Graduate Fellowship in Material Sciences winner: **Kristopher Olsen**.

Shoemaker Fellowship winner: **Yunteng He**.

Donovon Adpressa was awarded OSU's MCB Collaborative Catalyzer Award

Ross Overacker was awarded the American Society of Pharmacognosy's Lynn Brady travel award to attend the annual meeting in Copenhagen Denmark.

THE EVOLUTION OF C

by: Greta Kvinnesland

Online Learning in the Digital Age

The emergence of the World Wide Web in the early 1990s became a catalyst for sudden growth in the marketplace of distance education, prompting colleges and universities (most prominently the University of Phoenix) to begin offering courses and programs through the Internet. In 1998, NYU Online, Western Governors University, and California Virtual University all established themselves as contenders in the realm of online university programs.

However, in many cases, institutions struggled with success; while the vision was there, faculty and administrators alike lacked the understanding that a different medium of instruction would require a different pedagogical approach in order to be sustainable. The quality of asynchronous instruction was also in question. Research has shown that in order for online courses to be viable, they must be well-documented and designed in such a way that the instructor actively engages with the students, and it took some time to figure out the steps necessary to produce this kind of learning. The initial struggle ultimately resulted in failure for many programs. By 2001, even NYU Online—the only one considered able to compete with the expanse of University of Phoenix—had shut down.

Online Chemistry at OSU

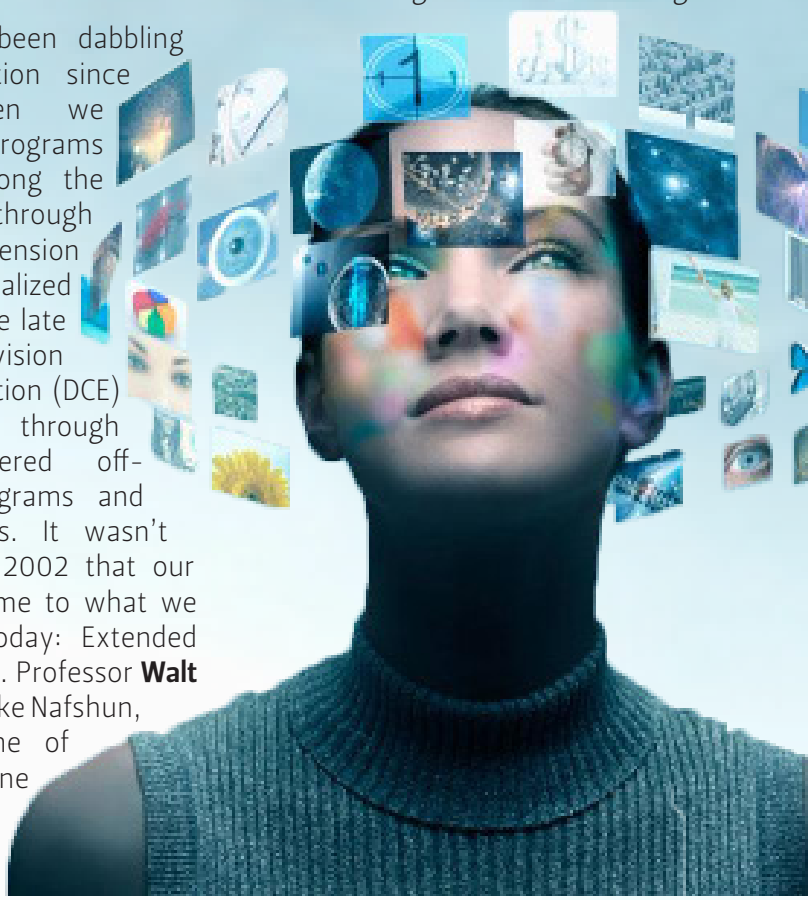
While others were closing their doors, OSU's Department of Chemistry decided to put out a virtual welcome mat. It was April 1998 – a time when nobody else was attempting science courses online – and Dr. **Richard Nafshun** decided to offer an online section of general chemistry (CH 223) for students. Students gathered in the Mole Hole, a computer lab on campus, to access the class. (Nafshun still has the files for this course preserved on a thick, fire-engine red floppy disk, wherein lies a treasured HTML collection complete with slightly off-kilter drop-down answer menus and MS Paint graphics of chemical apparatus.)

Using Nafshun's structural web template, others in the department soon began utilizing the server to host courses. Moving in the web-based direction was a seamless transition for some instructors, who already had a lot of this type of material (quizzes, lecture notes, PowerPoint, etc.) on a home page on the departmental server for their on-campus courses. Most of this initial online content was, however, only to the benefit of our own students here at OSU, i.e. those who had scheduling conflicts or wanted to have the material at home; registration-wise, there was no way yet to delineate it as an "online" class.

Oregon State has been dabbling in distance education since the 1930s, when we started offering programs in Portland and along the Oregon coast through the General Extension Division (a centralized state system). In the late 1970s, the OSU Division of Continuing Education (DCE) was established, through which we delivered off-campus credit programs and non-credit seminars. It wasn't until September of 2002 that our DCE changed its name to what we now know it as today: Extended Campus, or Ecampus. Professor **Walt Loveland**, who had, like Nafshun, been teaching some of his courses online through our private server, was our first to jump on board in 2002 and shift his CH 374, 390, 490, and 590 classes to Ecampus, thereby joining our department in a more holistic effort to provide distance learning. This extension offered support to our faculty and streamlined the registration process for non-resident students. Within a couple of years, all of our online courses were switched over to the Ecampus platform.

Pioneering Online Laboratories

Over the past decade, we've enriched our program by not only introducing new courses (e.g. CH 584, a graduate-level course for STEM educators), but also developing quality online laboratory methods. Nafshun can recall scanning in hand-written notes for his students to complete the lab work component of his online general chemistry class back in 2001. He subsequently turned to video modules—3-5 minute video recordings of his hands using

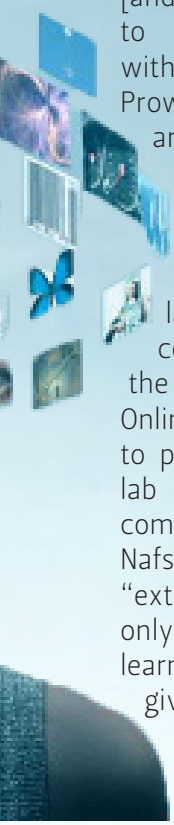


CHEMISTRY E-CAMPUS

chemistry laboratory glassware and instruments—which were posted on the course page.

Luckily, rising technologies soon offered a more tangible experience for the student. In 2006, we started using a virtual lab company that had identified us as a big fish (at the time probably the biggest online science program around) and reached out. This technology allowed students to learn by performing conceptual experiments using online software. However, there were several technical issues with the vendor over the next few years. At one point, the software went down for 2-3 weeks in the middle of the term, and we realized we needed to find a more maintainable option—something of our own creation.

Thus OnlineChemLabs, LLC was born. Founded in 2009, this virtual lab software has gone through several development phases and is still in use now. "We had the chemistry knowledge to do it; we knew what [tools were] needed [and] what the instructors wanted to see," says Lerner. Working with the Corvallis-based company Proworks Corporation, **Mike Lerner** and Rick Nafshun collaborated with Professor Emeritus **Michael Schuyler** to produce the website interface, database, software, etc. Implementing these laboratories in our 100-level courses was also a way to make the learning more interactive: OnlineChemLabs allows students to pair up, and working through a lab requires feedback or data and communication with their partner. Nafshun says the software is "extremely valuable" in that it not only challenges modern myths about learning science online, but also gives students opportunities they wouldn't otherwise get (e.g. taking part in a virtual NMR lab, since the logistics prevent general chemistry students from gaining access to this facility on campus).



While these virtual labs were perfect for our 100-level courses, it was always understood that delivery of upper-level chemistry laboratories would still necessitate an on-site component. In 2007, organic chemistry (CH 331 and 332) was introduced into the repertoire, at which point our fledgling online course load had actualized to include two foundational chemistry sequences. The following summer, Dr. **Jeff Walker** created our CH 337 summer hybrid lab course, thereby bookending the online organic series and making it, in his words, "attractive to regional, national and international students who require a complete sophomore organic chemistry sequence but are unable to fit a traditionally delivered sequence into their schedules."

With this growth came the need for more of an infrastructure. Although a departmental Ecampus Committee was appointed in 2008, it was becoming impossible for the instructors to develop and deliver new courses and also be available for all the other associated administrative tasks (marketing, overrides, proctoring, etc.). In 2011, as enrollment increased into the hundreds for some courses, the department hired an online coordinator—an instrumental move in helping to organize and evolve the program into what it is today.

Looking Ahead

Online teaching and learning isn't always easy, but that can be part of the fun. Our instructors continue to focus on that active engagement necessary for the posterity of virtual education. "I've had to learn to explain things in better and different ways—ways that I've never thought of before," says Dr. **Daniel Myles**, who teaches both organic and general chemistry online and on campus.

There are many exciting possibilities on the horizon for our online program. As **Paula Weiss** points out, our courses attract students from around the world. She too sees the opportunity for growth, and suggests including a one-term online Introductory Chemistry course in our curriculum. Lerner believes that, with synergistic development by our colleagues in the College of Science, we could be within a couple years of offering a chemistry major program via Ecampus and hybrid labs. We need to add one more course sequence (p-chem), and then the integrative labs. A major like this would be one of the first of its kind in the country.

Lerner and Nafshun both believe that we are still at the beginning of an interactive technology and people mode of education, and that in the near future this interaction will happen in noticeably more thoughtful and reproducible ways. "I think it's interesting," says Nafshun. "I think it's exciting. . .we believe that students are learning and understanding chemistry and STEM concepts that they otherwise may not because of our delivery." He cites students in the military, or the middle of Wyoming (one of his students had to drive an hour to go to the nearest library with internet), as prime examples. Many of the other instructors agree with this sentiment. Lerner adds how the speed of change in technologies in general will continue to improve our educational resources: "I think ten years from now we'll look back and say, '2016—that was really primitive.'"

2015-2016 HONOR ROLL

Fall 2015

Jordan Anderson
Dakota Backus
Kamila Bennett
Caitlin Berger
Corinne Brucks
Kathryn Chen
Abigail Chitwood
Tora Cobb
Jocelyn Conroy
Sergiu Coporan
Shannon Davis
Andrea Domen
Gillian Downey
Sara Dunagen
Janet Herguson
Zachary Fried
Duncan Fuller
Jeffrey Garcia
Jordan Garcia
Ester Gordon
Galen Hall
John Hergert
Lylan Ho
Joeun Kim
Derek Lafave
Shan Lansing
Cassandra Lew
Sarah Lund
Sarah Melancon
Steven Nguyen
Dakota O'Neil
Kyle Olsen
Brandon Parsons
Lars Paulson
Thu Pham
Ryan Pimentel
Kristin Potter
Philip Prater
Anastasiya Prymolenna
Nathan Raleigh
Jacob Ramsey
Ashraf Samhan
Trevor Shear
Hannah Smith
Kenneth Stout
Britany Swann
Karleigh Taylor
Lillian Treadtke
Ty Triplett
Mesa Walker
Theresa Xiong
Tianqi Zhang

Winter 2016

Tanner Aldous
Savinda Aponso
Jimmy Beaty
Corinne Brucks
Sara Bu Sharar
Kathryn Chen
Abigail Chitwood
Nathan Coddington
Jocelyn Conroy
Sergiu Coporan
Dionysius Copoulos
Andrea Domen
Gillian Downey
Stephen Duda
Blake Erickson
Zachary Fried
Duncan Fuller
Jordan Garcia
Galen Hall
John Hergert
Lylan Ho
Joeun Kim
Reid Kinser
Cassandra Lew
Sarah Lund
Kota Muto
Kayla Naas
Steven Nguyen
Katherine Oden
Kyle Olsen
James Palmiter
Thu Pham
Kristin Potter
Eric Qian
Ren Rasmussen
Jason Sandwisch
Trevor Shear
Hannah Smith
Kenneth Stout
Karleigh Taylor
Lillian Teadtke
Ty Triplet
Daisy Ubaldo-Zurita

Spring 2016

Ibrahim Alanazi
Tanner Aldous
Christopher Bahro
Amberlie Barnard
Sara Sharar
Sergiu Coporan
Dionysius Copoulos
Shannon Davis
Stephen Duda
Blake Erickson
Hanet Ferguson
Eaton Fong
Zachary Fried
Duncan Fuller
Trenton Gallagher
Marissa Gallegos
Kristina Halvorson
John Hergert
Franceska Hinkamp
Jason May
Kayla Naas
James Palmiter
Thu Pham
Kristin Potter
Benjamin Rist
Jason William Sandwisch
Jessica Scotten
Hannah Smith
Karleigh Taylor
Lillian Teadtke
Allison Turner
Daisy Ubaldo-Zurita
William Walls
Theresa Xiong
Xinhui Yu

A huge congratulations to the Chemistry Department, Class of 2016! This past year, we graduated our largest group yet, with over 75 graduates between our undergraduate and graduate programs. We couldn't be more proud of our graduates, and wish them all luck in their future endeavors!

Congratulations Class of 2016

Class of 2016

Kelly Baker, HBS (Bus)
Amberlie Barnard, BS (Adv CH)
Kamila Bennett, BS (Pre-Med)
Scott Best, BS (Bio)
Corinne Brucks, BS (Adv CH)
Abigail Chitwood, HBS (Pre-Med)
Tora Cobb, HBS (Pre-Med)
Dionysius Copoulos, BS (Pre-Med)
Shannon Davis, BS (Adv CH)
Gillian Downey, HBS (Env CH)
Blake Erickson, BS (Adv CH)
Julia Gabriels, BS (For Sci)
Cooper Gates, BS (Chem Ed)
Nicholas Goolsbee, BS (Pre-Med)
Ester Gordon, BS (Env CH)
Nhu Ha, BS (Bus)
Kristina Halvorson, BS (Biochem)
Benjamin Hamel, BS (Adv CH)
John Hergert, BS (Mat Sci)
Austen Hsiao, BS (Pre-Med)
Alec Kagele, BS (Pre-Med)
Reid Kinser, HBS (Adv Biochem)
Kevin Kreiner, BS (Chem Eng)
Shan Lansing, BS (Pre-Med)
Anna Magnuson, BA
Sarah Melancon, BS (Biochem)
Aron Montoya, BS (Pre-Med)
Kota Muto, BS (Mat Sci)
Dane Nagaoka, BS (Chem Eng)
Dang Nguyen, BS (Adv CH)
Phillip Nguyen, BS (Pre-Med)
Dakota O'Neil, BS (Pre-Med)
Lars Paulson, BS (Adv CH)
Austin Peterson, BS (Chem Eng)
Thu Pham, BS (For Sci)
Philip Prater, BS (Adv CH)
Nathan Raleigh, BS (Bus)
Jacob Ramsey, HBS (Pre-Med)
Giovany Rosales, BS (Adv CH)
Trevor Shear, BS (Adv CH)
Jenna Shearer, BS (Biochem)
Henry Stout, BS (Bus)
Britany Swann, BS (Chem Eng)
Karleigh Taylor, BS (Pre-Med)
Jackilyn Toftner, BS (Adv Biochem)
Yekaterina Toporkova, BS (Bus)
Jake Turner, BS (Pre-Med)
Valeria Ursa, BS (Pre-Med)
Samuel Walters, BA
Rachel Wold, BS (Chem Ed)
Tengjian Yan, BS (Chem Eng)
Tianqi Zhang, BS (Adv CH)
Karen Zhen, BS (Adv Biochem)
Baohuan Zhou, BS (Chem Eng)
Jonathan Barrett, PhD
Adam Barsamian, PhD
Lei Chen, PhD
Leah Chibwe, PhD
Colin Harthcock, PhD
Lin Huang, PhD
Yang Li, MS
Amila Liyanage, PhD
Maduka Ogba, PhD
Ommidala Pattawong, PhD
Stephanie Ramos, MS
Brittany Robertson, MS
Patrick Salvo, MS
Lindsey Sequeira, MS
Kevin Snyder, MS
Jayda Spong, MS
Nagarathanam Veerasamy, PhD
Yuanyuan Wu, PhD
Peng Zhao, PhD

From Central Intelligence to Ce

One man's journey from Che

by:

Kayla Shearer

Coding, secret writing, top secret research – all in a day's work for Chemistry Department Alumni John Stephenson. Yes, you read that title correctly; the guest list for the 3rd annual Chemistry Is Awesome party featured some pretty big names this year. Among those names was Dr. **John Stephenson**, an ex-CIA agent who graduated with a Ph.D. in chemistry from the Department of Chemistry in 1960.

Stephenson read about the CIA party in the Department's bi-yearly newsletter and naturally, felt the need to investigate further. Stephenson arrived at the Department building - conveniently named after the 1960 Department chair, Dr. Gilbert - early on June 1st, 2016 to begin his investigation. Current Department chair, Professor **Rich Carter**, led Stephenson on a tour of the department, detailing the upgrades and changes that have occurred since Stephenson's time here. Following the tour, we sat down with Dr. Stephenson to find out what really goes on in the CIA.

But first, here's a little background on one of the most notoriously secret organizations in the world. The CIA was established by President Harry Truman in 1947, only 13 years before Stephenson stepped on the scene. Following its formation, the CIA was charged with coordinating the nation's intelligence activities and correlating, evaluating and disseminating intelligence affecting national security – sounds pretty ambiguous if you ask me.

So what really happens inside the CIA? Well, who better to ask than an ex-agent themselves?

The interview begins with Stephenson reminding us that "it was a different world in the 1960's," what with the Cold War going on and the relatively low level of technology (compared to today). Stephenson worked for what he refers to as the DDP, Deputy Director of Plans, which, according to Stephenson, "was the real spies."

So what do the "real spies" do?

Well, it depends. But Stephenson, one of those "real spies," says he worked on secret writings, "which is really just chemistry on paper." Alas! All of our childhood stereotypes of spies and secret agents are being reaffirmed!

That's not all, though. Stephenson was among the first agents to work in the newly developed Directorate of Science and Technology (1963). Here, Stephenson worked on analyzing codes and inscriptions. On what? Stephenson didn't specify; perhaps because of the secret nature of the work. However, Stephenson describes his work in this directorate as, "that sort of work that you learn to do in graduate school." Well, it may not be especially descriptive, but it does prove what a good ol' Ph.D. from OSU can do for you (listen up, grad students!).

So the next time you ask yourself what you can do with a Ph.D. in chemistry, think big - really, really big.

How has the Department changed since 1960? Checkout our new Chemistry Department timeline at: chemistry.oregonstate.edu/timeline to find out!

Central Science:
Chemistry to CIA and back again

by: Luanne Johnson

The 3rd Annual CIA (Chemistry Is Awesome) Party was held Wednesday, June 1, 2016 in the Gilbert Hall / GBAD Breezeway. Live music by the Svens entertained the crowd as approximately 500 students, faculty and staff gathered around the demos. Demos included, performing color spectroscopy and testing the radioactivity of bananas and lantern mantles while waiting in line for a chance at nachos. Later in the evening, students gathered to watch as Liquid Nitrogen Ice Cream was made, then handed out to be devoured. One student commented, "I didn't expect it to be so creamy."

Meanwhile, Department Chair, **Rich Carter**, and Faculty member, **Richard Nafshun** along with numerous Graduate Student volunteers shivered away in the dunk tank while students enacted their tiny revenges for a full year of note taking and test anxiety.

ChUME (Chemistry Undergraduate Mentorship and Empowerment) held their second poster session during the event. With about 20 posters and undergrad presenters, this was the largest session yet. A fact which made ChUME extremely happy. Prizes were awarded for the top three posters at the session. First prize went to **Eric Qian** (CH), second to **Natasha Smith** (BB), and third place went to **Maceo Gutierrez-Higgins** (CHE).

With over 40 prizes to raffle off, thanks to our incredibly generous local businesses, student vied for the chance to win water bottles and gift cards to various local eateries among other things. The prize wheel drew nearly the same crowd. CIA pencils, buttons, T-shirts and even a few lab coats were on the chopping block if the pointer was landing in your favor.

Professor **Mas Subramanian** was on hand, along with Post-Doc, **Jun Li** and Grad Student, **Bella Giampaoli** discussing not just one, but two of the major research projects going on in their labs. Nail wraps using Mas's blue pigment were a big hit with everyone, especially the kids, and the electromagnet display was fun for all. Next year, Mas says, he may put the magnets inside a toy train. "That would be fun."

CIA co-sponser, CSMC (Center for Sustainable Materials Chemistry) was also on hand, with a demo and informational booth. This event wouldn't be as great as it is without their generous support, and for that, we thank them.

All-in-all, we're pleased with the turn-out. Many students reported they had a great time, and would be returning next year with friends. We learned some new things and have even more ideas for next year. Come on out, and see what new fun we've thought up over the summer. Can't wait to see you!

Department of Chemistry
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