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CHEMICAL & ENGINEERING NEWS
FEBRUARY 15/22, 2021

TRAILBLAZERS
Celebrating chemistry's diversity

'WE HAVE BEEN HERE ALL ALONG'

C&EN celebrates Black chemists and chemical engineers for its 2021 Trailblazers issue, curated by guest editor Paula Hammond

P.22

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SPECIAL ISSUE

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Collaboration and leadership

This is a guest editorial by **Murrell Godfrey** *from the University of Mississippi,* **Renã A. S. Robinson** *from Vanderbilt University, and* **Emanuel Waddell** *from the University of Alabama in Huntsville. They are the president, president-elect, and immediate past president of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE).*

The COVID-19 pandemic shed light on the historical, long-standing, and still current issues of systemic racism and social injustice in the US. Since the inception of the pandemic, racial inequities have meant increased hospitalization and mortality rates for Black people and other people of color. George Floyd's narration of his own death—which was made publicly available and shared widely through social media—was particularly revealing. Though we mourn his death and so many others, they have galvanized social movements. Floyd's tragic death catalyzed change in the US across many facets of life, chemistry included.

Within the field of chemistry, Black people and other people of color and their allies spent 2020 vocalizing the problems that have long plagued the chemical enterprise. These problems include the lack of diversity, equity, and inclusion (DEI) across departments and institutions (including academia, industry, and government sectors); inequitable barriers to the success of Black people and other people of color in science, technology, engineering, and mathematics (STEM); unwelcoming environments; off-ramps that are overflowing with talented Black trainees who decide to walk away from careers in STEM; microaggressions; and premeditated racist attacks.

Higher education and STEM have failed the Black community. They also continue to fail women. Disparities in salaries between Black and White people and between women and men in STEM persist. The problems run wide and deep. Although this editorial does not broach many of these issues, we acknowledge that being #BlackinChem or #BlackinSTEM is not an easy feat.

Social media and the use of platforms such as Zoom, Webex, and Microsoft Teams have made it easier for individuals and organizations to facilitate conversations on these and other difficult issues in STEM. Virtual conversations lower barriers to participation, increase accessibility, amplify previously unheard voices, and foster community. More importantly, DEI discussions on virtual platforms have yielded solutions. In promotion of Black scientists—and not just for Black History Month—we celebrate these virtual conversations and hope that they have benefited Black scientists and other scientists of color as well as allies and other individuals in their organizations. This visible change in conversation and attitude around issues of race and racism is necessary. However, the chemical enterprise needs to make DEI-based changes in policies and systems.

The change in systems and culture may seem beyond our reach. How does one change an entire field? A company? A university? A department? How do we ensure that all have access to a chemical enterprise that has historically failed so many?

We believe one solution is to systematize change itself. Several organizations, such as NOBCChE, the Society for Advancement of Chicanos/Hispanics and Native Americans in Science, the National Society of Black Engineers, and the Annual Biomedical Research Conference for Minority Students, were created to support, promote, and encourage those who are marginalized in STEM, during times when other organizations explicitly prohibited membership or full participation. Today, these organizations have a strong place in the chemical enterprise in providing community for their members and facilitating system-wide change. However, institutional and systemic racism require more than a single charismatic individual or lone organization to begin to make change a reality.

Creating change—as in truly realizing DEI in chemistry—will require organizations and agencies to partner to tear down old systems and build new ones. Realizing the value that each organization brings allows leaders to establish best practices and new approaches to DEI. The American Chemical Society is an example of an organization that has made a bold statement toward its DEI efforts by partnering with NOBCChE and other organizations supporting underrepresented groups to better meet the needs of all chemists, especially Black chemists and other chemists of color. In recent months, ACS has made strides in providing training to its governance and volunteer leaders in areas including DEI, implicit bias, the ACS code of conduct, microaggressions, and more.

Meaningful collaborations on a large scale between organizations, companies, departments, funding agencies, and others are key to combating systems that do not work and to replacing them with new systems that have DEI built into their fabric. The federal government has also supported NOBCChE and other organizations supporting underrepresented groups to improve DEI in STEM at the K–12 level. This support is morally correct and ensures continued US competitiveness.

The appointment of individuals from marginalized groups to leadership positions should also not be fleeting. The US witnessed historic firsts in 2021 when Kamala Harris became the first Black woman and first South Asian American woman sworn in as vice president; and Alondra Nelson was the first Black woman appointed deputy director of science and society at the White House Office of Science and Technology Policy, by President Joe Biden. These leaders will undoubtedly emphasize the importance of race and DEI in STEM during their national science discussions. Chemistry should be at the forefront of these conversations—and they must be honest and transparent conversations. Taking action and systematizing change through organizational collaborations and strong leadership will help move us in the right direction.

Concentrates

Chemistry news from the week

Highlights

OUTSOURCING

Lipids for COVID-19 vaccines get investment

Several specialty chemical companies are adding capacity to supply Moderna, Pfizer, and BioNTech

As Moderna and the partnership of Pfizer and BioNTech struggle to respond to huge demand for their messenger RNA (mRNA) COVID-19 vaccines, suppliers of the specialty lipids needed to deliver the vaccines in the body are scrambling to keep up.

Lipids are an unsung component in the two mRNA-based shots, the only vaccines to be authorized so far in the US. Naked mRNA quickly degrades in the body and can trigger an unwanted immune reaction. To get the genetic material to its target cells, vaccine developers combine it with a mixture of several sophisticated lipids to form lipid nanoparticles, or LNPs.

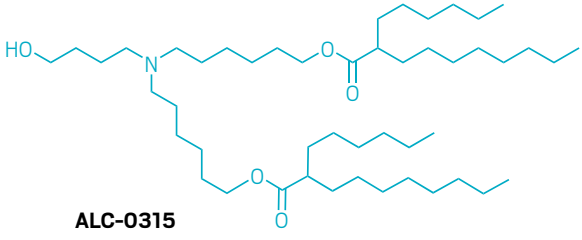
Very few companies in the world supply these custom lipids in significant quantities and to the standards needed for vaccine production. On Feb. 5, one of them, the German firm Merck KGaA, announced that it will "significantly accelerate the supply of urgently needed lipids" for BioNTech to use in producing the Pfizer-BioNTech vaccine. It expects to increase lipid shipments toward the end of 2021.

And on Feb. 11, Evonik Industries said it will begin lipid production at two sites in Germany, also as part of a partnership with BioNTech. The chemical company, a newcomer to large-scale specialty lipid manufacturing, expects to be making commercial quantities as early as the second half of 2021.

Other companies are likewise rapidly scaling up. Croda International, a British specialty chemical firm, is increasing production in Alabama at its subsidiary Avanti Polar Lipids to supply Pfizer. And the German pharmaceutical services firm CordenPharma has been investing in Switzerland, France, and Colorado to supply lipids for Moderna's vaccine under an agreement announced in May.

mRNA vaccine producers use a package of four lipids to formulate their LNPs: an ionizable cationic lipid that encapsulates the negatively charged mRNA; a pegylated lipid that helps control particle lifetime and size; distearoylphosphatidylcholine (DSPC), a phospholipid that helps form the structure of the LNP; and cholesterol, which also contributes to structure. The first two lipids are licensed from Acuitas Therapeutics, which calls them ALC-0315 and ALC-0159, respectively.

ALC-0315 is the most important of the four and the most complex to produce. Matthieu Giraud, global director of CordenPharma's business in peptides, lipids, and carbohydrates, says the synthesis requires about 10 steps and several product isolations. A complete manufacturing campaign is measured in months.



ALC-0315

To meet soaring demand for ALC-0315 and the other lipids, CordenPharma executives supplemented their primary lipid site in Switzerland with production in Chenôve, France. The firm also transferred lipid purification to a plant in Boulder, Colorado, home to its largest purification column. And it embarked on process optimization projects at each site, Giraud says.

Evonik Industries will add production of specialty lipids at this facility in Dossenheim, Germany.

CREDIT: EVONIK INDUSTRIES

These projects are just now beginning to bear fruit. "We started this month to kick off the next level that's expected by Moderna," Giraud says. Overall, CordenPharma has increased its lipid production for Moderna more than 50-fold, he adds, and more increases are possible depending on Moderna's future needs.

Although Evonik is new to lipid production, it has been formulating LNPs since it acquired the Canadian firm Transferra Nanosciences in 2016. Last year the company entered the cholesterol business with the purchase of Wilshire Technologies.

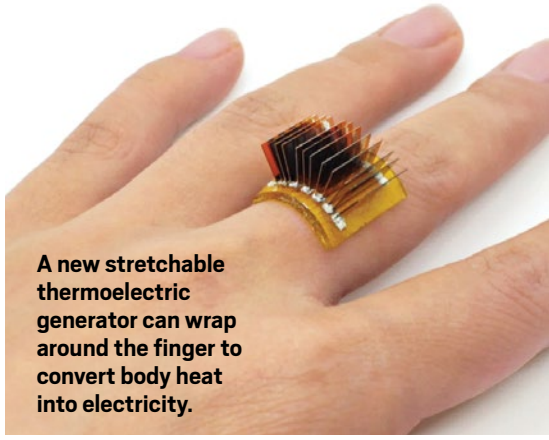
Now, says Stefan Randl, vice president of R&D for Evonik's health-care business, Evonik will add production at plants in Hanau and Dossenheim, Germany, for cationic and pegylated lipids.

Randl sees his firm's investment extending beyond vaccines to serve developers of next-generation mRNA-based medicines such as cancer immunotherapies and protein-replacement therapy. "We really believe this mRNA trend is there to last," he says.—MICHAEL MCCOY

ELECTRONIC MATERIALS

Stretchy material turns body heat into power

Powerful, self-healing thermoelectric generator could charge wearable devices



A new stretchable thermoelectric generator can wrap around the finger to convert body heat into electricity.

By converting heat into electricity, thermoelectric generators (TEGs) could power activity trackers or other wearable gadgets using the wearer's own body heat. Researchers have now made a highly stretchable TEG that produces enough power for such wearable devices, heals itself, and is easy to recycle (*Sci. Adv.* 2021, DOI: 10.1126/sciadv.abe0586).

In TEGs, a temperature difference across thermoelectric materials such as bismuth telluride alloys creates an electric current. But to effectively scavenge body heat, TEGs need to be stretchable and conform to the body, says Jianliang Xiao, a mechanical engineer at the University of Colorado Boulder. He and his colleagues inserted thermoelectric chips vertically into slots on a substrate made of polyimine, a stretchable, self-healing polymer. The finlike design boosts power output by maximizing the temperature difference between the tops of the chips, which are exposed to air, and the bottoms, which touch the skin. The polyimide chips are patterned with bismuth telluride alloy thin films and connected by flexible, printed gallium-indium alloy electrodes.

A 1 cm^2 device that can be worn like a ring has a power output comparable to previous flexible TEGs, but unlike them, it can stretch to over twice its size without a change in output. A device the size of a sports wristband could power a simple fitness tracker or electrocardiogram monitor from the heat generated by walking, Xiao says, and cost around $10.

Soaking the TEG in an amine-based recycling solution dissolves the polyimine substrate and separates the other components, which can be reused. Repairing a damaged device requires simply pressing the cut ends back together for 1.5 h. You can also combine two devices into one with this property, Xiao says.

This linking ability makes the devices easy to configure in different sizes and shapes, says Renkun Chen, a mechanical and aerospace engineer at the University of California San Diego. "If the power output is enhanced, which is entirely possible for this novel device architecture, it may also be used to power smart watches," he adds.—PRACHI PATEL, special to C&EN

DIAGNOSTICS

Glucose meter–based device detects pathogens

Gene circuits paired with glucose meters could work together for diagnostics

Researchers have co-opted glucose meters to detect infectious agents, including SARS-CoV-2, by pairing the devices with synthetic gene circuits that produce glucose in response to target analytes.

The work is "an important advance in synthetic biology toward more practical applications," Yi Lu, a chemist at the University of Illinois at Urbana-Champaign, who has previously used glucose meters to detect other analytes, writes in an email.

Evan Amalfitano, a graduate student in Keith Pardee's group at the University of Toronto, and coworkers have designed gene circuits that generate glucose in response to a target analyte—usually an RNA sequence specific to a pathogen of interest. The researchers add to their system RNA that they have extracted and amplified from a biological sample. The RNA binds to a "toehold switch," an RNA loop with segments that are complementary to the target RNA. When the RNA binds, the toehold switch opens and triggers the translation of a reporter enzyme that can convert a provided substrate to glucose (*Nat. Commun.* 2021, DOI: 10.1038/s41467-020-20639-6). A glucose meter then detects the glucose.

Such an approach can be tailored to detect most microbes by changing the target sequence in the switch. The researchers designed gene circuits to detect the *Salmonella* bacteria that cause typhoid and paratyphoid. They also made sensors for SARS-CoV-2 and antibiotic resistance genes that microbes might carry, as a way to detect drug-resistant pathogens.

Simplifying sample preparation is necessary for the system to be practical, Amalfitano says. Bacterial samples require centrifugation to concentrate the cells. Breaking open the cells and carrying out the necessary reactions require different temperatures. To do these steps, the researchers developed a temperature-cycling incubator. Decreasing the size of the incubator would make the approach more practical, Lu agrees.—CELIA ARNAUD

A glucose meter (left) can detect pathogens when paired with engineered genetic circuits operating in a temperature-cycling incubator (right).

CREDIT: *SCI. ADV.* (RING); STEVE SOUTHON/UNIVERSITY OF TORONTO (METER)

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2-D MATERIALS

Plasma gun sprays out high-quality graphene

The fast, low-cost method splits graphite particles into graphene flakes

Graphite can be split into high-quality graphene (black powder in bottles) with a plasma spray technique.

Graphene has slowly made its way into sports gear, anticorrosion coatings, and even fabric face masks. But widespread use of the strong, conductive material hinges on making high-quality graphene affordably and at large scale. Researchers now report an ultrafast way to peel graphene flakes up to a few atoms thick from graphite by using a high-temperature plasma spray process (*ACS Nano* 2021, DOI: 10.1021/acsnano.0c09451).

Exfoliation techniques that involve lifting monolayers of carbon atoms from graphite yield very small amounts of graphene, sometimes with defects. Chemical vapor deposition (CVD), the leading method of mass-producing graphene, requires multiple steps and is expensive.

Anup Kumar Keshri of the Indian Institute of Technology Patna and his team made graphene by loading graphite particles into a plasma spray gun, which melts powdered materials in a jet of plasma—a high-temperature gas of ions. The plasma spray ripped apart the graphite into graphene flakes; the researchers collected the resulting powder, put it in deionized water, and spun it in a centrifuge to remove unexfoliated clumps of graphite.

Analysis with microscopy and spectroscopy methods showed that 85% of the graphene flakes were a single atomic layer and the rest had a few layers. The flakes were as large as 3 μm in diameter, free of defects, and comparable in quality to graphene made using CVD.

The method yielded 48 g of graphene in 1 h and should be easy to scale up, Keshri says. The material cost $1.12 per gram to make, which "is competitive or even lower than commercially available graphene," he adds, and the cost should go down further when mass produced.

Cecilia Mattevi of Imperial College London says that while the quality of the reported graphene looks promising, it will still have to be benchmarked against CVD-produced graphene in demonstrated applications. The strength and novelty of this approach is "the high selectivity of monolayer graphene and the fast production rate in a nearly one-step process, which can enable large-scale production," she says.—PRACHI PATEL, special to C&EN

ASTROCHEMISTRY

Hydrogen chloride found in Mars's atmosphere

HCl's behavior tells scientists they still don't understand martian atmospheric chemistry

The ExoMars Trace Gas Orbiter detected HCl in Mars's atmosphere for the first time.

The first detection of hydrogen chloride gas in Mars's atmosphere is telling scientists there is still a lot to learn about the planet's chemistry (*Sci. Adv.* 2021, DOI: 10.1126/sciadv.abe4386). Oleg Korablev of the Space Research Institute of the Russian Academy of Sciences says he and his colleagues were looking for signs of methane in data collected by the European Space Agency–Roscosmos ExoMars Trace Gas Orbiter when they spotted signatures of HCl. Two infrared spectrometry instruments on the spacecraft confirmed the findings and recorded different amounts of HCl at different altitudes and times of year, sometimes finding none at all. Korablev says HCl appeared when Mars was closest to the sun, which can create warmer, dustier martian conditions.

That observation would fit with a hypothesis that the gas originates from chlorine-containing molecules in dust, which in turn implicates water in Mars's chlorine cycle: chlorine on the surface may have been part of sodium chloride in a long-gone martian ocean. A water-derived oxidant like the hydroxyl radical could liberate chlorine from dust particles blown into the atmosphere, forming HCl.

Other hypotheses for HCl's formation involve photochemistry or electrochemistry from lightning's freeing chlorine from dust in the air. Or chlorine could come from volcanic eruptions or magma bringing minerals close to the surface, though the group thinks this explanation is less likely.

Korablev favors the water-based hypothesis. Dmitry Shaposhnikov, also of the Space Research Institute but not involved in this research, agrees that available evidence points that way.

HCl's disappearance at the end of Mars's dusty season "is also quite a puzzling thing," Korablev says. The group suggests water ice on the surface or clouds may capture HCl.—SAM LEMONICK

CREDIT: *ACS NANO* (BOTTLES); ESA/D. DUCROS (ORBITER)

CATALYSIS

Solvent molecules catalyze reactions

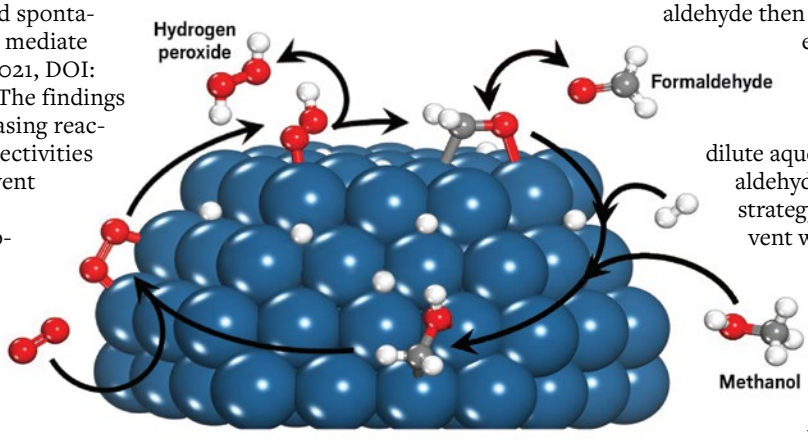
Organic solvents do an unexpected job at surfaces

Organic solvents can play an unexpected role in reactions at the solid-liquid interface.

Researchers find that organic solvent molecules can bind to the surfaces of metal nanoparticles and spontaneously form species that mediate redox reactions (*Science* 2021, DOI: 10.1126/science.abc1339). The findings may lead to ways of increasing reaction rates and product selectivities and reducing organic-solvent waste.

The work grew from observations showing that molecular hydrogen and oxygen react in methanol and other solutions at palladium nanoparticle surfaces to form hydrogen peroxide, which is made industrially from anthraquinone. Directly reacting hydrogen and oxygen gases could save energy, but water, not H_2O_2, is the thermodynamically favored product.

Analyses by David W. Flaherty of the University of Illinois at Urbana-Champaign, Matthew Neurock of the University of Minnesota, and colleagues reveal that liquid-phase methanol molecules bind to Pd, forming stable hydroxymethyl intermediates. These species readily transfer electrons and protons to adsorbed oxygen, forming H_2O_2 and formaldehyde. Formaldehyde then oxidizes hydrogen, regenerating the hydroxymethyl species, which form more H_2O_2. Pure water doesn't drive the reaction, but dilute aqueous methanol and formaldehyde work well, suggesting a strategy for reducing organic-solvent waste.



Hydroxymethyl species formed from methanol or formaldehyde mediate redox reactions that convert oxygen to hydrogen peroxide. Pd = blue, O = red, C = gray, H = white.

Catalysis specialist Lars C. Grabow of the University of Houston says characterizing reactions catalyzed by solvents as cocatalysts will create opportunities for researchers to further improve reaction rates and selectivity.—MITCH JACOBY

ATMOSPHERIC CHEMISTRY

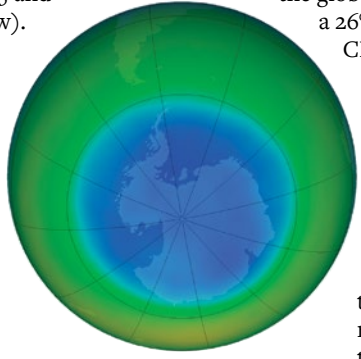
CFC-11 emissions fall again

Finding is good news for the ozone layer

Global emissions of a key contributor to the depletion of stratospheric ozone fell suddenly from 2018 to 2019, largely driven by reductions from within China, according to new analyses (*Nature* 2021, DOI: 10.1038/s41586-021-03260-5 and 10.1038/s41586-021-03277-w).

Stephen A. Montzka of the National Oceanic and Atmospheric Administration and colleagues had previously reported that annual emissions of trichlorofluoromethane, known as CFC-11, began to increase after 2012, even though the chemical was outlawed in 2010 by the Montreal Protocol on Substances That Deplete the Ozone Layer. The team linked 40–60% of the increase to emissions from China.

In one of the new studies, Montzka and colleagues measured chlorofluorocarbons (CFCs) at 13 remote field stations around the globe. Calculations revealed a 26% drop in average global CFC-11 emissions between 2018 and 2019, a return to pre-2012 levels. And in the other study, a different but overlapping team used atmospheric simulations to show that around 60% of the observed drop was attributable to China. The results "show the world that through atmospheric measurements, it's possible to validate the emissions that countries are self-reporting and point fingers at any discrepancies," says Martin Vollmer of the Laboratory for Air Pollution/Environmental Technology at the Swiss Federal Laboratories for Materials Science and Technology (Empa), who was not part of the analyses.



The ozone hole over Antarctica in August 2018.

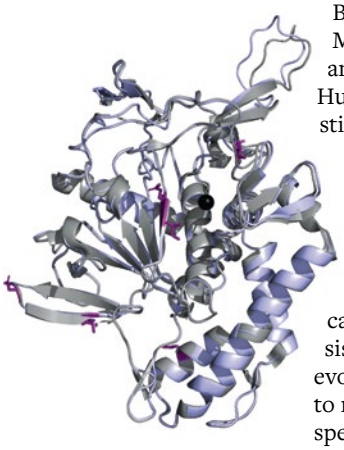
CREDIT: *SCIENCE* (MODEL); NASA OZONE WATCH (GLOBE)

In a separate recent study, Vollmer and colleagues detected emissions of three other, less-ozone-depleting hydrochlorofluorocarbon (HCFC) chemicals. Researchers had not detected one, called HCFC-132b, in the atmosphere before. But after analyzing archived canisters of air, the team determined that the chemical first appeared in the Northern Hemisphere during the late 1990s (*Proc. Natl. Acad. Sci. U.S.A.* 2021, DOI: 10.1073/pnas.2010914118). No one knows what these HCFCs are used for, Vollmer says, which makes eliminating them from the atmosphere difficult to tackle.—BENJAMIN PLACKETT, special to C&EN

BIOLOGICAL CHEMISTRY

Reprogramming botulinum neurotoxins

Proteases are enzymes that cleave other proteins at defined locations. Such enzymes are attractive as therapeutics, but reprogramming them to selectively target a specific substrate is challenging. The natural substrates of botulinum neurotoxin (BoNT) proteases, including the enzyme marketed as Botox, are proteins involved in the formation and release of vesicles in neurons. These enzymes are examples of clinically used proteases that researchers have attempted to repurpose with varying degrees of success. Now researchers have used directed evolution to successfully repurpose enzymes in this class, potentially opening a route to develop new anticancer drugs. David R. Liu of Broad Institute of MIT and Harvard and the Howard Hughes Medical Institute, Min Dong of Harvard Medical School, and coworkers have now used a directed evolution method called phage-assisted continuous evolution (PACE) to reprogram the specificity of BoNT proteases so they target proteins other than their natural substrates (*Science* 2021, DOI: 10.1126/science.abf5972). The researchers used both positive and negative selection PACE to evolve BoNT proteases that selectively target desired substrates. They evolved three distinct classes of BoNT proteases into variants that selectively cleave each of four protein targets chosen by the researchers, including phosphatase and tensin homolog, a signaling protein that is mutated in many cancers and is unrelated to any known native targets of natural BoNT proteases.—CELIA ARNAUD

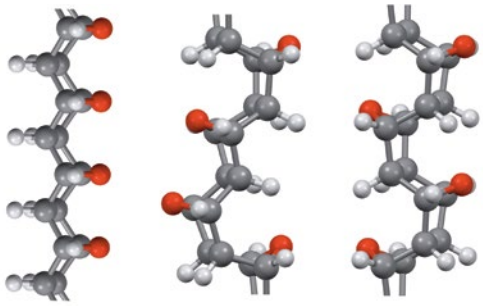


The structure of an evolved botulinum neurotoxin protease (lavender) is overlaid on the original protein (gray). The black sphere is zinc in the active site, and mutated amino acids are shown in dark purple.

NANOMATERIALS

Synthesis takes the pressure off carbon nanothreads

Carbon nanothreads are high-strength polymers typically made by squeezing tiny samples of benzene or pyridine in diamond anvil cells under enormous pressures of 23–30 GPa. But this method can produce only nanogram batches of nanothreads—a major roadblock to exploiting their properties. Researchers have now found a way to produce these nanothreads at one-half to one-third the pressures required previously, scaling up their synthesis so they can be investigated in more detail (*ACS Nano* 2021, DOI: 10.1021/acsnano.0c10400). By using liquid furan as the starting material, Elizabeth Elacqua of Pennsylvania State University and her team can make carbon-based nanothreads at just 10 GPa with a piece of equipment called a Paris-Edinburgh press. Furan has far less aromatic stabilization than benzene and more readily undergoes cycloaddition reactions to build the polymer. The press is larger than a diamond anvil cell and can produce about 5 mg of nanothreads in each run. Mass spectrometry measurements showed that each thread contained about 100 furan rings.—MARK PEPLOW, special to C&EN



Under pressure, furan molecules stack up to make carbon nanothreads in a mixture of syn and anti forms.

POLLUTION

Air pollution is elevated in subways

Subway stations in five US cities have surprisingly high levels of indoor air pollution (*Environ. Health Perspect.* 2021, DOI: 10.1289/EHP7202). These subterranean emissions may raise the risk of heart and lung disease in commuters and transit workers, says Terry Gordon, who studies environmental medicine at New York University's Langone School of Medicine and led the work. Gordon and his colleagues measured the prevalence of airborne particles smaller than 2.5 μm in diameter ($PM_{2.5}$) inside 71 subway stations during rush hour in New York City; Jersey City, New Jersey; Boston; Philadelphia; and Washington, DC. The researchers found $PM_{2.5}$ concentrations much higher than those in the ambient outdoor air in those cities, and on average two to seven times as high as 24 h exposure limits of 35 μg/m^3 set by the US Environmental Protection Agency. Subway stations in New York City consistently scored worse than those in other cities. The findings suggest the need for better ventilation, the authors say. Passenger subway trains are electric, so they don't generate emissions from combustion. But maintenance locomotives, which run on diesel, may be a source. Another probable source is dust created by friction on the rails—by train wheels, for example. These particles have a much higher iron content than those found outdoors. Researchers need to further characterize the chemical composition and toxicity

Subway stations have high levels of air pollution harmful to human health.

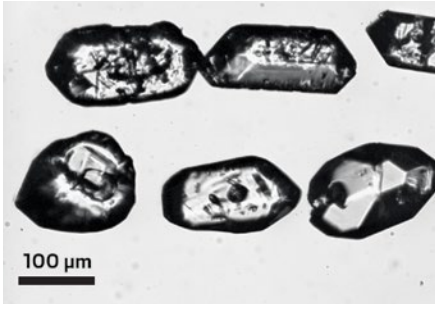
CREDIT: *ACS NANO* (NANOTHREADS); *SCIENCE* (PROTEASE); SHUTTERSTOCK (SUBWAY)

of subway particulate matter, Gordon says.—ALLA KATSNELSON, special to C&EN

GEOCHEMISTRY

Europium reveals time when earth was flat

Chemical data from tiny zircon crystals reveal a possible explanation for a time in Earth's ancient history known as the "boring billion"—a period between 1.8 and 0.8 billion years ago when evolution seemed to stall, producing few new forms of life. The zircon crystals suggest that mountains more than 1–2 km high were scarce during this time (*Science* 2021, DOI: 10.1126/science.abf1876). With fewer mountains around, there would have been less erosion and a short supply of nutrients flowing into the oceans—a geological famine that may in turn have starved life. Ming Tang of Peking University and colleagues studied actinide elements trapped in zircons, tough crystals that preserve a snapshot of the magma chemistry that spawned



These zircons helped reconstruct the history of Earth's mountain formation.

them. While most actinides adopt the +3 oxidation state, europium can exist as +2. This chemical difference depresses the amount of europium in zircons relative to samarium and gadolinium. Zircons that formed under higher pressures in thicker, mountain-forming regions of Earth's crust include less europium than those made at lower pressures (*Geology* 2020, DOI: 10.1130/G47745.1). "It had been very difficult to track mountain formation before we invented this new proxy," Tang says. The researchers compiled published data from about 20,000 zircons spanning 4 billion years of Earth's history and found a steady decline in crustal thickness during the mid-Proterozoic eon. This suggests very little mountain-forming activity around the time when evolution appears to have stalled.—MARK PEPLOW, special to C&EN

CREDIT: CALTECH (ARNOLD); LAURA MORTON PHOTOGRAPHY (DOUDNA); MING TANG (ZIRCONS); *ACS NANO* (LENSES)

Nobel laureates Frances Arnold (left) and Jennifer Doudna (right)

PEOPLE

Podcast: Frances Arnold and Jennifer Doudna talk celebrities, favorite elements, and life after the Nobel

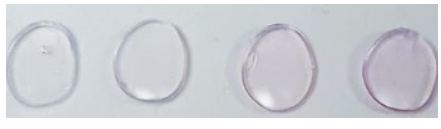
c&en's STEREO CHEMISTRY

Where do you take your career after you've won all of science's biggest prizes? In this episode of *Stereo Chemistry*, C&EN executive editor Lisa Jarvis sits down with Nobel laureates Frances Arnold and Jennifer Doudna to hear about whether their career goals changed after they got that early-morning phone call from Sweden and how the pandemic has shifted the way they approach their work. Listen at **cenm.ag/laureatespod.**—LISA M. JARVIS

NANOMATERIALS

Contact lenses adjust for color blindness

New contact lenses that incorporate gold nanoparticles could one day offer a safe, convenient way for people with what's commonly known as red-green color blindness to better distinguish those colors (*ACS Nano* 2021, DOI: 10.1021/acsnano.0c09657). In red-green color blindness—the most common type—reds can appear green, or vice versa, because light of certain wavelengths that fall between green and red triggers both sets of light receptors in the eyes. Some people with this type of color blindness wear tinted glasses or contact lenses that block these wavelengths and can help the wearer better distinguish colors, but some people don't like the glasses' tinted appearance, and organic dyes used in contacts could migrate out. Ahmed E. Salih



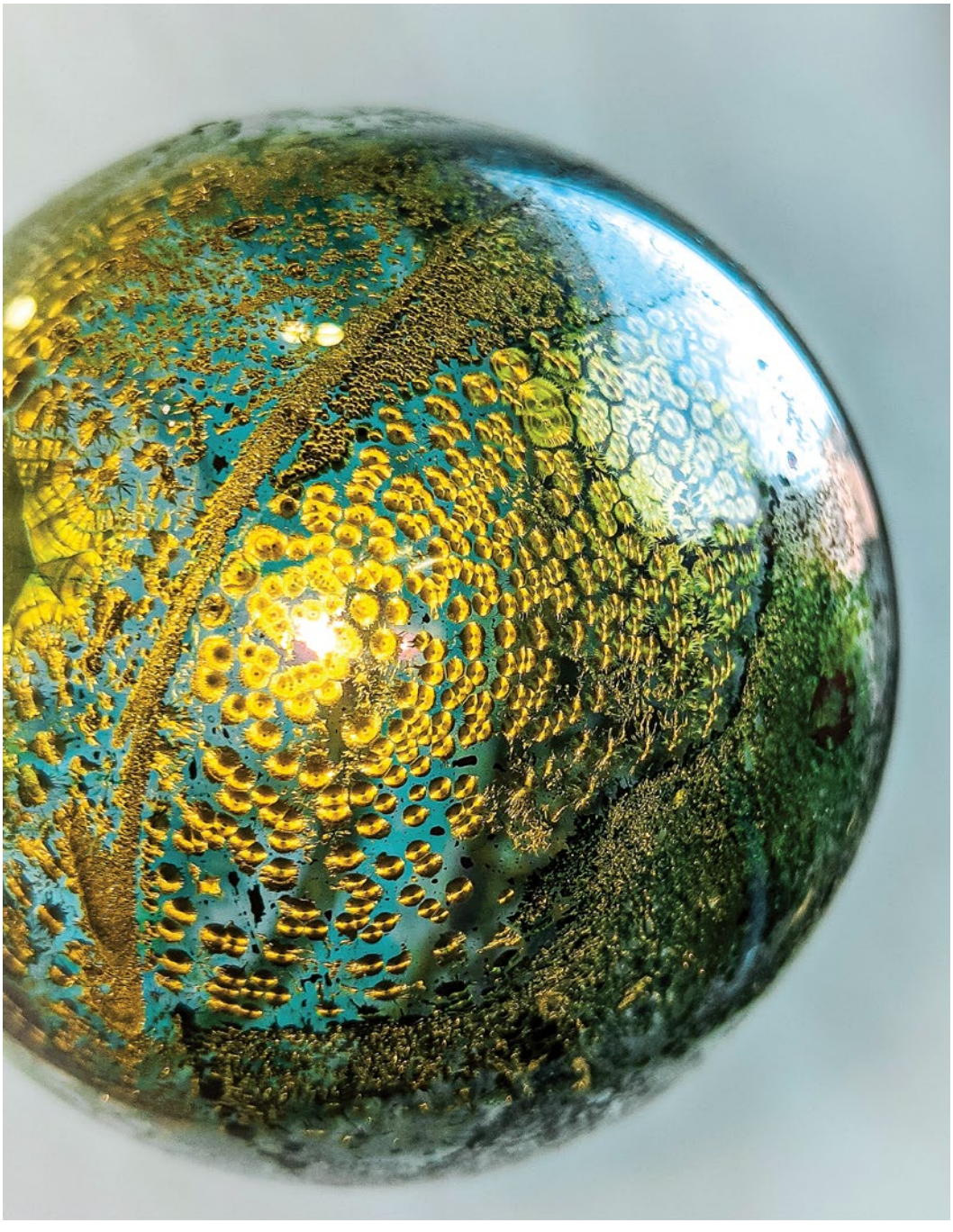
Contact lenses made with gold nanoparticles (at increasing amounts, left to right) block light wavelengths that cause red and green to look similar to people with red-green color blindness.

and Haider Butt of Khalifa University and their colleagues made lenses containing gold nanoparticles in place of dyes. The nanoparticles are stable and absorb light at wavelengths that depend on the particles' size. The researchers tested nanoparticles of three diameters in lenses, identifying two sizes that filtered the targeted wavelengths as effectively as widely used commercial corrective glasses. "We will soon test the biocompatibility of the lenses and if proven successful go to clinical trials," Salih says.—PRACHI PATEL, special to C&EN

CHEMISTRY IN PICTURES

The 2021 contest is on. Send us your captivating chemistry images at **cen.chempics.org/submit.**

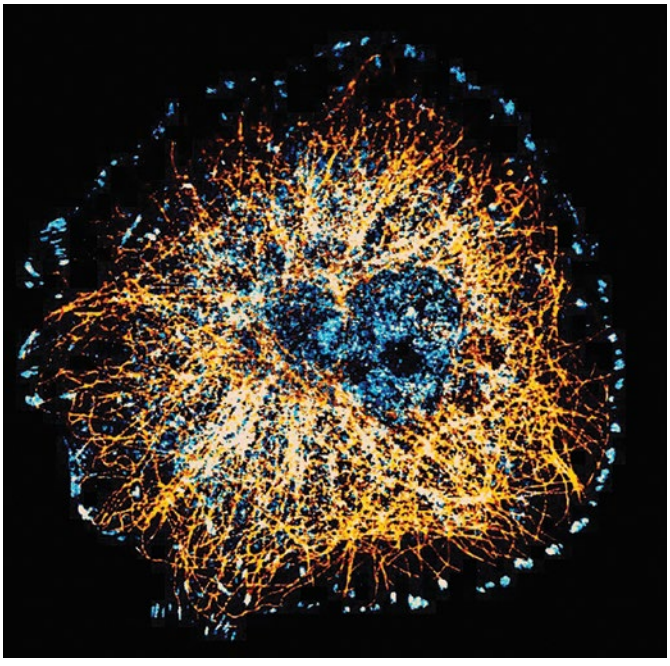
Congratulations to the winners of our 2020 Chemistry in Pictures photo contest! Grand-prize winner Lynn M. Stevens received a mobile phone photography kit



Grand prize: Golden globe

Regular readers of Chemistry in Pictures will remember Lynn M. Stevens's funky color-changing dye. But you might not recognize it here after Stevens purified the compound. Stevens makes and uses dyes like this one as part of her PhD research in Zachariah A. Page's lab at the University of Texas at Austin. She's investigating photosensitizing dyes that can absorb near-infrared light and trigger polymerization reactions, which could make one type of 3-D printing faster, more biologically compatible, and more energy efficient.—MANNY MORONE

Submitted by Lynn M. Stevens



1st runner-up:
Milky Way malady

This image, taken with a confocal microscope, shows a pancreatic cancer cell. The cell's irregular surface is covered with adhesions, tiny structures that help the cell attach to other cells and interact with its environment. The long, thin strands are microtubules that make up the cell's cytoskeleton. Lorna Young, a postdoctoral researcher with the Institute of Translational Medicine at the University of Liverpool, captured this image. Young's team studies how healthy and diseased cells move within the body.—ALEXANDRA TAYLOR

Submitted by Lorna Young

2nd runner-up:
BODIPY on fire

Look closely. Are those flames? Andrea Cabrera-Espinoza, a graduate student at the University of Valle, dropped BODIPY (boron dipyrromethene) derivatives dissolved in chloroform into quartz cuvettes containing methanol. The compounds are less soluble in methanol than in chloroform. That solubility difference helped slow their diffusion, allowing Cabrera-Espinoza to capture the movement under ultraviolet light; the effect was the illusion of colored flames.—CRAIG BETTENHAUSEN

Submitted by Andrea Cabrera-Espinoza

MERGERS AND ACQUISITIONS

Lonza to sell specialties business to private equity firms

$4.7 billion deal with Bain and Cinven will turn Swiss firm into a drug services pure play

The business Lonza is selling includes ingredients for wood preservation, agriculture, cleaning, and other markets.

Bain Capital and Cinven have struck a deal to buy Lonza's specialty chemical business for $4.7 billion. The deal will move 17 manufacturing sites and 2,800 employees to the private equity firms and allow Lonza to focus on its health-care business, including a 10-year deal to manufacture Moderna's messenger RNA vaccine for COVID-19.

In 2020, when CEO Pierre-Alain Ruffieux announced Lonza's intention to get out of specialty chemicals, the unit posted $1.9 billion in sales, 31% of the firm's total for the year. "This provides the [specialty chemical] business with a significant opportunity to find a home where its value can be fully appreciated and its potential can be unlocked," Ruffieux wrote in the Swiss firm's 2020 annual report.

The divestment is part of Lonza's transition into a pure-play health-care company providing active pharmaceutical ingredients and other contract manufacturing services to the drug industry. It reverses a diversification move the company made in 2011, when it acquired the antimicrobial chemical maker Arch Chemicals for $1.4 billion. That deal made Lonza the largest supplier of pool disinfectant chemicals and brought several related business lines.

Lonza took a first step toward undoing the diversification in 2018, when it sold the pool chemical operations to the private equity firm Platinum Equity for $630 million. The sale to Bain and Cinven includes other former Arch operations, as well as longtime Lonza businesses such as biocides, ketene chemicals, and resins for composites.

Sibylle Bischofberger Frick, a financial analyst who covers Lonza at Bank Vontobel, is optimistic about what the sale means for the firm. "They kept the strong growth units and they will grow fast, mainly in biologics, cell and gene therapy, and bioscience," she says. "The remaining business is a pure contract development and manufacturing organization with good margins and interesting growth potential."

Bischofberger expects Lonza to invest the sale proceeds in new plants and equipment, acquisitions, efficiency improvements, and R&D.—CRAIG BETTENHAUSEN

SPECIALTY CHEMICALS

Lanxess will acquire Emerald Kalama

Purchase for $1.1 billion will put German company in the benzoate chemical business

Once again, the German chemical maker Lanxess is acquiring a US-based specialty chemical company. Five years after acquiring Chemtura for $2.5 billion, Lanxess has announced a deal to buy Emerald Kalama Chemical for $1.1 billion.

Based in Vancouver, Washington, Emerald Kalama has about 500 employees and posted sales of $425 million last year. About 45% of its sales are in North America, Lanxess says. The seller is American Securities, a private investment firm that has owned Emerald Kalama since 2014.

Emerald Kalama is the world's largest producer of benzoic acid, which it makes via toluene oxidation at its original plant in Kalama, Washington, and at a facility in Rotterdam, the Netherlands, that it acquired from DSM in 2010. The firm makes derivatives including benzaldehyde, benzyl alcohol, and sodium benzoate at both sites. A facility in Widnes, England, acquired in 2015, produces benzaldehyde-based aroma chemicals.

When Lanxess acquired Chemtura, CEO Matthias Zachert said the deal was driven by the company's desire to grow its business in specialty additives for lubricants, rubber, plastics, and other industrial markets.

This time, Zachert told analysts on a conference call, the goal is to boost sales to consumer markets. Consumer specialties represent roughly 75% of Emerald Kalama's sales, Zachert said, including sodium benzoate for food and animal-feed preservation and aroma chemicals for flavors and fragrances.

On the call, Zachert acknowledged that benzoic acid is a commodity that is increasingly made by companies in China. But he argued that Emerald Kalama's strength is its integration into high-end derivatives. For example, after a $40 million upgrade of the Rotterdam site in 2017, Emerald Kalama is perhaps the only company in the world that can make ultra-high-purity benzoates, he said.

Emerald Kalama upgraded its plant in Rotterdam, the Netherlands, in 2017.

Lanxess had earlier signaled to investors that it has 2 billion euros (about $2.5 billion) available for acquisitions. On the call, one analyst asked whether the company is done shopping. Zachert responded that the process of integrating Emerald Kalama should be "speedy" and that Lanxess continues to monitor a list of about 10 potential acquisition targets. "Our financial power is still there," he said.—MICHAEL MCCOY

CREDIT: SHUTTERSTOCK (CLEANING); EMERALD KALAMA (PLANT)

DRUG DEVELOPMENT

Centessa aims for R&D efficiency

Centessa Pharmaceuticals is the latest firm to explore whether an asset-centered model can make the process of bringing drugs to market cheaper and faster. Founded by the life sciences investment firm Medicxi, Centessa launches with $250 million in funding from a venture syndicate and with a diverse collection of drug programs.

An asset-centered model of drug development centralizes management and resources like manufacturing and regulatory support around sometimes disparate programs, with the hope that experienced managers can guide them efficiently. At Centessa, managers include former big pharma executives like CEO Saurabh Saha and Chief Scientific Officer Moncef Slaoui, who led R&D at Bristol Myers Squibb and GlaxoSmithKline, respectively.

Centessa brings together 10 private biotech firms—each focused on a single asset or biological pathway—under its management umbrella. The result is a pipeline encompassing a range of diseases and featuring four clinical-stage drug candidates.

Centessa is not the first firm to house a collection of drug discovery programs under one management roof. Other examples of the approach include PureTech Health and BridgeBio Pharma.

PureTech founder and CEO Daphne Zohar argues that the model offers advantages over the conventional biotech setup, including efficiency with capital; flexibility in how assets are developed—whether alone, through partnerships, or spun out into their own entities; and the freedom to make decisions more objectively. "Unlike a biotech where everything rides on one or two programs and there's a built-in bias to push programs forward, we have set up incentives to kill programs early so we can move resources to the successful ones," Zohar says.—LISA M. JARVIS

NEUROSCIENCE

Denali's blood-brain barrier shuttle shows promise

Technologies for smuggling large biologics into the brain may open up new therapeutic opportunities

Denali Therapeutics has found a way to sneak biologics past the blood-brain barrier (BBB), suggest preliminary Phase 1 data on its DNL310 in Hunter syndrome.

Hunter syndrome is a rare, lysosomal storage disorder caused by mutations in iduronate 2-sulfatase (IDS), an enzyme that degrades sugar molecules called glycosaminoglycans. People with the disease are typically treated with Takeda's enzyme-replacement therapy idursulfase. But this biologic can't cross the BBB, so most patients still suffer from progressive cognitive decline brought on by the accumulation of glycosaminoglycan in the brain.

Denali's BBB-bypassing candidate, DNL310, consists of the IDS enzyme fused to a protein fragment that binds the transferrin receptor—a carrier protein found in the cells that make up the blood vessels that feed the brain. This "Trojan horse" approach hijacks the receptor to carry a therapeutic into the brain.

The preliminary results covered five boys treated weekly with intravenous DNL310. By 3 months, cerebrospinal fluid (CSF) levels of a key glycosaminoglycan fell by an average of 85%, returning to normal or near normal levels. Glycosaminoglycan levels in the urine fell too, suggesting that DNL310 is also active outside the central nervous system.

"It's very impressive data," says the University of Washington professor William Banks, who studies the BBB. "To see those kinds of changes in the CNS is really very helpful."

Although the drop in sugar molecules is encouraging, Denali must still prove its drug can prevent or slow cognitive decline.

Other companies have attempted to address Hunter syndrome's cognitive effects, but their treatments floundered in late-stage studies. In 2015, a Phase 1/2 trial of intrathecal idursulfase (IT-idursulfase), wherein the enzyme replacement is delivered directly into the CSF by lumbar puncture, lowered CSF glycosaminoglycans levels by 90%. But a Phase 2/3 trial failed to show that the therapy slowed cognitive decline. Takeda, which acquired this drug in 2018, still hopes to receive regulatory approval later this year based on subsequent analyses that suggest the drug benefits patients who start treatment before the age of 6.

Denali is unfazed by the setback for intrathecally delivered enzyme-replacement therapy. Whereas IT-idursulfase diffuses into the brain from a lumbar puncture in the lower spine, intravenously dosed DNL310 gains access through a 600 km network of small capillaries that surround the brain. As such, DNL310's biodistribution will be better, says Carole Ho, Denali's chief medical officer.

Denali CEO Watts and chief medical officer Ho

Preclinical and clinical findings back that up, Ho adds. "We have additional biomarker data that tells us that we're doing something differently and that we are having an effect on lysosomal function," she says.

Denali plans to start a larger trial of DNL310 in 2022.

These early results have good implications for Denali's technology, says CEO Ryan Watts. "Getting the molecule into the brain, no overt immunogenicity, and sustained responses: those should read through for all our transport vehicle programs," he says.

Denali plans to advance two more BBB-busting therapeutics into the clinic by early 2022—one for frontotemporal dementia and the other for Alzheimer's disease—and is in the process of picking an antisense oligonucleotide-shuttle program.—ASHER MULLARD, SPECIAL TO C&EN

CREDIT: DENALI

FINANCE

Chemical producers make a strong finish to 2020

COVID-19 shadowed most of the year, but the final quarter was encouraging

A year like no other is in the books for the chemical industry. And while COVID-19 dragged down sales and earnings for nearly all companies, they finished 2020 strongly as the global economy started to recover.

DuPont completed the year with a sales decline of 5.2% and drop in profits of less than 1%. The company's ace has been its electronic materials business, which, despite the COVID-19 pandemic, saw five consecutive quarters of year-over-year growth, driven by brisk sales of materials for the latest smartphones.

"Throughout the year, we have focused on positioning ourselves for growth through strategic investments, streamlining our overhead structure, improving working capital, and strengthening our balance sheet," CEO Ed Breen says in a statement.

Celanese posted a sales decline of 10.2% and an earnings drop of 19.8%. COVID-19, which shut down the auto industry early in 2020, hit the company's engineered materials business hard, pulling sales down by 12.8%. By the fourth quarter, however, sales in the materials business had bounced back; they rose 8.7% from the third quarter.

Celanese CEO Lori Ryerkerk says she is pleased with how her company weathered the downturn. "As we look at 2021, we are optimistic about how we have entered the year," she told analysts. "Much of the demand uncertainty we experienced across 2020 appears to have resolved at this stage."

DSM managed to increase sales by 1.4% in 2020. Sales in its nutrition segment, which performed well all year, more than offset a slump in its materials business, which relies heavily on the auto industry.

Eastman Chemical saw declines across its businesses in 2020 and ended the year with drops of 8.6% and 15.1% in sales and earnings, respectively. But the firm's recovery toward the end of the year was so vigorous that its fourth-quarter earnings set a record. Some $150 million in cost savings Eastman pieced together in reaction to the pandemic also helped.

"While we prioritized cash, our earnings performance was resilient, which is a testament to the tremendous investments we've made in our innovation portfolio and our overall business portfolio over the last decade," Eastman CEO Mark J. Costa told analysts.

Commodity-oriented LyondellBasell Industries posted bigger 2020 declines than most: 20.1% in sales and 44.9% in earnings. While the company's polymer businesses rebounded toward the end of the year, its refining businesses continued to be hit by low fuel demand due to the pandemic and posted a loss for the year.

These results follow encouraging early signs from larger chemical makers. Last month, BASF came out with healthy preliminary results. At $71.6 billion, its sales were nearly even with 2019, and its earnings beat analyst estimates.

Bolstered by a solid performance in polyethylene and a sharp recovery in polyurethanes, Dow reported a 4.9% rise in fourth-quarter sales year over year, though full-year sales fell 10.3% compared to 2019.—ALEX TULLO

Full-year chemical results

Chemical companies escaped 2020 with declines but without losses

	Change from 2019, %	
	Sales	Earnings
Celanese	↓10.2%	↓19.8%
Chemours	↓10.1	↓21.5
Dow	↓10.3	↓53.2
DSM	↑1.4	↓5.5
DuPont	↓5.2	↓0.9
Eastman Chemical	↓8.6	↓15.1
Huntsman	↓11.5	↓38.2
LyondellBasell Industries	↓20.1	↓44.9

Source: C&EN tabulations based on company documents.

INVESTMENT

SNF will add polyacrylamide capacity

The polyacrylamide specialist SNF will spend $300 million in 2021 and 2022 to increase its production capacity in the US. The investment will boost annual output at the company's plant in Plaquemine, Louisiana, by 30,000 metric tons (t) of polyacrylamide and 100,000 t of acrylamide monomer. The move follows SNF's $1.2 billion round of expansions worldwide, which are wrapping up now. Polyacrylamide forms a gel with water and is used as a flocculant, mainly for water treatment.—CRAIG BETTENHAUSEN

RECYCLING

Coke comes out with 100% recycled bottles

Coca-Cola says it is debuting its first bottles in the US made from 100% recycled polyethylene terephthalate (PET). A new 390 mL bottle made of recycled PET will be available in select states starting this month, followed by standard 590 mL bottles. The company says the shift will reduce its use of new plastic in North America by over 20% compared with 2018.—MICHAEL MCCOY

As part of the rollout, Coke will start making Sprite bottles clear, rather than green, to ease recycling.

ENVIRONMENT

Siemens forges low-carbon partnerships

Germany's Siemens and France's Air Liquide are joining to develop large-scale proton-exchange membrane (PEM) electrolyzers for making hydrogen from water and renewable energy. The partnership will lay the foundation for the mass manufacture of electrolyzers in Europe, the firms say. In a separate initiative, Siemens has partnered with BASF to implement a series of low-carbon technologies, including PEM electrolyzers, at the chemical firm's flagship site in Ludwigshafen, Germany.—ALEX SCOTT

SUSTAINABILITY

Shell pivots to chemicals

Shell has set out a new strategy in which it will steadily move away from oil production while increasing its cash flow from chemicals by as much as $2 billion annually by 2030. Shell will also bolster its activities in sustainable technologies with the aim of being carbon neutral by 2050. As part of its plan, the firm will reduce its refinery network from 13 to 6 sites and cut its fossil fuel production 55% by 2030. It will invest $4 billion to $5 billion annually to increase chemical production, with emphasis on performance chemicals. The firm aims to turn 1 million metric tons (t) per year of plastic waste into chemicals by 2025 and increase the level of recycled plastics in its packaging to 30% by 2030. Shell also plans to have access to 25 million t per year of carbon capture and storage (CCS) capacity by 2035. It is involved in CCS projects in Canada, the Netherlands, and Norway. In addition to investing in its chemical arm, the firm will spend about $3 billion annually to grow its lubricants, biofuels, and electric vehicle–charging network and up to $3 billion on renewable energy activities, including green hydrogen.—ALEX SCOTT

ELECTRONIC MATERIALS

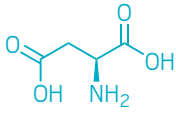
Sumitomo expands advanced photoresists

Sumitomo Chemical will add production lines for argon fluoride and extreme ultraviolet photolithography resists at its plant in Osaka, Japan. The expansion builds on other advanced photoresist investments at the site, which the firm says exceed $94 million over the past 3 years. Overall, the moves will quadruple capacity in Osaka when completed in early 2022. Sumitomo expects demand for such photoresists to grow by 6% per year, driven by 5G mobile phones as well as personal computers and data centers that support increased teleworking.—CRAIG BETTENHAUSEN

SUSTAINABILITY

Lygos to develop biobased aspartic acid

Lygos, a biobased organic acid firm, will develop fermentation-derived L-aspartic acid with partner NanoChem Solutions, a supplier of aspartic acid–based polymers. Such polyaspartates are used in detergents, fertilizers, water treatment, and deep sea oil and gas drilling. Polyaspartates, which are biodegradable, compete with polyacrylic acid, which is not. Past efforts to make them via fermentation were not cost effective, however. NanoChem's parent company, Flexible Solutions, has made an investment in Lygos.—MELODY BOMGARDNER



L-Aspartic acid

GREENHOUSE GASES

C-Zero raises funds for methane pyrolysis

C-Zero has raised $11.5 million from Breakthrough Energy Ventures, Mitsubishi Heavy Industries, and other investors to advance its low-CO_2 process for making hydrogen. The technology, developed at the University of California, Santa Barbara, uses methane pyrolysis to split methane into hydrogen and solid carbon. The hydrogen can be used as a fuel or to make chemicals. Mitsubishi, which is developing hydrogen gas turbines, is also an investor in the methane pyrolysis firm Monolith Materials.—MELODY BOMGARDNER

OUTSOURCING

Wacker buys plasmid DNA expert Genopis

Expanding its contract manufacturing business, Wacker Chemie will acquire

CREDIT: COCA-COLA

Genopis, a San Diego–based expert in plasmid DNA (pDNA) technology, from Helixmith for $39 million. Genopis operates a 500 L pDNA fermentation line and is building a small-scale fermentation facility. "The acquisition allows us to establish a local presence in the large US market for biologics," Wacker CEO Rudolf Staudigl says in a press release. Wacker says it will work with Helixmith to produce a pDNA therapy for diabetic peripheral neuropathy.—RICK MULLIN

OUTSOURCING

Quotient Sciences acquires Arcinova

The British drug services firm Quotient Sciences has acquired Arcinova, a contract development and manufacturing organization in Alnwick, England. Formed in 2016 by the entrepreneur Ian D. Shott, Arcinova has about 160 employees involved in both pharmaceutical chemical and finished drug production. Arcinova, an innovator in continuous process manufacturing, will expand Quotient's drug services platform, which promises customers 12 months' time savings in drug development and production.—RICK MULLIN

Arcinova's site in Alnwick, England, was originally a Sterling Drug facility.

CREDIT: ARCINOVA

BIOTECHNOLOGY

Immunai gets funds for immunotherapy

Immunai has raised $60 million in series A financing to develop immunotherapies by studying the immune system at the single-cell level. The company says the financing brings its total funding to $80 million, which it will use to expand its cell database and improve its work in reprogramming immune cells. Immunai recently partnered with Baylor College of Medicine to analyze genetically engineered natural killer immune cells being tested in clinical trials for neuroblastoma.—MEGHA SATYANARAYANA

INVESTMENT

Dana-Farber launches R&D firm with Deerfield

Dana-Farber Cancer Institute and Deerfield Management, a life sciences investment firm, have formed Riverway Discoveries to develop diagnostics and drugs for cancer. Deerfield has invested in research at several universities in recent years and formed its first partnership with Dana-Farber in 2018, when it promised to bankroll up to $80 million of research on small-molecule protein degraders. Through Riverway, Deerfield will spend up to $130 million over 10 years on translational research projects proposed by Dana-Farber scientists and assessed by a joint steering committee.—RYAN CROSS

GENE THERAPY

Ensoma launches for gene therapy

Ensoma, a Boston-based gene therapy start-up, has launched with $70 million in series A financing. Ensoma is developing gene therapies that target hematopoietic stem cells (HSCs), which give rise to a variety of cells in the blood, including B and T cells and red blood cells. Whereas other groups remove HSCs from the body, edit them in the lab, and reinject them, Ensoma says its engineered adenoviruses can directly target HSCs in the body. Takeda Pharmaceutical also struck a partnership with Ensoma that could earn the start-up $100 million for preclinical research and $1.25 billion overall.—RYAN CROSS

Business Roundup

Elkem has acquired a new organofunctional silicones facility near Lyon, France, for more than $10 million. The metals and materials firm expects to start up the plant, bought from an undisclosed seller, by year's end.

Clariant has made "a significant contribution" to Swiss Federal Institute of Technology (ETH), Zurich, in exchange for 10 years of research into catalysis and sustainable chemistry. The goal is to better understand the effect of catalysts' properties on performance.

EnginZyme, a Swedish start-up developing catalysts based on enzymes fixed to packed-bed reactors, has increased its first round of funding to $13.2 million, from $7.0 million raised in April. Investors include Industrifonden, SEB Greentech VC, and Sofinnova Partners.

Syngenta and Insilico Medicine, an artificial intelligence software company, are collaborating to accelerate the development of crop protection molecules. The project will work with AI and deep-learning techniques that Insilico has employed in pharmaceutical research.

Snapdragon Chemistry has received a $1.5 million grant from the US Defense Advanced Research Project Agency to develop continuous technology for making drug intermediates and fine chemicals. The grant is part of an initiative to bolster the US drug supply chain.

Lonza will expand its solid-form pharmaceutical services operation in Bend, Oregon. Solid-form screening and characterization of small molecules at the site are designed to complement the Swiss firm's production services for small-molecule drug ingredients.

AbbVie will work with the CRISPR company Caribou Biosciences to use its Cas12a gene-editing technology to develop off-the-shelf CAR T-cell therapies for cancer. Caribou will receive $40 million up front and up to $300 million in other payments.

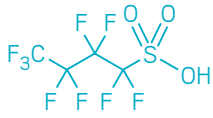
Bristol Myers Squibb will use Molecular Templates' engineered toxin body technology to develop cancer therapeutics. Molecular, which will get $70 million, says the technology can be used to deliver therapies and to inactivate ribosomes to kill target cells.

PERSISTENT POLLUTANTS

EPA yanks assessment of PFBS

Agency says political interference compromised scientific integrity of PFBS document

Political meddling and a breach of scientific integrity led the US Environmental Protection Agency to reconsider a toxicity assessment for perfluorobutanesulfonic acid (PFBS), the EPA says.



PFBS

PFBS is part of a family of environmentally persistent chemicals called per- and polyfluoroalkyl substances (PFAS), many of which are toxic. PFBS has been widely detected in drinking water, wastewater, and food packaging, according to the EPA.

Invoking a Jan. 27 memo on scientific integrity and evidence-based policy making from President Joe Biden, the EPA announced Feb. 9 that it was removing the PFBS assessment from its website and reviewing the document.

The move came after EPA scientists scrutinized a package of actions on PFAS, including release of the PFBS assessment, announced Jan. 19, during the last hours of the Trump administration. The scientists determined that the conclusions on PFBS "were compromised by political interference," the agency says in a statement.

"Issuing documents, like the PFBS Toxicity Assessment, that include conclusions purporting to reflect science when in fact they are the product of biased political interference undermines the agency's scientific integrity policy and erodes the trust that the American public has in EPA, the quality of our science, and our ability to protect their health and the environment," says EPA career scientist Jennifer Orme-Zavaleta. She is the agency's acting assistant administrator for research and development and acting science adviser.

The assessment had set a safe daily dose for long-term exposure to PFBS of 0.0003 to 0.001 mg per kilogram of body weight. This differed from previous EPA toxicity assessments, which set a single value.

"At political direction, the PFBS assessment was changed to provide ranges of values rather than the previously peer-reviewed and vetted reference value," Orme-Zavaleta says in an emailed response to a C&EN query. "These changes were made after the assessment had completed external peer review and public comment" and following final review by the agency and an interagency group, she says.

Presenting toxicity values as a range is not scientifically sound, Orme-Zavaleta adds, and would create "significant challenges" to EPA regulators attempting to rely on the assessment to set cleanup or drinking-water limits.

Giving a range for the safe daily dose of PFBS "does not serve the interest of communities," says Melanie Benesh, legislative attorney for the Environmental Working Group, an advocacy group. "It gives too much discretion to cook the books and calculate less protective safety thresholds."

3M introduced PFBS to replace surfactants that were based on one of the first-generation PFAS, perfluorooctanesulfonic acid, and were used for decades in the company's Scotchgard products. PFBS is used as an industrial surfactant and to make water- and stain-resistant coatings.—CHERYL HOGUE

POLLUTION

Declining funds slow US hazardous waste cleanup

Remediation of many EPA Superfund sites delayed

The federal Superfund program for cleaning up toxic waste sites in the US has slowed over the past 20 years as its funding dwindled, an analysis finds.

In fiscal 2020, a budget shortfall in the Environmental Protection Agency's Superfund program delayed the starts of 34 projects, the report by the US Public Interest Research Group Education Fund finds. This is the largest backup of pending work since 2005, says the analysis, which relied on EPA data.

The Superfund program draws from a trust fund filled by a former tax on feedstock chemicals, crude oil, and corporate income. That levy expired in 1995. The trust fund reached its peak of $4.7 billion in 1997 and had fallen to $225 million in 2020, according to the report.

Congress also provides general taxpayer money to the Superfund program, but annual appropriations have declined in inflation-adjusted dollars from 1999 to 2020, the report says.

The EPA prioritizes funding for ongoing cleanup rather than new projects, the analysis finds. Consequently, declining available dollars reduces the number of sites where cleanup can start, it says.

In 2017, then-EPA administrator Scott Pruitt selected 21 sites across the US for targeted action. The analysis finds that this led to faster cleanup at those places. However, the report says, "it does not address the larger lack of resources that slows down the cleanup of toxic waste sites" across the Superfund portfolio.

CREDIT: US EPA

The report recommends that Congress reinstate a Superfund tax to shift the financial burden of cleanup from taxpayers to polluters. It doesn't suggest which industries should pay the tax.

The US chemical industry has historically opposed resurrecting the Superfund tax.—CHERYL HOGUE

CHEMICAL REGULATION

EPA to revamp risk evaluation process

In an about-face, the US Environmental Protection Agency has abandoned a Trump-era process for deciding which safety studies and other evidence to include in its chemical risk evaluations. The action follows a scathing report from the National Academies of Sciences, Engineering, and Medicine that calls the approach "unworkable."

The EPA developed the controversial method in 2018 to guide the agency's first 10 chemical risk evaluations under 2016 revisions to the Toxic Substances Control Act. The National Academies committee found the process difficult to follow, saying it is not well documented. The lack of details about specific steps related to identifying scientific evidence led to "reduced confidence in the findings," the report says.

The EPA says it is no longer using the approach and is developing a new protocol that incorporates the process used by the agency's Integrated Risk Information System (IRIS) program, as recommended by the National Academies' report. The agency plans to publish and request input from stakeholders on the new protocol later this year.

Environmental groups, which were critical of the EPA's risk evaluation method under the Trump administration, applauded the changes. "EPA must substantially improve this approach to ensure that risk evaluations are scientifically robust and protect public health," Jennifer McPartland, senior scientist at the Environmental Defense Fund, says in a statement. The EPA's announcement "is a welcome signal that it is prioritizing health and the use of strong science in its decision-making," she says.—BRITT ERICKSON

POLICY

EPA nominee emphasizes environmental justice

Michael Regan also wants to limit PFAS releases to air and water

Ensuring environmental justice and controlling releases of per- and polyfluoroalkyl substances (PFAS) are priorities for Michael S. Regan, President Joe Biden's pick to run the US Environmental Protection Agency.

Regan said at his confirmation hearing earlier this month that he plans to "restructure" the EPA and place an environmental justice official in each of the agency's regulatory offices—three, focused separately on air, water, and land pollution, plus one centered on chemical safety. He told the Senate Environment and Public Works Committee, which held the hearing, that he would seek additional funding for these new positions and for an environmental justice adviser to the EPA administrator.

Regan also discussed PFAS, a group of environmentally persistent synthetic chemicals, some of which are highly toxic, that are commonly used for nonstick and water-repellent coatings. Since 2017, in his job leading the North Carolina Department of Environmental Quality, Regan has grappled with PFAS-tainted drinking water affecting hundreds of thousands of the state's residents. He has also overseen PFAS cleanup by chemical maker Chemours, the source of much of that pollution.

At the hearing, Regan said that in addition to setting limits on PFAS in drinking water, he wants the EPA to establish thresholds on allowable industrial releases of these chemicals.

"We need to have a full accounting of how these 'forever chemicals' are entering into our water as well as our air," Regan told the committee. "We need to take a very strong look at the emissions that are coming from the combustion and incineration of products" and whether these processes send PFAS into the atmosphere.

Regan told a Senate committee that environmental protection is essential for economic growth.

North Carolina's senators, Republicans Richard Burr and Thom Tillis, who are not members of the committee, introduced Regan at the hearing. They endorsed him, saying that he is highly qualified for the job as EPA chief. The committee voted in favor of confirming Regan, who now awaits approval from the full Senate.—CHERYL HOGUE

OVERHEARD

"Huge gaps in research on gender and its interlinkages in toxicology and risk assessments exist. The white male body is still used as prototype."

—MSP Institute, a nongovernmental organization focused on sustainable development, in a summary of a webinar series held last year on gender equality in chemical management

CREDIT: BRANDON BELL/UPI/NEWSCOM


C&EN's
TRAILBLAZERS


WE HAVE BEEN HERE ALL ALONG

PAULA HAMMOND, SPECIAL TO C&EN

It is with great excitement that I introduce this special issue on Black Trailblazers in the chemical sciences and engineering! This issue celebrates the work and legacy of Black chemists and chemical engineers at all career stages, throughout the US, in their own voices.

This issue has special meaning to me. I know the impact of having scientific role models who have the same heritage and background, who have faced many of the same or perhaps greater obstacles. I was fortunate to have my own father to look up to. A PhD biochemist and among the first Black men in his academic cohort to receive the degree at his institution in the 1950s, he would become the director of health laboratories for the city of Detroit. My mother was dean of nursing at Wayne County Community College (now called Wayne County Community College District). Their examples shaped my perspective and showed me what I could achieve. I did not have to reach far to find examples of African Americans making a positive impact on the world through science and education.

However, this experience is not a common one for Black scientists and other scientists of color. Inspiration comes from within homes, communities, and the broader world—and it is key that when young Black people and other underrepresented people look around these places, they see chemists and engineers who look like them. Exposure is key to engaging future chemists and chemical engineers. We must introduce a more diverse group of young people to the opportunities that science provides and the many options that await them in chemistry.

As we learn from several of the personal stories highlighted in this issue, such exposure can take many forms, but that first connection to science and research is critical to engage and inspire the next generation.

It was especially important to me to highlight and celebrate Black scientists and technologists in the US in this special issue of C&EN. For centuries, our national narrative has centered on images of scientists and engineers that are predominantly White and nearly uniformly male. This has created a world in which Black Americans do not feel a part of the scientific venture, and thus we cannot fully realize the opportunity and impact that the Black perspective can bring to science, technology, engineering, and medicine. Nor can we fully realize the good we can do for our communities through science, technology, engineering, and math (STEM).

In the worst case, Black people's sense that we do not have a voice in the scientific enterprise can lower our community's participation in critical areas of need, such as getting vaccinated or exposing kids to STEM education.

Without awareness of the significant contributions or even presence of Black participants across scientific fields in the US, our efforts and our work go unrecognized. When we tell stories of Black scientists, students of color who are considering future careers hear evidence that they can go beyond existing in the scientific world—they can thrive in it. It is important that we hear the voices of Black chemists, chemical engineers, and technologists—what inspires them, why they chose their paths, and how they are improving the world through their science.

The history of Black people in chemistry in this country is a long and deep one. Indeed, we have been here all along. Past trailblazers include chemist Alice Ball, who isolated the key active ingredient for leprosy treatment in 1922. There's Percy Lavon Julian, a chemistry PhD and scholar whose work led to the key synthetic route to a glaucoma drug and the development of fire-retardant foams. Julian founded a chemical company in the 1950s. And Bettye Washington Greene, the first Black female PhD chemist at Dow, developed several colloidal and latex materials.

These historical figures, and others you will read about in this package, are but a handful of many names. We must recognize them and numerous other outstanding early contributors to the chemical sciences and engineering, many of whom were the first or among the first to achieve graduate degrees at their institutions or to found or lead companies, departments, or organizations within the field. These names are not in textbooks, and their presence is not generally a part of the national dialogue around chemical discovery. Yet they made important and lasting contributions—discovering molecules, engineering systems, and impacting our field through significant scholarly and practical developments.

Turning to the present day, I had a very difficult time narrowing down the list of accomplished scientists and engineers to the Trailblazers featured in this special issue. Many outstanding chemists and chemical engineers could not be mentioned only because of fit and scope. However, it is inspiring to know the expanse of excellence that these featured scientists represent. I worked closely with the C&EN editorial

Trailblazers 2021 guest editor **Paula Hammond** is the David H. Koch Chair Professor of Engineering and head of the Department of Chemical Engineering at the Massachusetts Institute of Technology. A pioneer in nanomaterials and drug delivery, she is also the cofounder of LayerBio, an associate editor at *ACS Nano*, and a member of all three National Academies (Sciences, Engineering, and Medicine). Hammond is also a member of C&EN's advisory board.

CREDIT: COURTESY OF PAULA HAMMOND

staff to locate people who are at different career stages. It was important to me not only to celebrate highly distinguished scholars at the top of the field but also to highlight those excelling midcareer and early in their careers. The breadth of stories in this issue illustrates the progression of work and the learning that takes place at every career point, showing how a chemist or chemical engineer's career evolves over time.

Furthermore, we chose to present scholars and researchers who trained at and work at a range of US institutions. For example, this issue reveals the huge impact that our historically Black colleges and universities have had on educating a diverse scientific workforce. This Trailblazers issue also shows the role of our public universities and our most elite private institutions and showcases the fact that a great career can be formed from any or all of these kinds of institutions. Another important form of diversity in the issue is the breadth of the African diaspora and the large and diverse Black community that has formed in our nation. This includes Black scientists whose families have been in the US since the slave era, as well as those whose families arrived in this country more recently from the Caribbean islands and from the African continent, sometimes via other countries.

I hope that this issue will inspire all who read it. It is full of examples of incredible work. We hear about the discovery of a molecule that might act as the next therapeutic against prostate cancer and about a technology to regenerate torn knee ligaments. Our colleagues share inspirational stories, many of which come with a personal perspective. For example, we learn about exciting science applied to address sickle cell anemia—led by a biochemist who has the disease. We hear about efforts led by a Nigerian American to address tropical diseases that have real global impact but garner less funding and attention in the US. We find that we are on the cutting edge in every area. Black chemists and chemical engineers are innovators in flexible electronics, smart sensors, light-emitting diodes, and new materials.

And we are reminded of the power of collaborating, through stories of lifelong research partnerships and high-impact, multimillion-dollar centers of research that address soft matter and sustainability.

This issue also provides a unique opportunity to hear these perspectives told through the voices of Black scholars and writers so that we can appreciate the impact of community, mentorship, and visibility. One of the things I am most proud of in this issue is the fact that the entire package was written and told through Black voices, with the exception of some historical profiles previously published on C&EN's website. All the original photography comes from Black creators. Black science writers wrote the contemporary biographical articles in this issue, thus enabling a telling of the Trailblazers' stories that highlights aspects of particular relevance to our community. The package also includes conversational interviews between established Trailblazers and graduate students or postdoctoral scholars. In those articles, we feature the exchange between scientists at different career points as they share excitement around the science, messages of encouragement, and hope that spans generations.

In bringing into focus the unique lives of this set of accomplished Black scientists in chemistry and chemical engineering, I hope this issue opens the door to constant recognition of our presence in the field. We have always been present in the sciences—but now more than ever, not only scientists but all citizens must appreciate and acknowledge the contributions of Black people and other people of color. We must find ways to continue to raise our voices and celebrate our work. As a nation, we all benefit from the huge talent gained when everyone is included in the scientific enterprise.

CAREER LADDER: PAULA HAMMOND

This MIT professor and entrepreneur engineers polymers for robotics and medicine

MARSHA-ANN WATSON, C&EN STAFF

1970s

Discovering the nerd within

Paula Hammond poses for a picture with her brothers.

Paula Hammond's family moved to Detroit during the 1970s. When they arrived, their area "was an all-White neighborhood," she recalls, but it "quickly became Black." Thanks to this demographic shift, Hammond grew up surrounded by accomplished Black professionals. Her father was a biochemist and her mother a nurse—so it seemed only natural that she should gravitate toward science.

In high school at the all-girls Academy of the Sacred Heart, her first woman science teacher awoke a love of chemistry. Mrs. Herr showed her students how chemicals could be combined, their colors changing as new compounds formed. "I learned that I loved chemistry and that I could actually use that interest to perhaps create things," Hammond says. Noting Hammond's skill in math and science, Herr encouraged Hammond to consider a career in chemical engineering.

With her father's assistance, she began exploring her options and visiting schools. During a visit to the Massachusetts Institute of Technology, she felt at home. "There was something calling to the nerd in me," she says. She embraced that inner nerd, and after high school she moved to Cambridge, Massachusetts, to study chemical engineering at MIT.

1980s

Building a home at MIT

At MIT, Hammond says, she felt like a kid in a candy shop. "You were running past people who were at the top of their field; you were in classes with people who had done amazing things," she says. But as a Black woman in chemical engineering—which at that time was a field led predominantly by White men—she experienced impostor syndrome, uncertain if she belonged.

"There was a definite feeling of being there but being different," she recalls. In her classes, she was often the only Black person and one of few women. "You begin to feel isolated," she says. But Hammond didn't give in to the isolation. "There was no way I was going to let someone think that I can't hang. So I'm going to meet the challenge and I'm going to be here, and I'm going to succeed." She formed a support system with her fellow Black students, and upper-level students within the Black Students' Union provided advice and support that ultimately gave her the confidence to do more with her research.

New experiences and new challenges

When Hammond finished her degree at 20, she moved to Florida with her fiancé, a fellow engineer. They began working at Motorola. As a process engineer, Hammond worked on packaging for integrated circuits for cell phones. She was responsible for keeping the plant going, "solving problems and ultimately improving the processes," she says. But she soon became frustrated. "I couldn't use a lot of my engineering know-how," she says. The environment at Motorola was not inclusive. It was "clear that people weren't used to somebody Black or somebody who was a woman," she says. "I was teased about how long a woman engineer could last in the division."

1990s

Mastering polymers

When her husband decided to pursue an MBA in Atlanta, Hammond saw an opportunity to earn her master's degree. While studying at the Georgia Institute of Technology, she worked as a research engineer at the campus-based Georgia Tech Research Institute (GTRI). "Georgia Tech was a much better experience" than Motorola, she says. At GTRI, she had a great boss who also supervised her master's thesis on developing conductive elastomers for robotic tactile sensors.

As she wrapped up her master's degree, she was drawn to a new project started by Robert Cohen, an MIT professor who had inspired her interest in polymers when she was an undergraduate. She was thrilled to return to MIT to complete her PhD, during which she took a "deep dive" into applications for polymers in electrochemical and optical devices.

Paula Hammond (back row, second from right) at the Academy of the Sacred Heart

Paula Hammond and her child in 1995

Paula Hammond at the Massachusetts Institute of Technology in 2002

CREDIT: COURTESY OF PAULA HAMMOND (BROTHERS, ACADEMY, CHILD); STUART DARSCH (MIT)

1990s–2010s

Exploring biomedicine

After a postdoc at Harvard University, Hammond returned to MIT as an assistant professor. She established her lab in 1995 and initially focused her research on the self-assembly and electro-optical properties of polymers. But she had always been interested in biomedical applications, and now that she had her own group, she had a chance to pursue this topic for the first time. "I was always curious about how you might be able to manipulate cells and deliver drugs," she says. Once Hammond got tenure, she took a sabbatical, visiting David Tirrell at the California Institute of Technology to learn more about bioderived polymers. At Tirrell's lab, she learned about the language of cells, biomaterials, and the challenges of drug delivery—as well as how to write proposals for the US National Institutes of Health.

When she returned to MIT, Hammond applied for numerous grants and received funding to expand her research into medical applications. A US Army request for proposals drew her eye. The army was interested in funding projects that would use nanomaterials for medical applications and to protect soldiers in the field. Hammond was excited. "I've always been interested in applying the work that we do to helping humankind in some way," she says. She formed a multidisciplinary group of MIT faculty that ultimately became the Institute for Soldier Nanotechnologies. The team worked on materials for protective clothing using high-strength fibers and developed materials that could rapidly stop bleeding on the battlefield.

Hammond's lab at MIT continued working on biomedical applications and developed multilayer polymer films that could release drugs. "We had these very nice results on bone regeneration and wound healing," she says. Hoping to take the research even further, Hammond became an entrepreneur. She cofounded LayerBio with a colleague, Kenneth Mandell, who was focused on ophthalmologic applications for polymers. Given Mandell's expertise in ophthalmology, the start-up focused on polymer films that release anti-inflammatory drugs in the eye after surgery.

Paula Hammond stands with colleagues Angela Belcher (left) and Sangeeta Bhatia at the Koch Institute for Integrative Cancer Research.

Paula Hammond demonstrates how genetically engineered viruses can be used to produce self-assembling solar cells and batteries during President Barack Obama's visit to MIT in 2009.

Today

Welcoming MIT's new scientists

Hammond is now head of MIT's Chemical Engineering Department. She has seen many changes since her days as a student. "The number of underrepresented minority students has increased significantly," she says. And in her department, women—who made up less than 20% of students during her undergrad years—now make up around 50% of students. "It's really cool," she says. MIT now also has an "understanding that students need to be made to feel welcome," Hammond says. While she has always felt excited to be there, Hammond says the institution has not always done a great job "helping students feel at home." What's important now, she says, is that "we're having the conversations"—particularly about inclusivity, diversity, and privilege—and this discussion has improved the atmosphere.

Hammond's MIT lab focuses on the biomedical applications of polymeric nanomaterials in thin-film coatings for implants, and drug delivery approaches, including nanoparticles, artificial peptides, and nucleic acids. But the SARS-CoV-2 pandemic has affected her research: in 2020, Hammond's main focus was "to a large extent about trying to understand and meet the needs of the lab and my department." She was concerned about the impacts on her international students and about the challenges all her students have had studying and working from home. But one positive is that "it has provided an opportunity for all of us to think more deeply about some of the aspects of our work," she says. "When we come out of this, perhaps we'll have a more reflective and more directly engaged community because we've had time to learn the things that we need."

CREDIT: KOCH INSTITUTE (COLLEAGUES); DOMINICK REUTER (OBAMA); MIT OPENCOURSEWARE (CURRENT PHOTO)

ONE ON ONE WITH OLUWATOYIN ASOJO

Grad student **Michael Hopkins** talks with this structural biologist on her calling to develop drugs for neglected diseases

Eclectic, bold, and fearless. Meet Oluwatoyin Asojo, a structural biologist at Hampton University, who is working to improve therapeutics for rare tropical diseases. Her scientific career began in her father's research lab in Nigeria and has taken her around the world. Spanning multiple fields, Asojo blazed her own trail as an interdisciplinary researcher and worked in industry and government before carving out her niche in academia. Michael Hopkins spoke with Asojo about her compassion for helping people and mentoring the next generation of scientists. This interview has been edited for length and clarity.

Michael Hopkins: Could you tell me about your research?

Oluwatoyin Asojo: Broadly, my objective is to make therapeutics. I use structural biology, biophysics, and computation to study protein interactions with each other or with small molecules to design improved therapeutics.

MH: What diseases are you trying to treat with these therapeutics?

OA: I've done work on glioblastoma. When I was in industry, I worked primarily on HIV. Right now I'm working on vaccines and drugs for neglected pathogens, working on different diseases like leishmaniasis and schistosomiasis. Occasionally I collaborate with people in industry to work on cancer. I also have some collaborations for infectious diseases like malaria.

MH: Why did you choose this field—specifically, structural biology and drug development?

VITALS

OLUWATOYIN ASOJO

- **HOMETOWN:** Ibadan, Nigeria
- **EDUCATION:** BSc, Trent University, 1993; PhD, University of Houston, 1999
- **CURRENT POSITION:** Chair, chemistry and biochemistry, Hampton University
- **GO-TO STRESS RELIEVER:** Nothing beats long walks in nature. After the first 2 mi, I have found solutions or new insights to nagging problems.
- **BEST PROFESSIONAL ADVICE SHE'S RECEIVED:** Avoid saying yes or no right away. Instead, say, "I'll think about it," and do so. It avoids impulsive decisions and shows that you respect yourself and the other person.

CREDIT: COURTESY OF OLUWATOYIN ASOJO

VITALS

MICHAEL HOPKINS

➤ **HOMETOWN:** Raleigh, North Carolina

➤ **EDUCATION:** BS, North Carolina Central University, 2018

➤ **CURRENT POSITION:** PhD candidate, biological chemistry, Johns Hopkins University, working in Seth Margolis's lab

➤ **ON CARING FOR HIS PLANTS:** My lone survivor is a corn plant I've named Cornelius. He seems to be thriving, despite my negligence.

➤ **DREAM VACATION:** Exploring South Africa

CREDIT: COURTESY OF MICHAEL HOPKINS

Michael Hopkins is studying the molecular mechanisms behind a novel protein degradation complex found in brain cells. He is CEO of Black Scientists Matter.

OA: It chose me. I really wanted to make drugs. So when I started grad school, my goal was to be an organic chemist and synthesize chemicals in the lab. Then my mentor allowed me to play with every project in the lab, and I chose to drop all the synthesis projects and work on the structural ones. My intent was never to become a crystallographer; it just happened.

MH: Your research sits at the interface of math, chemistry, biology, and computation. How has being an interdisciplinary researcher contributed to your success as a scientist?
OA: Oh, it's everything. I think the ability to see connections where people don't normally see connections is so important. When you're able to think about problems from a bird's-eye view rather than being stuck on the small, incremental aspects of it, you come up with solutions that people may think are crazy, but they end up being the best approaches. Of course you also fail a lot more, because you pursue crazy ideas. But in the process of failing, you find new directions that enhance your research.

MH: Can you tell me about your academic journey, starting from the very beginning?
OA: My academic journey started when I decided to run away from Nigeria—I'm joking! I was supposed to go to medical school, but I was fortunate enough to get a United World College (UWC) scholarship. I went to Pearson UWC and did my International Baccalaureate. Then I got another scholarship to go to Trent University in Ontario, where I double majored in chemistry and economics and minored in English. After that, I moved to Texas and did my PhD in chemistry at the University of Houston. Next I did a short postdoc at the National Cancer Institute in Frederick, Maryland. After that, I went to industry briefly. I've been in different academic positions ever since.

MH: Your education has taken you all over the world. How have these different environments and perspectives contributed to your scientific career?
OA: One of the constants in my research is I don't like doing projects that everybody is interested in. So I focused my research on neglected tropical diseases. Traveling, moving, and mixing with people have actually reinforced that idea, because there are all these diseases that affect so many people that don't get the level of focus because nobody wants to study them, or there's not enough funding.

MH: What motivates you to keep conducting research even when it is challenging?
OA: I know that if I don't do it, the chances of somebody else doing it is slim to none.

MH: You mentioned that you've worked in academia, industry, and government throughout your career. Which is your favorite and why?

I know that if I don't do it, the chances of somebody else doing it is slim to none.

OA: By far, academia! One word: students. I think hanging around with people that still have that passion for learning keeps me excited to learn new things. I believe I'm not going to stop learning until I'm brain dead, so I like being around people that have that zest for life and that passion for science and that optimism. They're not jaded.
MH: Yeah, I agree. I came into my first year of college thinking I was going to cure cancer.
OA: Uh-huh. I'm one of those people who believe that my role in academia is to nurture that belief students have. Who am I to say that the student standing in front of me is not the one that is going to cure cancer? My purpose is to be a catalyst for them to achieve that vision.

MH: Speaking of mentorship, your first scientific mentor was your father?
OA: Yep.
MH: That's a unique experience. What was it like to be mentored in the lab by a parent?
OA: I'll put it this way: my dad didn't realize he was mentoring me; he thought I was just coming to hang around in the lab. I remember when I was in elementary school, after school, I would just wander over to his lab. And before long, when I was in middle school, I was coming over and helping with experiments. It was just fun, and it was a way to hang out with my dad.

MH: You and your colleagues at Hampton University recently received a $1.5 million grant from the National Institutes of Health to train and develop a diverse pool of undergraduate students. What was it like to conduct research at an HBCU [historically Black college or university]?
OA: Doing research at an HBCU is amazing because the students are hungry. They come with excellence in so many different areas that inform their science. Having the opportunity to nurture the intellectual growth of this pool of students is a privilege.

BIOCHEMISTRY

LAURA M. K. DASSAMA

Drawing insights from structural biology, this chemist hopes to develop treatments for sickle cell disease

VITALS

- **HOMETOWN:** Monrovia, Liberia
- **EDUCATION:** BS, Temple University, 2007; PhD, Pennsylvania State University, 2013
- **CURRENT POSITION:** Professor of chemistry, Stanford University
- **FAVORITE LAB TOOL:** Pipettes, crystal microscope—I have too many; it's hard to pick just one!
- **BEST PROFESSIONAL ADVICE SHE'S RECEIVED:** Pick problems, not projects.

As a child growing up in Monrovia, Liberia, Laura M. K. Dassama would run around and play sports with the neighborhood kids. But for some reason, she always seemed to tire out more quickly than her friends did. Her arms would hurt. Her legs would ache. She often lost her breath.

These episodes of exhaustion were sometimes so severe that she needed to be hospitalized and receive pain medication and blood transfusions. When she was about 5 years old, the doctors figured out why she was always running out of steam: sickle cell anemia.

Now a chemist at Stanford University, Dassama wants to use structural biology to help find potential therapies that could help treat sickle cell disease in people like her. In the US, about 100,000 people have the inherited disorder, according to the US Centers for Disease Control and Prevention (CDC). The disease is present in one of every 365 Black babies born in the US, and in sub-Saharan Africa, about 300,000 children are born with the illness every year, according to the US Department of Health and Human Services Office of Minority Health.

Sickle cell disease is caused by a mutation in the gene that codes for hemoglobin, the protein that carries oxygen in red blood cells. The mutation causes the blood cells to take on a crescent, sicklelike shape instead of the usual disk shape. These irregularly shaped cells can get stuck together in the body's superhighway of arteries and veins, thwarting the flow of blood. As a result, people with the disease experience insufficient oxygen transport in their bodies, leading to fatal organ damage. Many people with sickle cell anemia die of it by the time they are 43, according to the CDC.

"For a long time, the goal was that it's not going to ruin my life. I'm going to win at this," says Dassama, who has had to limit her physical activity since childhood. "These are small battles every day in the big war, and eventually, I'm going to have to find a way to manage it."

In her quest to find potential treatments for sickle cell disease, Dassama is focusing on a protein called fetal hemoglobin, which is essentially unaffected by the mutation that causes the disease. This form of hemoglobin is most prevalent during fetal development, and its levels drop as people age. It binds to oxygen much more tightly than the adult version of hemoglobin does. For people with sickle cell disease, fetal hemoglobin can keep their red blood cells more oxygenated and prevent them from becoming sickle shaped.

People produce different amounts of the fetal version of hemoglobin. About 15% of the hemoglobin that Dassama produces is the fetal

"I'm living proof of what happens when you have increased levels of fetal hemoglobin."

CREDIT: ASHLEIGH REDDY

version, while her sister, who also has sickle cell disease, makes none. As a result, Dassama has had fewer medical emergencies related to sickle cell disease than her sister. At Stanford, Dassama is trying to design a molecule that can go to the bone marrow, where red blood cells are made, and increase levels of fetal hemoglobin by reactivating the gene that codes for it.

"I'm living proof of what happens when you have increased levels of fetal hemoglobin," Dassama says. "It's not a high barrier for us to be able to find a molecule that can allow us to turn on this fetal hemoglobin."

Dassama's current goal is to develop a molecule that increases fetal hemoglobin levels in the body from less than 1% to around 15%, which could potentially reduce the severity of sickle cell–induced bouts of pain and help people live healthier lives. Experts in the field hope Dassama's and others' research with small molecules could increase fetal hemoglobin levels by as much as 30%.

"That would be transformative. You would essentially make the disease's symptoms completely go away," says Stuart Orkin, a pediatric hematology-oncology researcher at Harvard Medical School whose lab Dassama worked in before coming to Stanford.

Though there are gene therapy approaches for sickle cell disease, those treatments are expensive and may not be as widely accessible. "If you had a pill for that and say you could distribute that widely, you could make this a nondisease," Orkin says.

Scientists have already identified the protein, or transcription factor, that silences the fetal hemoglobin gene as we get older. Known as BCL11A, the transcription factor begins repressing fetal hemoglobin by the time a person is 1 year old. Dassama's research is focused on finding ligands, such as small antibody fragments, that can inhibit BCL11A, degrade it, or change its function.

"Her work represents an attempt to bring new chemistry and structural biology to really focus in on a target for reactivating fetal hemoglobin," Orkin says.

Mekedlawit Setegne, a graduate student in Dassama's lab, said she was inspired to work with Dassama because of how she combined chemistry with a drive to make a change for others, especially Black Americans and Africans.

"I had always just assumed those two things had to be separate: you're a scientist, you come and you do science, and then you go home and then think about the rest of the world," Setegne says. But through working with Dassama, she learned she "can rigorously study something that has such an impact, and it's OK to care about that impact."—NICHOLAS ST. FLEUR, special to C&EN

MATERIALS

ONE ON ONE WITH CORDELL HARDY

Grad student **Roneisha Haney** talks with this 3M executive about using science to improve lives

Cordell Hardy knows that successful students become successful adults. With over 15 years of experience in industry, Hardy is now responsible for leading corporate R&D operations, which provides technical infrastructure for 3M's R&D community. His journey began at Florida A&M University (FAMU), a historically Black university in Tallahassee. Roneisha Haney spoke with Hardy about his career decisions and all the places his career has taken him. This interview has been edited for length and clarity.

Roneisha Haney: Can you remember the moment you decided to become a scientist?

Cordell Hardy: I was raised in Philadelphia and went to public city schools throughout my childhood. My mom was an educator, and my dad worked in the finance industry. Neither of them had a technical background, so they didn't necessarily push me toward science. One thing my mom did do at a very early age was expose me to problem-solving challenges. I didn't watch many cartoons, but I did enjoy playing chess and playing with building blocks. I think that sort of problem-solving mentality and feeling comfortable tackling problems was something that stuck with me.

As I went through school, I was exposed to different careers. I thought I was going to be a lawyer because I had an uncle I thought was really cool, and he was a lawyer. I had an aunt who was a doctor, and so I thought, "I'm going to be a doctor." In high school, I particularly enjoyed chemistry and calculus. I did well in the AP [Advanced Placement] classes, and so I was thinking about a field that would allow me to do math and chemistry.

RH: Being from Philly, how did you end up at FAMU?

CH: Around the time I was applying for college, I had the chance to meet FAMU president Frederick Humphries, a very influential figure in FAMU history. He explained to me that if I were to attend FAMU and major in chemical engineering, I would have a scholarship and an internship at a company I had never heard of (at the time) named 3M. So I eagerly accepted the offer. I enjoyed the idea of going to an HBCU [historically Black college or university], going from Philly to Florida, and getting a chance to have a full scholarship. All of that seemed too good to be true. In fact, the scholarship was called the Life-Gets-Better Scholar-

VITALS

CORDELL HARDY

- **HOMETOWN:** Philadelphia
- **EDUCATION:** BS, Florida A&M University, 1998; PhD, University of Minnesota, 2003
- **CURRENT POSITION:** Vice president of corporate R&D operations, 3M
- **PETS:** We have a pair of tortoises that I understand will outlive me by decades.
- **BEST PROFESSIONAL ADVICE HE'S RECEIVED:** Early in my career at 3M, after a couple of years working on projects that were less technical and impactful than I imagined they would be, I considered looking across the company for other positions. My R&D director learned of this and challenged me to create the opportunity rather than look for it.

CREDIT: COURTESY OF CORDELL HARDY

VITALS

RONEISHA HANEY

- **HOMETOWN:** Charlotte, North Carolina
- **EDUCATION:** BS, Clemson University, 2016
- **CURRENT POSITION:** PhD candidate, chemical engineering, Florida A&M University, working in Subramanian Ramakrishnan's lab
- **FIRST JOB:** Cashier, McDonald's
- **SOMETHING SHE DID FOR FUN RECENTLY:** Tried out different authentic Ethiopian recipes

CREDIT: COURTESY OF RONEISHA HANEY

Roneisha Haney seeks to understand structure-performance relationships of polymer-based composites used in extrusion printing of lightweight, functional materials.

ship. Reflecting on how critical education funding was in my life motivates me to keep looking for ways to provide similar opportunities for future students. In fact, 3M just committed $5 million in scholarship funding for students in the Twin Cities to attend HBCUs.

RH: That's great to hear! During your time at 3M, what would you say has been one of the most exciting research moments?

CH: I was working on a formulation for an adhesive. I leveraged structure-property relationships and polymer phase behavior that I had studied while earning my PhD. At that time, I had made 500 formulations. I could tell the very moment when the mixture worked as I intended, and I knew we were going to be successful commercializing it. That was a very gratifying moment.

RH: Nice.

CH: That's just one example. 3M sells tens of thousands of products. And in my 18 years at 3M, I've had the chance to touch quite a number of different value-added solutions that are in the market. Concerning COVID-19, 3M produces disposable respirators that have been very much in the news. I've had the chance to serve as manager for some of the world's leading scientists and experts in this field. The depth of polymer science going into formulating and processing electret filter media used to produce respirators is astounding. Then to produce these at controlled cost and high throughput, helping so many to stay safe while facing pandemic risks, is at once impressive and gratifying. It's a great example of the power of science and its ability to improve lives.

RH: Now that you're in an executive position, do you miss being in the lab and working hands-on with the development of these different products?

CH: That's a fair question. I wouldn't say that it's better or worse; it's just the path that I ended up following. I would say that if you are working in a research capacity at a large company and you are formally asked to lead by other senior leaders at the company, it's generally a good idea to try, right? There are things that I would have never even thought about doing that I've ended up doing over the course of my career. You find your way into those spots by being open minded and doing the best you can on the problem at hand today.

RH: It sounds like you're definitely involved in a number of different projects on a larger scale. What is your typical day like?

CH: Pre-COVID-19 I would get up and go into the office. My entire organization has several hundred people, all outside the US. The role that I fill now has responsibility for providing technical infrastructure for 3M's R&D community wherever we work around the world. I've gone places in the context of my job that I never thought I'd have a chance to experience—China, Thailand, Singapore, Australia, Japan, Mexico, Brazil, Canada, Korea, India, Germany, and the UK. My passport has been stamped quite a bit and that exposure is transformative, especially given how little I traveled growing up.

You find your way into those spots by being open minded and doing the best you can on the problem at hand today.

CH: What are you studying at FAMU?

RH: I'm a fifth-year PhD candidate in chemical engineering. Over the past few years, I have worked to develop polymer-based composite materials to be used as feedstock in 3-D extrusion printing. I'm trying to understand their structure-performance relationships to enhance the performance of polymer-based composites. I'm in my last year, and I will most likely go into industry.

CH: Do you have any companies in mind?

RH: No specific companies, but I am interested in consumer products. I know that's broad, but it's similar to what you were saying: I would like to be in a space where I can make a direct impact on our everyday lives.

CH: What made you choose this field? You're an African American female PhD candidate. How did you get drawn into this space?

RH: I'm a first-generation college student. My mom and grandmother raised me, and I was brought up in Charlotte, North Carolina. I've always loved calculus, but I knew I didn't want to be a teacher. When it came time to choose a major, I spoke with my chemistry teacher, and she introduced me to the field of engineering. During my undergraduate studies, I did an internship with a consulting firm. I worked with the engineers that were on the bachelor's level, but I would also see the PhDs. They were kind of running the show, but it was behind the scenes. I admired them, and I knew that I wanted to be in a position where I had a specialized and deeper level of understanding.

CH: Good. That sounds really neat. You're a trailblazer in a lot of different ways.

HISTORIC TRAILBLAZERS

These Black chemists helped level the scientific playing field

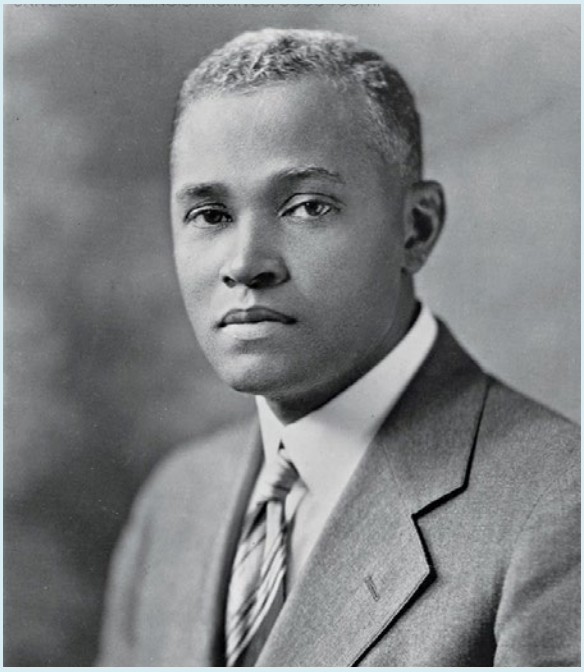
In this issue, C&EN honors the contributions of trailblazing Black chemists and chemical engineers from history. These predecessors shaped the chemical enterprise, educated and inspired young scientists, and helped level the playing field for future generations. Read about more historic trailblazers at cenm.ag/knowblackchem.

ALICE BALL

At the beginning of the 1900s, leprosy was a major public health concern in Hawaii. Alice Ball was a chemistry instructor at the College of Hawaii, which would become the University of Hawaii. She had earned a master's degree in chemistry from the institution, looking for active components in a medicinal plant, the kava root. Ball was the first woman and first Black woman to earn a chemistry degree at the university as well as to become an instructor at the university.

In 1916, Harry Hollmann, a doctor at Kalihi Hospital who was treating people with leprosy, asked Ball to help him determine the active ingredients in chaulmoogra, a plant that had been used with some success to treat the disease. Hollmann was looking to isolate something concentrated and injectable, and in 1 year, Ball had determined how to fractionate the active oil, allowing her to solubilize it (*Arch. Dermatol. Syphilol.* 1922, DOI: 10.1001/archderm.1922.02350260097010).

Ball died suddenly at the age of 24, possibly of accidental chlorine poisoning in a laboratory. Her work was taken up by a male scientist who tried to take credit for her discoveries. Chaulmoogra injections based on Ball's work became a standard treatment for leprosy until the 1940s. In 2000, Hawaii lieutenant governor Mazie K. Hirono named Feb. 29 Alice Ball Day.—MEGHA SATYANARAYANA



ST. ELMO BRADY

In 1916, St. Elmo Brady, born in Louisville, Kentucky, became the first African American to earn a PhD in chemistry. He did his graduate work at the University of Illinois at Urbana-Champaign, and his research focused on how the acidity of carboxylic acids changed according to the addition of different chemical groups. He taught for several years at what would eventually be called Tuskegee University and later became the chair of the Chemistry Department at Howard University.

Several years later, Brady returned to Fisk University, where he had earned his undergraduate degree, to lead its Chemistry Department. He took over from another noted Black chemist, Thomas W. Talley.

At Fisk, Brady created the nation's first graduate program in chemistry at a historically Black college; he created chemistry graduate programs at three other universities as well. In 2019, the American Chemical Society honored Brady with a National Historic Chemical Landmark designation because of the work that Brady accomplished at the University of Illinois at Urbana-Champaign, Fisk, and other institutions. He died in 1966.—MEGHA SATYANARAYANA

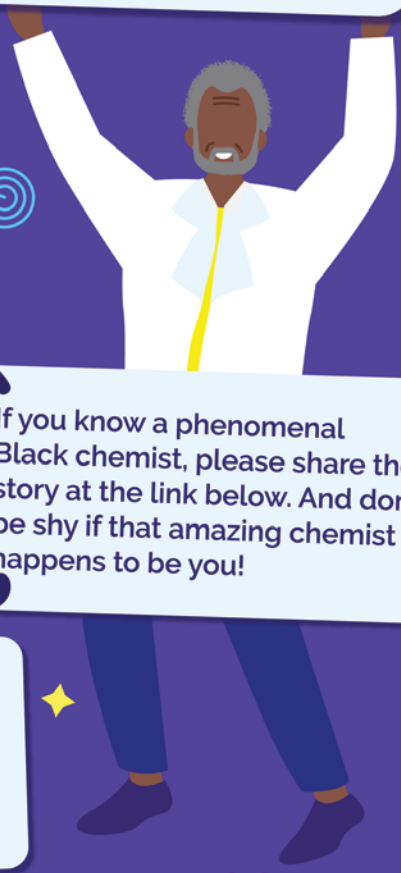
CREDIT: WIKIMEDIA COMMONS (BALL); UNIVERSITY OF ILLINOIS ARCHIVES (BRADY)

CELEBRATING BLACK EXCELLENCE IN SCIENCE

For far too long, Black scientists have not received adequate recognition. February marks Black History Month in America. However, C&EN BrandLab, in partnership with Pfizer, is committing to celebrating Black chemists throughout 2021.

If you know a phenomenal Black chemist, please share their story at the link below. And don't be shy if that amazing chemist happens to be you!

Starting in March, we will select 30 Black chemists to showcase from the nominations in social media posts across C&EN's platforms.



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SHARE THEIR STORY AT

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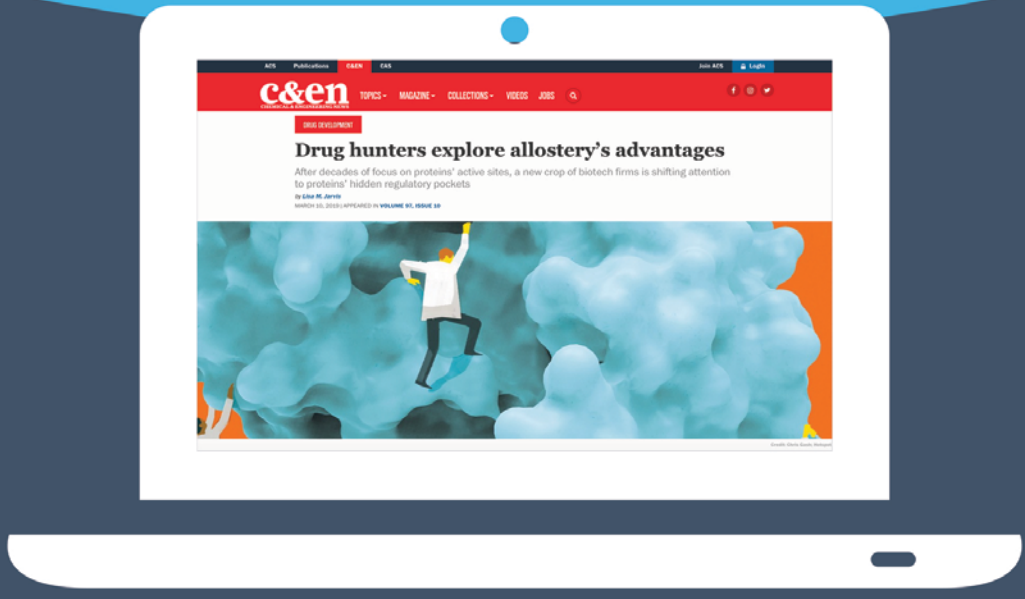

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MARIE MAYNARD DALY

Marie Maynard Daly was the first Black woman in the US to earn a PhD in chemistry. She earned her doctorate from Columbia University in 1947. As a graduate student, she studied the workings of a digestive enzyme, and as a postdoctoral fellow, she investigated the mysteries of the cell nucleus. Her research helped scientists understand histones, proteins that both aid in the organization of our genomes and influence gene expression.

Daly also showed that high blood pressure led to clogged arteries and that high levels of cholesterol were an important contributor to clogged arteries. She also investigated the role of smoking in high blood pressure.

Outside the lab, Daly taught at Howard University and Albert Einstein College of Medicine and worked hard to improve the ranks of underrepresented groups in medicine and science. In 1988, in honor of her father, who had to abandon his chemistry degree because of the cost, she started a scholarship for Black students at Queens College, where she had earned her bachelor's degree in chemistry.—MEGHA SATYANARAYANA

CHARLES DREW

Every 2 s, a person in the US needs to receive a blood transfusion, according to the American Red Cross. Since the 1940s, countless people around the world have received a second chance at life thanks to medical advancements made by Charles Drew, the father of the blood bank.

Drew was born in 1904 in Washington, DC. An athlete since a young age, he attended Amherst College on a scholarship for football and track and field. Though he excelled against challenges on the grass and gravel, he faced racism and segregation both in athletics and in academics. After graduation, Drew pursued medical studies at McGill University Faculty of Medicine, a place known for treating its Black students with more respect than similar institutions in the US. In 1933, he graduated second in his class of 137.

He had a keen interest in blood transfusions, but like all Black scholars, he was barred from pursuing this interest at the Mayo Clinic, where he had hoped to study. So he began work at Howard University College of Medicine as a teacher and enrolled at Columbia University to pursue a doctoral degree. In his graduate research, he found that blood could be preserved longer once the plasma and the red blood cells were separated. This insight extended how long blood could be stored from a couple of days to a week. This discovery was well timed: World War II was breaking out in Europe. Britain, in need of Drew's expertise, called on him to start a blood bank in 1940.

The American Red Cross too called upon Drew. He fought against the group's insistence that Black and White blood be segregated, because there was no scientific merit for the separation. Drew eventually resigned in protest because the organization refused to end the practice.

On April 1, 1950, at the age of 45, Drew overturned his car while driving through North Carolina to a medical conference. He was rushed to a segregated White hospital and, despite receiving a blood transfusion, died of his severe wounds. Mere months after his death, the Red Cross ended its segregated blood donation program, ending one of the racial barriers that Drew poured his blood and sweat into toppling.—NICHOLAS ST. FLEUR, special to C&EN

CREDIT: TED BURROWS/ARCHIVES OF THE ALBERT EINSTEIN COLLEGE OF MEDICINE (DALY); PERMISSION GRANTED BY SCURLOCK STUDIO RECORDS, ARCHIVES CENTER, NATIONAL MUSEUM OF AMERICAN HISTORY, BEHRING CENTER, SMITHSONIAN INSTITUTION (DREW)

ENVIRONMENT

VERNON MORRIS

This chemist is unlocking the secrets of atmospheric dust and expanding field research opportunities

VITALS

- **HOMETOWN:** 10 cities (US Air Force brat)
- **EDUCATION:** BS, Morehouse College, 1985; PhD, Georgia Institute of Technology, 1991
- **CURRENT POSITION:** Director, School of Mathematical and Natural Sciences, New College of Interdisciplinary Arts and Sciences, and professor of chemistry and environmental sciences, Arizona State University
- **BOOK THAT MADE AN IMPACT ON HIM:** *The Souls of Black Folk*, by W. E. B. Du Bois. It allowed me to better understand American culture and society, put into words many of my experiences and thoughts, and revealed that Black people had possessed this deeper insight for centuries.
- **BEST PROFESSIONAL ADVICE HE'S RECEIVED:** Trust in yourself, but put in the work to justify that trust.

There's a whole hidden molecular world floating around above our heads, and atmospheric chemist Vernon Morris is determined to demystify it. Morris, previously a professor at Howard University and now a director at Arizona State University's New College of Interdisciplinary Arts and Sciences, has spent his career illuminating the surprising chemical and physical properties of atmospheric dust. In doing so, he's left an indelible mark in fields such as climate science, meteorology, satellite imagery, and public health.

But Morris's chemistry career almost never got off the ground. It was only because of a chance encounter with renowned chemist Henry McBay that he even considered majoring in chemistry, Morris recalls. Four decades ago, as an undergraduate at Morehouse College, he was taking a shortcut through the chemistry building when he ran into McBay. "I was trying to go get a job to pay for some school debts," Morris says. "And [McBay] said, 'Look, if you major in chemistry, I'll take care of that.'" McBay helped Morris land a job in an atmospheric chemistry lab, and he's been enthralled by the subject ever since.

Years later, after Morris had joined the faculty at Howard, serendipity struck again, this time in the form of an opportune collaboration. A colleague, satellite oceanographer Roy Armstrong, approached Morris with a problem: his satellite images were being obscured by clouds of dust originating from the Saharan desert. To extract the noise, he needed help determining the dust's properties.

Morris suspected that those properties were probably constantly evolving—his chemistry instincts told him that reactions and physical interactions with the atmosphere were probably transforming the dust midflight as it traveled from the Sahara over long distances. To test that notion, the two scientists boarded a small vessel and sailed off the coast of Puerto Rico to harvest dust samples at various locations.

"I was seasick all the time," Morris says of that first voyage. "But we were getting some really interesting data." They found that the dust's properties varied from one side of the island to the other. The properties were

"[Morris] provided kind of a fuel to bring more people together and to create a more supportive community. It's almost like he laid the path, or the template, for the next generation of young scientists to continue."

—Gregory Jenkins, atmospheric scientist, Pennsylvania State University

changing over time, just as Morris had predicted.

Those preliminary data provided the impetus for what would become the Aerosol and Ocean Science Expeditions, or AEROSE, a first-of-its-kind series of transatlantic research cruises to track and characterize the properties of Saharan dust. With Morris as chief scientist, field expeditions produced data that have proved instrumental in validating satellite measurements, refining climate and weather models, and answering fundamental questions about atmospheric chemistry. These data have clarified, for instance, dust storms' effects on ozone chemistry and hurricane formation. And they have revealed thriving airborne communities of bacteria and fungi living on the dust particles' surfaces. Morris has found that these microbes can aggravate asthma and other health conditions when the dust finally settles back to earth.

Gregory Jenkins, an atmospheric scientist at Pennsylvania State University and a former colleague of Morris's at Howard, points out that the AEROSE campaigns have also helped usher in a diverse new generation of atmospheric scientists. On the 12 AEROSE cruises conducted since 2004, Morris has brought along dozens of students from Howard and other institutions serving people of color.

"Quite often, students and faculty members of color are excluded from these kinds of big field projects," Jenkins says. "I always have felt that the field campaigns, if we could get students from underrepresented groups on those, it would be potentially a game changer." Indeed, Morris and others proudly point out that over the past decade, Howard's graduate program in atmospheric science, which Morris helped create, has produced roughly one in every two Black atmospheric science PhDs minted in the US and roughly one in every three Latino PhDs.

As Jenkins sees it, these successes reflect Morris's knack for community building and his drive to make atmospheric science a more inclusive field. He "provided kind of a fuel to bring more people together and to create a more supportive community," Jenkins says. "It's almost like he laid the path, or the template, for the next generation of young scientists to continue."—ASHLEY SMART, special to C&EN

CREDIT: MATT WILLIAMS

ANALYTICAL CHEMISTRY

ONE ON ONE WITH ISIAH M. WARNER

Grad student **Devin Swiner** talks with this analytical chemist about the importance of mentorship

A leading expert in fluorescence spectroscopy, Isiah M. Warner has spent the past few decades creating novel materials called GUMBOS—for "group of uniform materials based on organic salts"—which have a wide array of analytical and materials applications. Outside research, Warner is regarded as an exceptional mentor, having graduated about 70 PhD students, many of them women and people of color. More than 500 undergraduate students have worked with him in his research laboratory or educational programs. Devin Swiner spoke with Warner about his passion in both areas. This interview has been edited for length and clarity.

Devin Swiner: Hi, Dr. Warner! I am really excited about this interview. There is so much I want to talk to you about!
Isiah M. Warner: Hi, Devin! I'm excited as well.

DS: How'd you get into chemistry?
IW: It was my high school English teacher. She knew that I was very bright and got me into a summer chemistry institute that literally changed my life. Those who did well in the institute got to skip the first year of chemistry if they attended Southern University. That was an easy decision for me since I had a full scholarship to attend Southern. However, it wasn't easy jumping into sophomore chemistry. The chair, Dr. Vandon White, heard that we were grumbling about the difficulty and called us into his office for a pep talk. He told each of us our singular characteristic that would make us a great success, and when he got around to me, he said, "Mr. Warner, you will have your PhD before you're 30." I had no idea what a PhD was, but once I did, I aspired to get one. So that is what brought me along; there were mentors along the way that helped and guided me.

DS: That's similar in a lot of Black students' stories. I went to the University of Pittsburgh, and "second-year Devin's" plan was to get a master's in forensics. I didn't know what a PhD even looked like. Like you, I had mentors, like Dr. Renã Robinson and Dr. Tara Meyer, who told me, "You're good at research. You need to consider this as a viable option." So I agree, it is important for the next generation of Black scientists to have good mentors. What about analytical chemistry—what drew you to that?
IW: When I was graduating from Southern, Battelle Northwest came to interview. They were impressed with me and made me an offer, and I accepted it right there, no

VITALS

ISIAH M. WARNER

- **HOMETOWN:** Bunkie, Louisiana
- **EDUCATION:** BS, Southern University, 1968; PhD, University of Washington, 1977
- **CURRENT POSITION:** Vice president for strategic initiatives, Philip W. West Professor of Analytical and Environmental Chemistry, and Howard Hughes Medical Institute professor, Louisiana State University; Boyd Professor, LSU system
- **FUN PROJECT HE'S BEEN WORKING ON:** Writing a new book on mentoring
- **DREAM VACATION:** To visit the entire continent of Africa

CREDIT: COURTESY OF ISIAH M. WARNER

VITALS

DEVIN SWINER

- **HOMETOWN:** Upper Marlboro, Maryland
- **EDUCATION:** BS, University of Pittsburgh, 2016
- **CURRENT POSITION:** PhD candidate, analytical chemistry, Ohio State University, working in Abraham Badu-Tawiah's lab
- **FAVORITE LAB TOOL:** I really love the P200 pipette! I work with small volumes in my research, and that's the one I almost exclusively use. I try to keep one stashed by the lab bench I work on.
- **GO-TO STRESS RELIEVER:** I am a couch potato, so my go-to stress reliever is binge watching something on a streaming service. I watch different genres of shows, so I never run out of things to watch. I also love a good rewatch. I probably have seen *The Office* a total of 10 times at this point.

CREDIT: COURTESY OF DEVIN SWINER

Devin Swiner is developing a new ionization source for mass spectrometry using cellulose materials for applications in clinical diagnostics. She is a cofounder of the #BlackinChem movement.

negotiations or visits. That was the beginning of a job that was largely analytical chemistry. I was a technician, which I did not really like. I ended up going on to graduate school to get a PhD, and because I had done analytical chemistry, that helped when I took cumulative exams. At the same time, I was always very curious—and that is certainly what you need in order to be an analytical chemist.

DS: I agree! I was that "Well, why?" child, and I think the beauty of it is that those are the questions that we answer every day in our research. What is your research group currently focused on?
IW: I'm nearing retirement, probably this year. Therefore, I am no longer taking any graduate students. The only graduate student I have left is now working in industry and simultaneously trying to finish her PhD. I also have two postdocs who are great researchers and also working with the last few undergraduates in my laboratory.

DS: I hope that you look back on everything you've done in the last few decades and are really proud of it, because I know I am impressed. I read one of your reviews on GUMBOS, and I like that they are tunable. Being able to manipulate a material's property to fit an application is the perfect use of chemistry. Can you describe GUMBOS for readers?
IW: I worked in ionic liquid chemistry for a while, and those are organic salts that have low melting points—less than 100 °C. I was fascinated with this chemistry and how you can manipulate the chemistry of those liquids simply by changing the counterions. It occurred to me that if you were to do the same thing in the solid state, it would be just as fascinating. So that's what we are doing. We already have several acquired or pending patents in this area.

DS: I was reading that GUMBOS have been used for almost anything—sensing arrays, organic LEDs [light-emitting diodes], MALDI [matrix-assisted laser desorption ionization] matrices, etc. I'm a mass spectrometrist, so the fact that you can use them for MALDI was really neat.
IW: This area is better known now that we have published several manuscripts. I'm reviewing papers in the literature where people are talking about GUMBOS chemistry. There was a paper that I reviewed recently where the researchers designed this GUMBOS complex so that it could go in solution and selectively fish out their molecule of interest for analysis. That was really cool and interesting.

DS: That's so awesome. Another research-related question: What has been your favorite GUMBOS research discovery?
IW: If I had to pick a GUMBOS idea, there's one thing that really sticks in my mind. Are you familiar with the quartz crystal microbalance?

Hang in there, do your best, challenge yourself, and look for positive mentors.

DS: Yes, it's largely a weighing device, right?
IW: Right. You can weigh small amounts of materials by looking at the change in vibrational frequency of the quartz crystal. We discovered that by depositing a film of GUMBOS on a quartz crystal balance, we could determine the molecular weights of volatile organic compounds. We filed for a patent, and that was the fastest patent I've ever gotten.

DS: That's impressive! You've also been recognized as an amazing mentor, receiving numerous awards for it. What would you describe is the most rewarding thing about serving as a mentor to not only Black students but other underrepresented communities?
IW: It is the feeling that I'm helping someone. I wouldn't be on the path I'm on had there not been persons in place for me, so it's important for me to help others. I'm actually writing a book about mentoring.

DS: I recently asked some of my mentees to write blurbs for my website, and it's always funny when I read things they say. It's like, "Wait, you feel that way? I'm just being myself and actually caring about you and your journey." I cry every time.
IW: I'm the same way. I read some of the things my mentees have said about me. I literally do cry, because I never looked at it from their point of view.

DS: What kind of advice would you give to other Black chemists as they're going through their journeys?
IW: The advice I would give would be to hang in there, do your best, challenge yourself, and look for positive mentors. Look for that person or persons who give you positive energy. Do not let that negative energy turn you off from science.

SYNTHESIS

MALIKA JEFFRIES-EL

Interdisciplinary thinking and synthetic savvy drive organic chemist's design of novel semiconductors

VITALS

- **HOMETOWN:** Brooklyn, New York
- **EDUCATION:** BA, Wellesley College, 1996; MPhil, 1999, and PhD, 2002, the George Washington University
- **CURRENT POSITION:** Professor of chemistry and associate dean of the Graduate School of Arts and Sciences, Boston University
- **FIRST JOB:** Cashier, Burger King
- **BEST PROFESSIONAL ADVICE SHE'S RECEIVED:** Bring your authentic self to the workplace. Don't feel compelled to change to fit in; make them adapt.

Malika Jeffries-EL is on a mission to find a better blue. Her medium is not paint or pastels but organic light-emitting materials found in cell phones, TVs, and other electronic devices.

In her lab at Boston University, she and her team develop organic semiconductor materials that enable flexible, lightweight, environmentally friendly electronics. "Organic semiconductors combine the electronic properties of conventional semiconductors like silicon with the ease of processing of organic materials like polymers," Jeffries-EL says.

While traditional semiconductors are based on elements such as silicon and germanium, organic semiconductors are made from carbon-based molecules that can be synthesized in a lab, allowing chemists like Jeffries-EL to engineer their atomic structure and shape building blocks for new materials.

Bendy and versatile, these organic materials can be printed onto thin surfaces and packaged inside compact devices at relatively low cost. "These are the materials that are driving almost all the cool technology everyone is so dependent on these days," Jeffries-EL says.

Organic semiconductors are found in biosensors that measure blood glucose. They're found in paper-based thin-film transistors made with aerosol jet printers. In organic light-emitting diodes (OLEDs), they produce bright, high-contrast colors in tablets, smartphones, and flat-screen displays.

Though ubiquitous, OLEDs have an Achilles' heel. "You can usually generate every color combination you need if you have the core three primaries: red, blue, and green," Jeffries-EL says. But OLEDs tend to suffer from short lifetimes because they are susceptible to damage from exposure to oxygen, moisture, and high temperatures. Blue OLEDs are the least stable.

Jeffries-EL and her research team have developed semiconducting molecules that emit deep-blue light while maintaining thermal stability, which increases a device's life span, as OLEDs can degrade when they heat up.

The chemist also works on novel materials for photovoltaics. Today, most solar cells are made with crystalline silicon and are usually rigid and bulky, Jeffries-EL says. "Organics are thinner; they're lightweight," she says. "They can be made on flexible devices. So you can make curves and bends in a way that you can't with the silicon."

Flexibility presents enormous potential, says Gregory Welch, a chemist at the University of Calgary who prints small-molecule

"These are the materials that are driving almost all the cool technology everyone is so dependent on these days."

semiconductors. “You can print these organic materials, just like classical inks,” Welch says. In the coming years, he says, “it’s easy to see printing miles of solar panels at cents per watt.”

Like the polymers in her lab, Jeffries-EL stays flexible at work, Welch says. “What Malika has been able to do, very elegantly, is she’s developed a tool kit where she can make new materials, understand their structures, and then determine all their properties,” he says. “By doing that, she can really fit the function.”

The two primary areas of research for these materials now focus on conjugated small molecules and polymers, which Jeffries-EL has engineered into unique structures for more than a decade.

“While her materials have found some application in devices, it is her contributions to developing new examples of conjugated materials that make her stand out,” says Seth Rasmussen, a chemist-historian at North Dakota State University who has mentored Jeffries-EL.

Whether she’s creating new polymers for solar cells or small molecules to make a better blue-emitting OLED, Jeffries-EL thrives in the creative environment of her lab. “I love what I do scientifically because it’s so interdisciplinary,” she says. “I think there are lots of exciting opportunities at this interface between chemistry and materials.”—SHANTAL RILEY, special to C&EN

CREDIT: CIDGY BOSSUET

BIOCHEMISTRY

ONE ON ONE WITH SQUIRE J. BOOKER

Grad student **Tariq Mehdi Bhatti** talks with this chemist about the catalytic moments of his career

Squire J. Booker is a product of a close-knit Black community in Beaumont, Texas. He benefited from several early mentors and role models who guided his early path of achievement. Today, Booker's research on radical-dependent enzymes has uncovered the mechanisms of antibiotic resistance and natural product biosynthesis. He has been recognized with the 2004 Presidential Early Career Award for Scientists and Engineers, a 2012 Arthur C. Cope Scholar Award from the American Chemical Society, and election to the National Academy of Sciences in 2018. Tariq Mehdi Bhatti spoke with Booker about what inspires him. This interview has been edited for length and clarity.

Tariq Mehdi Bhatti: When you were growing up, who were your role models in Beaumont?

Squire J. Booker: I was raised by my grandmother, Cleona Price, but I had three uncles who were very important in keeping me going in the right direction. One of them was a mathematics professor at the local university, who had also mentored Joseph Francisco, past president of the American Chemical Society and the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers. The second uncle was a high school teacher and principal.

The uncle with whom I was closest was Albert Price. He was one of the very first Black commercial pilots. He had worked at NASA and was an Air Force pilot and was also elected to the Texas House of Representatives. Just incredibly ambitious, loved to talk, loved to mentor. And he was always interested in learning. He was always reading. And every time he saw me, he asked, "What are you reading?" And I had better been reading something!

TMB: Your summer undergraduate research experience at the Massachusetts Institute of Technology seemed like an important turning point in your career. Can you tell me more about that?

SB: The person who got me to do that was Joe Francisco. Joe called me and urged me to apply and get some research experience, to help stand out on future applications. I worked under Chris Walsh and the late Bill Orme-Johnson. I liked the whole idea of discovery. I liked the quantitative aspect of generating and interpreting data. I learned some techniques in anaerobic biochemistry. I learned how to purify proteins, which was absolutely key. And I just liked the atmosphere in the lab. It was a collegial place. I sort of ended up in the right situation, in the right environment, with the right people, at the right time.

VITALS

SQUIRE J. BOOKER

- **HOMETOWN:** Beaumont, Texas
- **EDUCATION:** BA, Austin College, 1987; PhD, Massachusetts Institute of Technology, 1994
- **CURRENT POSITION:** Evan Pugh University Professor of Chemistry and of Biochemistry and Molecular Biology, Pennsylvania State University
- **FUN PROJECT HE'S BEEN WORKING ON:** Since the pandemic, I've been working on my ancestry. Really interesting. Got me intensely engaged in American history.
- **DREAM VACATION:** Spending the entire spring in Paris, hitting up all the museums, with weekend excursions to the wine country.

CREDIT: COURTESY OF SQUIRE J. BOOKER

TARIQ MEHDI BHATTI

- **HOMETOWN:** Crofton, Maryland
- **EDUCATION:** BS, University of Maryland, College Park, 2009
- **CURRENT POSITION:** PhD candidate, organometallic chemistry, Rutgers University–New Brunswick, working in Alan Goldman's lab
- **FIRST JOB:** Quality-control technician, W. R. Grace
- **BEST PROFESSIONAL ADVICE HE'S EVER RECEIVED:** Imagine that you're the only person who can solve this problem. What would you do?

Tariq Mehdi Bhatti is studying mechanisms of electron-transfer oxidation of pincer iridium hydrides with the goal of aerobic and electrochemical alkane dehydrogenation.

CREDIT: COURTESY OF TARIQ MEHDI BHATTI

TMB: And then you applied to MIT for graduate studies.

SB: I think that was actually the only place I applied to. And I was fortunate enough to get in. I worked for JoAnne Stubbe. My only real research experience was that summer at MIT. I needed some guidance, and she liked people who needed some guidance. She was very rigid in how people should be trained; so if you weren't trained at all, that's better than having been trained poorly. But soon enough, I came into my own.

TMB: Today, your most fruitful line of research seems to be on SAM [*S*-adenosyl methionine] methyltransferases. How did you start down that path?

SB: When I was with JoAnne, her major project was ribonucleotide reductases, these enzymes that make 2′-deoxyribonucleotides for DNA biosynthesis. One of the classes of those enzymes uses adenosylcobalamin. The way that enzyme works is that there is an organometallic bond between the cobalt of cobalamin and the 5′-carbon of 5′-deoxyadenosine. That bond homolyses to generate a radical on that 5′-carbon. And that radical is superpotent, and it abstracts a hydrogen atom from the nucleotide substrate. While I was a graduate student, Perry Frey at Wisconsin had discovered a new system by which that same radical is generated, a system that doesn't use cobalamin but uses *S*-adenosyl methionine, which is a methylating agent, and an iron-sulfur cluster. So that was very hot at the time. I later worked with Perry on lysine 2,3-aminomutase. And so while I was a postdoc in his lab, there was this pivotal paper published saying that lysine 2,3-aminomutase was a paradigm enzyme in this huge superfamily of enzymes that use *S*-adenosyl methionine and a 4Fe-4S cluster to create radicals.

At that point, I'm like, "Wow, there are other really interesting reactions out there that I could perhaps study that involve this radical-generating system."

TMB: What do you see as your most significant work today?

SB: One of the most important areas of research in my lab right now is to understand how to methylate nonnucleophilic atoms using *S*-adenosyl methionine. A big hit was understanding how unactivated carbon centers in ribosomal RNA get methylated. And it turns out that bacteria that can do that become resistant to over seven classes of antibiotics currently in use. That was a really important reaction to understand. We were clearly the leaders in that area, and we published that initial work in two papers in *Science* in 2011.

More recently, we've been looking at other ways to install methyl groups on unactivated carbon centers. We published some papers in the *Journal of the American Chemical Society* and in *Biochemistry* on cobalamin-dependent methylases, which are found in biosynthetic pathways for numerous natural products that have clinical value. We've shown that the cobalt-methyl bond of methylcobalamin can be cleaved homolytically—a radical substrate can perform a single-electron nucleophilic attack on the methyl group. Before our studies, it was assumed that methylcobalamin is only cleaved heterolytically in enzyme reactions. The second big area of my research is how to functionalize unactivated carbon, something like a hydrocarbon, with sulfur. We know how to do that with oxygen and cytochrome P450s and such, but we know less about installing sulfur.

I liked the whole idea of discovery. I liked the quantitative aspect of generating and interpreting data.

TMB: How fun is that! I'm researching controlled, oxidative functionalization of alkanes myself.

SB: Yours isn't enzymatic—it's organic?

TMB: Organometallic, studying electron transfer oxidation of late transition-metal hydrides.

SB: Right, sure. So C–H functionalization is what you do?

TMB: Exactly that, merging C–H activation with metal hydride oxidation.

SB: Yeah, so we do it enzymatically. We've been studying the mechanism of lipoyl synthase. We found that it uses the radical created from SAM to rip off hydrogen atoms from C8 and C6 of octanoic acid. And then those carbon-centered radicals attack a sacrificial iron-sulfur cluster on the protein. It yanks sulfur out of an iron-sulfur cluster! And then in 2017, we published another *Science* paper where we identified a system in *E. coli* that will put the sulfur back into the protein just as fast as it's being used up.

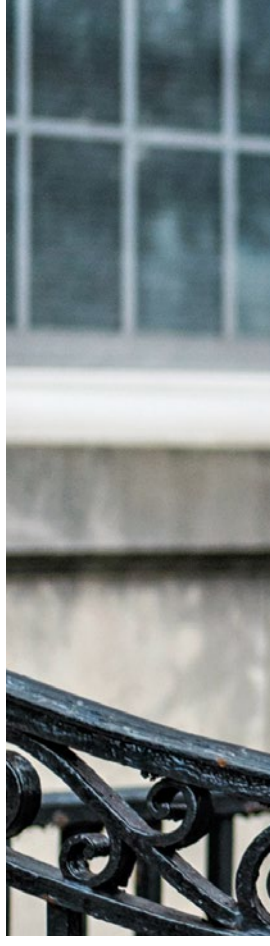
TMB: And then it's ultimately catalytic.

SB: It's ultimately catalytic! It was awesome, awesome.

BIOCHEMISTRY

PATRICK YMELE-LEKI AND JAMEL ALI

These friends and chemical engineers want to better understand the biochemistry of biofilms to find new ways to foil bacterial infections



CREDIT: MARK WALLHEISER/FAMU-FSU COLLEGE OF ENGINEERING (ALI); MICHAEL A. MCCOY (YMELE-LEKI)

Patrick Ymele-Leki and Jamel Ali met in 2011, when Ali was a graduate student pursuing his master's degree in chemical engineering at Howard University and Ymele-Leki had recently joined the same department as an assistant professor. It's unusual for friendships to be forged across the student-professor divide, but since then, the pair have stuck together like two microbes in a biofilm.

These films, which bacteria make by releasing sugars, form a barrier impenetrable by many molecules and help make the microbes resistant to antibiotics. In August of 2020, the National Science Foundation awarded Ymele-Leki and Ali—now a professor at Florida A&M University–Florida State University College of Engineering—a grant to study the detailed mechanisms by which bacteria create these biofilms.

Little is known about how biofilms form. Ymele-Leki and Ali hope to uncover the details of how the flow of surrounding fluids affects biofilm formation early in the process. In the bloodstream, the gut, and environments such as groundwater, water treatment systems, catheters, ship hulls, and industrial piping, bacteria experience mechanical forces caused by the flow of liquids.

Ymele-Leki and Ali are evaluating how external flow affects the microbes' ability to stick to surfaces and the initial distribution of bacteria on surfaces. Next, they'll measure the forces that flow exerts on biofilms and how these bacterial interactions drive biofilm formation.

"These flows have a huge impact on the ability of bacteria to stick to surfaces, stay firmly attached, and grow," Ali says. Bacteria have power in numbers. When they congregate in biofilms, they gain properties they do not possess individually. For example, thanks to enhanced cell signaling and changes in gene expression, microbes living in biofilms are up to 1,000 times as resistant to antibiotics as individual cells are. Ali says he hopes this research will provide fundamental insights into how a bacterium's external environment influences its survival and interaction with its microbial kin.

Ramesh C. Chawla, a chemical engineer at Howard University, says Ali and Ymele-Leki have a lot in common—and not just their research interests. "They are both diligently committed to their work, inquisitive yet patient, likely to come up with out-of-the-box approaches to tackling major scientific challenges," he says. The pair work on more than science. Their personal backgrounds drive their passion for outreach as well. Both, Chawla says, are "equally passionate about mentoring a younger generation of scientists and developing outreach programs for underrepresented middle and high school students."

The scientists bonded when they met because they both have international backgrounds. Born in France to parents of Cameroonian descent, Ymele-Leki immigrated to the US to go to college. Ali was born in the US to an Indo-Trinidadian father and an African American mother. At the time, his father was pursuing a graduate degree at Howard, while his mother was working for the Federal Bureau of Investigation. Ymele-Leki and Ali pursued similar academic routes, earning PhDs in chemical engineering and then teaching at historically Black colleges and universities (HBCUs).

In their individual labs, the pair work on complementary aspects of microbiology. Ymele-Leki is searching for new antibiotic candidates. Ali, with the help of middle and high school mentees in his lab, is investigating how nutrient types and concentrations affect the virulence of various microorganisms.

The researchers hope their work will ultimately pave the way for new antibiotics that can fight resistant bacteria. Their achievements, Ymele-Leki and Ali say, are a by-product of the chemical bond between friends who became colleagues.—FRIEDA WILEY, special to C&EN

VITALS

PATRICK YMELE-LEKI

- **HOME COUNTRIES:** France and Cameroon
- **EDUCATION:** AS, Montgomery College, 2001; BS, 2003, and PhD, 2009, University of Maryland, Baltimore County
- **CURRENT POSITION**: Professor of chemical engineering, Howard University
- **GO-TO STRESS RELIEVER:** Movies and animes
- **BOOK THAT MADE AN IMPACT ON HIM:** *Makes Me Wanna Holler: A Young Black Man in America*, by Nathan McCall

VITALS

JAMEL ALI

- **HOMETOWN:** Washington, DC
- **EDUCATION:** BS, 2011, and MS, 2013, Howard University; PhD, Drexel University, 2016
- **CURRENT POSITION:** Professor of chemical and biomedical engineering, Florida A&M University–Florida State University College of Engineering
- **GO-TO STRESS RELIEVER:** Classical music
- **BEST PROFESSIONAL ADVICE HE'S RECEIVED:** Find a field that you're passionate about and one that is not oversaturated.

HISTORIC TRAILBLAZERS

These Black chemists helped level the scientific playing field

BETTYE WASHINGTON GREENE

In 1965, Bettye Washington Greene was putting the finishing touches on her PhD in physical chemistry from Wayne State University. Her thesis focused on how particles distribute themselves in emulsions, and this research served her well. Later that year, Greene became the first Black woman to work for Dow Chemical.

While at Dow, she worked on developing colloids and on ways to improve latex. She published several papers on developing polymers, including the different properties that aid the redispersion of latex.

Among Greene's many accomplishments are several patents related to latex, including a latex-based adhesive that uses a carboxylic acid copolymerizing agent, and coatings made of latex polymers modified with phosphates. Greene died in 1995.—MEGHA SATYANARAYANA

JAMES ANDREW HARRIS

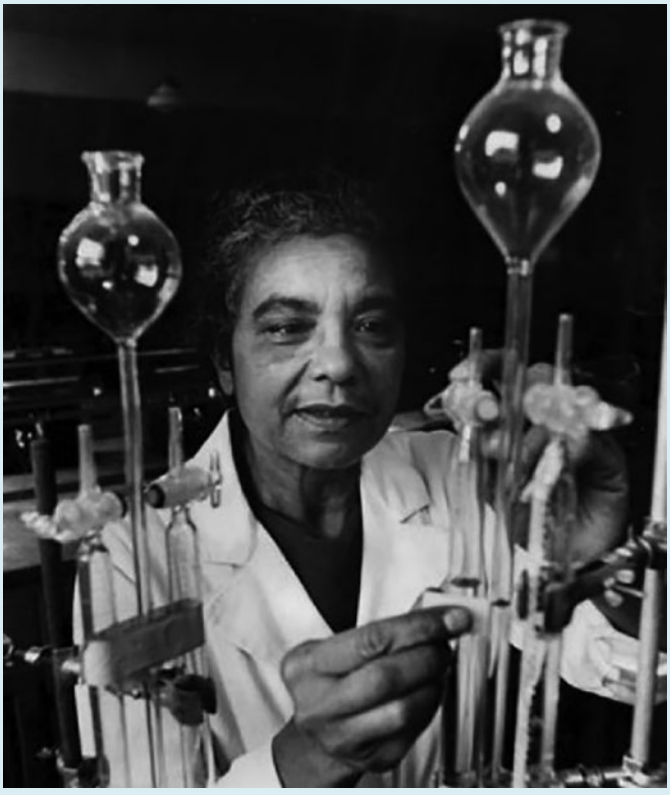
The discovery of an element is a rare occurrence. Defying racial and academic expectations, James Andrew Harris played a prominent role in the discovery of two elements.

Harris, who grew up in both Texas and California, earned a bachelor's degree in chemistry in 1953 from Huston-Tillotson College in Austin, Texas. He then served in the US Army, ultimately earning the rank of sergeant. After his honorable discharge from the army, he struggled to find work as a chemist because of racial discrimination, as most potential employers did not accept that a Black man was qualified to work in science. Harris eventually landed a job as a radiochemist at Tracerlab in Richmond, California, in 1955, where he worked for 5 years.

His most noteworthy work was at Lawrence Berkeley National Laboratory in the 1960s and 1970s. Despite not having a PhD, Harris thrived at the national lab, leading the Heavy Isotopes Production Group as a part of the Nuclear Chemistry Division. His primary job was to prepare targets for the discovery of heavy elements. These are the materials that scientists bombard with elementary particles and nuclei from other atoms to forge new elements. While working with Harris to produce heavy elements, famed nuclear chemist Albert Ghiorso once noted that Harris's target was "the best ever made for heavy element research." A major factor in his successful preparation of these targets was his proficiency in executing difficult chemical separations. Thanks to Harris's persistence and scientific acumen, his team discovered two elements: elements 104, rutherfordium, and 105, dubnium.

An avid golfer, traveler, science communicator, and devoted family man, Harris retired in 1988 after 28 years of service at Berkeley Lab. He died in 2000.—DARRYL A. BOYD, special to C&EN

CREDIT: SCIENCE HISTORY INSTITUTE/WIKIMEDIA COMMONS (GREENE); UNIVERSITY OF CALIFORNIA, BERKELEY (HARRIS)



CREDIT: *LOUISVILLE COURIER JOURNAL* (HILL); SCIENCE HISTORY INSTITUTE (JULIAN)

MARY ELLIOTT HILL

Mary Elliott Hill was a chemist and teacher who worked alongside her husband, Carl Hill, for many years in the mid-1900s. The duo specialized in plastics, using Grignard reactions to form ketenes, highly reactive compounds used in the formation of esters, amides, and other challenging compounds. Mary Elliott Hill was an analytical chemist, designing spectroscopic methods and developing ways to track the progress of the reactions according to solubility.

Hill was born in 1907 in South Mills, North Carolina. She earned a bachelor's degree in chemistry in 1929 from what would later be called Virginia State University. Throughout her career, she taught chemistry at the high school and college levels. In 1951, she became the head of the Chemistry Department at Tennessee State University, eventually leaving to become a professor at Kentucky State College when her husband was named the school's president.

Hill instituted student chapters of the American Chemical Society at some of the historically Black colleges and universities where she taught. Many of her students became chemistry professors, and she won awards for her teaching. Hill died in 1969.—MEGHA SATYANARAYANA

PERCY LAVON JULIAN

Percy Lavon Julian made many discoveries in a wide array of chemical disciplines, and all during an era in which segregationist laws limited Black Americans' access to higher education. Born in 1899 in Montgomery, Alabama, he left the South to enroll at DePauw University. Because of segregation in Montgomery, there was no public high school for Black people, and at DePauw, he had to take high school classes at the same time as his college courses to fulfill the university's undergraduate requirements.

After receiving a master's degree from Harvard University, Julian taught, first at Fisk University and then at Howard University, where he became the chair of the Chemistry Department. He then went to Austria to get his doctoral degree in organic chemistry at the University of Vienna. Afterward, Julian returned to DePauw and began the hallmark research that would lead to his 11-step synthesis of physostigmine, an alkaloid in the Calabar bean that can be used to treat glaucoma.

Later in his career, as chief chemist and the director of the soybean section of Glidden, a chemical company known for paints and varnishes, Julian drew from his academic research to develop efficient syntheses of steroids, as well as nonmedicinal products, such as a fire-retardant foam that was used during World War II on gasoline fires. Julian also started his own chemical company, Julian Laboratories, and the nonprofit Julian Research Institute. Before his death in 1975, he was elected to the National Academy of Sciences.—MEGHA SATYANARAYANA

MORE ONLINE

Get to know more trailblazing Black chemists at **cenm.ag/knowblackchem.**

MATERIALS

ONE ON ONE WITH CARL E. BONNER JR.

Grad student **Isaiah Speight** talks shop with this 'jack of all chemistries'

From his time as a student of William Jackson, one of the founders of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE), to getting Norfolk State University's materials science program off the ground, Carl E. Bonner Jr. has a decorated past that continues to propel him as an independent researcher. His research passions include inorganic and organic chemistry, electrochemistry, nanofabrication, and optical spectroscopy—a list so varied you might call him a jack of all chemistries. Isaiah Speight spoke with Bonner about his early inspirations. This interview has been edited for length and clarity.

Isaiah Speight: So, Dr. Bonner. Can you briefly describe your research?

Carl E. Bonner Jr.: My research grew out of the work of Norfolk State University's Center for Materials Research, which was started in 1994 to make solid-state rare-earth laser materials for NASA. We were making laser materials made of single-crystal oxide glass with neodymium or other rare-earth ions. I did the optical spectroscopy of crystals grown by another group and of prototype lasers fabricated by a third group in the center.

My interests have since grown to include a fair amount of nonlinear optics of materials. This allows me to put a finger in a lot of different pots, which is what I enjoy. These range from things like working on generating piezoelectricity by using laser excitation as a heat source, to promoting electron transfer across interfaces for nonlinear optics, to being able to follow chemistry by performing electrochemistry on metamaterials, which can give us control over the refractive index of a material.

IS: I'm on more of the synthesis side, so I'm wondering: Could your techniques work in monitoring inorganic transformations?

CB: We can monitor the current that passes through as either products

VITALS

CARL E. BONNER JR.

- **HOMETOWN:** Chicago
- **EDUCATION:** BS, 1982, and MS, 1985, Howard University; MS, 1991, and PhD, 1996, University of Rochester
- **CURRENT POSITION:** Professor of chemistry, Norfolk State University
- **FIRST JOB:** Scooping ice cream at Baskin-Robbins in high school
- **FUN PROJECT HE'S BEEN WORKING ON:** I play in a band and at blues jams when I can get away.

CREDIT: COURTESY OF CARL E. BONNER JR.

VITALS

ISAIAH SPEIGHT

- **HOMETOWN:** Portsmouth, Virginia
- **EDUCATION:** BS, Norfolk State University, 2016
- **CURRENT POSITION:** PhD candidate, chemistry, Vanderbilt University, working in Timothy Hanusa's lab
- **FAVORITE LAB TOOL:** A ball mill. I've come to love mechanochemistry so much I try to use it over traditional synthesis.
- **BEST PROFESSIONAL ADVICE HE'S RECEIVED:** To be early is to be on time, to be on time is to be late, and to be late is not to be present at all.

CREDIT: JOSLYN WOODS

Isaiah Speight is using solid-state chemistry, specifically ball milling, to make inorganic and organometallic complexes. He is NOBCChE's national student representative.

or reactants in an electron-transfer reaction. Take for example one of the simplest chemical reactions imaginable: transfer of a single electron to or from an iron surface. If the reaction is set up properly, it can be performed reversibly. From there you can look at the effect of the environment on the electron-transfer rate and just measure that rate as a function of current caused by the transfer of electrons. It's interesting because I don't work much on the synthesis of the materials but rather on the effect of their environment.

IS: That is interesting! Speaking of things being interesting, when was the moment you got interested in applied research?

CB: When I started college, I thought I wanted to be a psychiatrist. The MCAT convinced me that I wasn't going to be a physician. I decided to change gears and attend Howard University's graduate program in chemistry.

I was fortunate that I met Professor William Jackson during my time at Howard. Bill was a top scientist in a field that I knew nothing about. He also reminded me of my dad both in his demand for excellence and his direct manner. Bill had a big influence on me because what he was doing at the time didn't fit my image of what chemistry was. His group was doing astrochemistry using high-resolution laser spectroscopy and computer simulations. So I decided to take a course of his in Fortran programing that was focused on chemistry.

Turns out I was more familiar with Fortran than he was, and at the time, I wasn't shy about pointing it out. So he pulls me aside and says, "You can sit there and be quiet, or I can give you a project. Your entire grade will be based on the project." Silly me chose the project. It was much more interesting, but it was the most challenging thing I had ever done up to that point. Not only did I have to learn quantum mechanics of rotational-vibrational spectroscopy, but I had to do the computations on a computer with 32 kB of memory and a text-only monitor and printer. I only got a B+, but it introduced me to a world of research that I never knew existed. I was hooked.

IS: So it seems that your time with professor Jackson really propelled you forward and inspired you. When you think back to that time, what one skill did you find most useful in your personal career?

The interdisciplinary nature of the group not only made me an interdisciplinary, independent researcher but has also helped me find a common language with students.

CB: I can think of several. One, let people know what your research group wants to accomplish. With Bill, we were always clear about the big picture, but to a large extent we had the freedom to arrange things to meet a specific objective. Bill was always willing to tell you that you were wrong. He was good at giving clear feedback. He never expected you to not tell him what your plans were. He would say, "Just because you were wrong today doesn't mean you were wrong forever." As a result, to a large extent, we weren't afraid to struggle. We didn't take it as a character flaw.

Two, make sure you are communicating in concepts, not words. If you share the concept, you can learn the word for a concept in any language or vocabulary. At that time in graduate school, the Jackson group was interdisciplinary, with students from chemistry and physics. So we had to find a common language, which turned out to be quantum mechanics. The interdisciplinary nature of the group not only made me an interdisciplinary, independent researcher but has also helped me find a common language with students.

IS: So here's a fun question. What would you be doing if chemistry, in all forms, were off the table?

CB: Well that kind of wipes out a big part of the map. First, I need to thank my wife and family for graciously sharing me with my students and colleagues. I would take the opportunity to spend some more time with my family. Aside from that, I took up guitar around Christmas of 2010. Depending on who you ask, I'm either getting better or louder.

BIOMATERIALS

CATO T. LAURENCIN

This tissue regeneration innovator is driven by his twin passions for surgery and biomedical engineering

VITALS

- **HOMETOWN:** Philadelphia
- **EDUCATION:** BSE, Princeton University, 1980; MD, Harvard Medical School, 1987; PhD, Massachusetts Institute of Technology, 1987
- **CURRENT POSITION:** Albert and Wilda Van Dusen Distinguished Professor of Orthopaedic Surgery, University of Connecticut
- **BOOK THAT MADE AN IMPACT ON HIM:** The Bible
- **BEST PROFESSIONAL ADVICE HE'S RECEIVED:** Dream big (advice from my mom and dad)

For Cato T. Laurencin, being asked to choose between engineering and orthopedic surgery would be like having to choose which arm to cut off. These twin passions have driven his innovation in biomedical engineering, including many pioneering achievements in tissue regeneration.

As a sports medicine fellow in the early 1990s, Laurencin saw a fair number of injuries to the anterior cruciate ligament (ACL). This major knee ligament stabilizes the joint and is a common site of injuries, particularly in athletes. He believed there had to be a better way to address those injuries, and he thought the answer could come from using biomaterials to regenerate the ligament. One night, he sketched out a preliminary drawing of how he might do just that.

While a chemical engineering professor at Drexel University from 2001 to 2003, a textile-engineering colleague showed Laurencin two objects that helped with his plan: a flimsy fiber that broke easily and a bar that looked and felt like metal. Both things were made of the same material—one was stronger than the other because it was braided. It dawned on Laurencin that braiding technology could make materials strong and pliable enough to regenerate the ACL.

Laurencin, now at the University of Connecticut, took that inspiration and, along with PhD student James Cooper, developed the patented Laurencin-Cooper Ligament, a surgically implantable, biocompatible, biodegradable 3-D matrix for regenerating the ACL. Once implanted, the device encourages healing. Cells attach to the matrix, grow in the direction of the engineered fibers, and start to regenerate the ligament across the fibers.

Laurencin next turned to regenerating other tissues. His team explored combining polymers and ceramics for musculoskeletal repair in the 1990s and pioneered the use of biocomposites to aid bone and tissue repair.

Laurencin has won the National Medal of Technology and Innovation and has been elected to the National Academies of Engineering and Medicine. Between that aha moment in the textile lab and the crush of accolades that followed, Laurencin has refined the field of tissue engineering with a set of ideas he calls regenerative engineering. These ideas center on integrating tissue engineering with advanced materials science and developmental biology to regenerate complex tissues, organs, and organ systems.

Cedric M. Bright, associate dean for admissions at the Brody School of Medicine, says that in addition to Laurencin's legion of

CREDIT: OCTAVIO JONES

"That's what I'm dedicated to—to improving the human condition."

professional accomplishments, he is best defined by his compassion and caring, particularly when it comes to equity and fairness with colleagues. "He embodies the adage 'If you want to go far, take somebody with you.' Cato is a champion of climbing and reaching back."

For his work mentoring hundreds of students in engineering and medicine and developing initiatives to improve diversity in medicine and science, Laurencin has also received the Herbert W. Nickens Award for promoting justice in medical education and health-care equity.

Laurencin continues to push engineering and medical boundaries in working to regenerate increasingly more complex tissues. Three years ago, his Connecticut Convergence Institute for Translation in Regenerative Engineering announced the Hartford Engineering a Limb (HEAL) project, which has set the goal of regenerating a human limb by 2030. The team has already regenerated every tissue of the leg.

While this goal strikes many as more science fiction than science, Laurencin points out that growing bone cells and regenerating the ACL also seemed far off at one point. In the HEAL project, as well as his work mentoring students and developing new healing technologies, Laurencin says he's driven by the desire to help people. "This is at the heart of everything we think about," he says. "That's what I'm dedicated to—to improving the human condition."—MELBA NEWSOME, special to C&EN

SYNTHETIC BIOLOGY

ONE ON ONE WITH KRISTALA L. J. PRATHER

Postdoc **Korie A. Grayson** talks with this chemical engineer about harnessing the synthetic power of microbial systems

Kristala L. J. Prather is studying the design and assembly of novel pathways for biological synthesis, enhancement of enzymatic activity and control of metabolic flux, and bioprocess engineering and design. She spent 4 years at Merck Research Laboratories before returning to academia. Korie A. Grayson spoke with Prather about her career path and what she is working on today. This interview has been edited for length and clarity.

Korie A. Grayson: What made you go from Merck back to academia?
Kristala L. J. Prather: I intentionally chose to use industry as a training ground to help me develop ideas and learn a little more about how technologies are adopted and how new innovations in a lab might actually translate into what would happen in a company. I felt like I understood academia very well but didn't have a clear sense of the kind of work that's done and, more importantly, how that work is executed in an industrial setting. So when I interviewed for industrial positions at the end of my graduate career, I was very clear with potential employers that my goal was to work for just 2 or 3 years—that I was interested in applying for faculty positions. And that's what I did. What I really liked about my job at Merck was working with the junior staff. Seeing them develop into independent scientists gave me the greatest joy. And that's the essence of what an academic career is.

KG: I can relate. Before I started my PhD program, I worked at a biomedical device company. I was in industry for about 2 years before I started my program, and now I am at the University of Michigan as a postdoctoral research fellow in Lola Eniola-Adefeso's lab. I get asked all the time, "Are you going to go into academia?" And I'm like, "I don't know" or "I'm not exactly sure yet."
KP: Not everyone is going to end up in academia. But for people who are interested in academic careers, what I always say is, "Somebody is going to get the job; why not let it be you?"

KG: That's good to hear. Let's track back all the way before you even became a professor at the Massachusetts Institute of Technology. What was your initial in-

VITALS

KRISTALA L. J. PRATHER

- **HOMETOWN:** Longview, Texas
- **EDUCATION:** SB, Massachusetts Institute of Technology, 1994; PhD, University of California, Berkeley, 1999
- **CURRENT POSITION:** Professor of chemical engineering, Massachusetts Institute of Technology
- **BOOK THAT MADE AN IMPACT ON HER:** *The Autobiography of Malcolm X*
- **BEST PROFESSIONAL ADVICE SHE'S RECEIVED:** Pick a problem that is difficult enough that people will be impressed when you solve it, but not so difficult that you can't make sufficient progress on the timescale of a tenure clock.

CREDIT: COURTESY OF KRISTALA L. J. PRATHER

KORIE A. GRAYSON

➤ HOMETOWN: Everywhere but nowhere (military brat)

➤ EDUCATION: BS, Norfolk State University, 2012; PhD, Cornell University, 2020

➤ CURRENT POSITION: Postdoc, chemical engineering, University of Michigan, working in Lola Eniola-Adefeso's lab

➤ FIRST JOB: Journey's shoe store

➤ DREAM VACATION: A peaceful adventure in Bali or Thailand

CREDIT: COURTESY OF KORIE A. GRAYSON

Korie A. Grayson is studying nano- and microparticles as therapies in acute inflammatory disease and cancer.

terest, or how did you get interested in the STEM [science, technology, engineering, and mathematics] field in the first place?

KP: I grew up in Northeast Texas with my older sister and mother. My father died when I was young, so it was really just the three of us. And I remember once—I don't know if it was my mother or my sister—but someone dropped their necklace in the drain, and I'm like, "Give me a wrench." I was the one who fixed it. It wasn't until I was in high school my junior year that my history teacher asked me what I wanted to study. I said, "I like math and I like science." She was like, "When you put those two together, they become engineering." I liked chemistry, so she's like, "OK, you should study chemical engineering, and you should go to MIT." I really just trusted my teacher and was like, "If she says I should study engineering, I should study engineering. And if she says I should go to MIT, I should go to MIT."

KG: How did you get into your specific research field within chemical engineering?

KP: I was always interested in the bio side of chemical engineering. So to me, what was really cool about biotech was the DNA. I loved the idea that you could cut and paste pieces of DNA and put them together. I loved the idea that there is a way to visualize DNA. For a kid who liked tinkering with things and being able to take them apart and put them back together again, the biotech side, or the genetic engineering part of biotech, is what really appealed to me. When I was looking to go to graduate school, I was interested in biomolecular engineering. So as a grad student, I focused on tools to engineer microbial systems to produce chemical compounds.

KG: How would you explain your research to an eighth grader?

KP: We're surrounded by stuff. The clothes that you're wearing are often synthetic materials, your cell phone case is a synthetic material—that's stuff. And all that stuff has to be made in some particular way. Too much of it now is actually made from nonrenewable sources that are environmentally damaging. And so what we focus on is, "How do we actually get access to more renewable and sustainable stuff by taking advantage of renewable inputs?" So, using biomass-derived carbohydrates as inputs into the system as opposed to fossil-derived petroleum.

My work has always had this focus on using microbial systems or biological systems that produce chemical compounds. In my lab at MIT, the particular emphasis that we've tried to place is thinking about, "How do we actually expand beyond well-established pathways provided by nature? How do we get the biosynthetic capacity of biological systems to be expanded so that we can get access to more materials?" If we think about all the materials that are made, and if we want to move away from fossil fuels as inputs to make those, you have to have alternatives, which means we have to actually have the synthetic capacity for biological systems—in this case, to be able to produce some of those other materials. That's where my lab started.

The exponential way in which you can actually have a positive impact is by taking good care of the people who are placed into your academic and intellectual trust.

KP: So Korie, tell me what research you're working on now. Lola actually gave a seminar to our department, so I saw some aspects of it.

KG: She probably talked about the preferential uptake of microparticle rods by neutrophils, a type of cell that mediates inflammation. We're taking that type of technology and applying it as an antineutrophil therapeutic for an acute lung injury model of acute respiratory distress syndrome (ARDS).

KP: What do you want to be when you grow up?

KG: I'm still figuring that out. I try not to think too far ahead because things can change. I took this postdoc and really wanted to have a Black female mentor and learn from her, but I'm still very interested in government regulatory affairs. I'm excited to see what will happen in the future.

KG: Kristala, I have one last question for you: How important is mentorship?

KP: Oh, it's critical, and I've had wonderful mentors. The exponential way in which you can actually have a positive impact is by taking good care of the people who are placed into your academic and intellectual trust. That's how we make a difference. All the rest of it, the papers and stuff, are great; the individual recognition, we love it when it comes. But that's not really what's going to make the difference. What's going to make the difference is being able to have this multiplicative effect by actually sending more people out into the world who are ready to continue to do more and to do good and to give back.

POLYMERS

SAMSON A. JENEKHE

This polymer scientist's pioneering research has contributed to advances in commercial OLEDs and organic solar cells

VITALS

- **HOMETOWN:** Okpella, Nigeria
- **EDUCATION:** BS, Michigan Technological University, 1977; MS, 1980, MA, 1981, and PhD, 1985, University of Minnesota
- **CURRENT POSITION:** Boeing–Martin Professor of Chemical Engineering and professor of chemistry, University of Washington
- **FIRST JOB:** Quality-control technician, Nestlé
- **GO-TO STRESS RELIEVER:** Watching action and thriller movies

In polymer science, it pays to be persistent. University of Washington chemical engineer Samson A. Jenekhe has dedicated decades of research in the lab to understanding and optimizing the properties of semiconducting polymers. In recent years, this persistence has paid off, with some of his work leading to advances that enabled new consumer products—including the glowing screen you might be holding in your hand right now.

Some of Jenekhe's work has contributed to the development of low-power, high-brightness organic light-emitting diodes (OLEDs). Now nearly ubiquitous in smartphone and TV screens, this technology struggled to make it out of the lab because researchers could not figure out how to achieve sufficient brightness (quantum yield) from conductive molecules or from polymers that glow when conducting an electrical current. In 1994, Jenekhe showed it was possible to produce light-emitting organic materials with high quantum yields by introducing buffer molecules that prevent the conducting molecules from ordering themselves in a way that quenched their luminescence. That work set a foundation for the development of OLED materials—whether based on polymers or small molecules—with efficiencies suitable for commercial applications.

"It's been very thrilling to see the commercialization of OLEDs and to know we had a small part to play," says Jenekhe, who holds more than two dozen patents related to his work on semiconducting polymers.

Jenekhe has also made major contributions to the advancement of polymer solar cell materials. Organic solar cells have historically been made with expensive fullerene molecules that help transfer charges within the devices. However, the absorption properties of fullerene molecules are difficult to tune, which limits the performance of devices made with them. Jenekhe's lab pioneered the synthesis of organic nonfullerene acceptors, which are more thermally stable. Polymer photovoltaics containing nonfullerene acceptors have recently shown photon-conversion efficiencies as high as 18%, Jenekhe says. For comparison, commercial silicon-based solar cells convert about 25% of the energy in sunlight into electricity. "Getting organic devices that close to silicon is quite remarkable," he says.

Jenekhe's wide-ranging work on semiconducting polymers has not only enabled new consumer products but has also been celebrated by his scientific colleagues. He is the 2021 recipient of the American Physical Society's Polymer Physics Prize "for pioneering and sustained" contributions to the synthesis, physics, and characterization of semiconductor polymers.

This honor is well deserved, says the University of Chicago's Matthew Tirrell, who was Jenekhe's PhD thesis co-adviser. "Sam is among a handful of leaders who have rapidly advanced the field of electroactive conducting materials in the last 3 decades," he says.

CREDIT: MERON MENGHISTAB

Jenekhe is not resting on his laurels. He is continuing to develop more efficient and durable conductive polymers that may be integrated into less expensive manufacturing processes, potentially reducing OLEDs' cost. His lab works primarily with benzene rings and conjugated polymers, which have backbones with alternating single and double bonds; such molecular structures yield a cloud of delocalized electrons with semiconducting properties. Because of their relatively low efficiency, these materials lag behind small-molecule light emitters in commercial applications. Over time, Jenekhe predicts, conjugated polymers will become the preferred material "because you can process them from solution, which is a lot cheaper."

Another exciting application of conjugated polymers, Jenekhe says, is in organic thin-film transistors (TFTs) for flexible electronics. Such materials could be woven into clothing or embedded into any other flexible material or surface. His lab was among the first to develop polymer TFTs that are durable and stable over several years under ambient conditions.

"It's been very thrilling to see the commercialization of OLEDs and to know we had a small part to play."

Jenekhe, a native of Nigeria, credits some of his success, and his early fascination with science, to his "biggest intellectual mentor," his maternal grandmother, who was known as the local village doctor. "She would take me on trips during school breaks, and I would watch her use various medicinal plants to help people get healed," he says.

After more than 3 decades as a leading research scientist, Jenekhe has come to embrace his own role as a mentor. He says he is keenly aware of the loneliness and isolation of being Black in science and engineering. He makes sure to encourage his Black and female students to "set goals for yourself and work very hard to achieve them, no matter what obstacles stand in your way."

However, he says, it's also important for society to broaden access to education to underrepresented groups, especially those with lower means. "You don't know who is going to grow up to be the inventor of a major new drug or a new way of doing computing."—JERMEY N. A. MATTHEWS, special to C&EN

SYNTHESIS

ONE ON ONE WITH DAVITA L. WATKINS

Grad student **Samantha Theresa Mensah** talks with this supramolecular chemist about the collaborations central to her chemistry

Davita L. Watkins is manipulating complex systems to answer fundamental questions about self-assembly, putting materials to the test in different settings, including optoelectronic devices, bioimaging, and nanomedicine. She is the youngest of five and a first-generation PhD. Samantha Theresa Mensah spoke with Watkins about the power of collaborations. This interview has been edited for length and clarity.

Samantha Theresa Mensah: It seems like you're going beyond optoelectronics applications and into a whole bunch of other really cool projects. Can you describe the materials you're using and how you're applying them?

Davita L. Watkins: I have a few research projects. One is a protein-based hydrogel study with Susan Pedigo to look at how we can modify protein backbones to make them stimuli responsive and bear drug molecules so they can treat inflammation in cases like arthritis.

We've also been working with St. Jude's research hospital and Rhodes College on derivatives of the chemotherapy drug panobinostat for childhood multiple myeloma as well as neuroblastoma. This is a collaboration between three women.

In another case, we're doing a lot of really interesting chemistry with conjugated polymers. We're making them amphiphilic so they self-assemble into nanopolymers. Our goal is to be able to use them for near-infrared and shortwave IR bioimaging.

This next project is my beloved, the project that started my independent career. This project is based on halogen bonding, which is like the weird cousin of hydrogen bonding. You replace that hydrogen with a halogen and then you can take advantage of the σ-hole, an area of electron deficiency on your halogen that you can actually coordinate with nitrogens, oxygens, and sulfurs.

Lastly is our research on self-assembling block copolymers. I actually thought about this as a graduate student when I was taking a biomaterials course. These materials have really interesting architectures and properties. If you change the weight ratio between the two segments—one being hydrophilic, one being hydrophobic—you can actually form some really interesting nanoaggregates.

VITALS

DAVITA L. WATKINS

- **HOMETOWN:** Memphis, Tennessee
- **EDUCATION:** BS, Vanderbilt University, 2006; PhD, University of Memphis, 2012
- **CURRENT POSITION:** Professor of chemistry and biochemistry, University of Mississippi
- **FAVORITE LAB TOOL:** As an organic chemist, I am expected to say a column, but I cannot go without a Büchner funnel with a fritted disk. Often my research involves products and materials with low solubility in organic solvents. I use them for purification, separations, isolation, etc. They are my quick and easy go-to glassware after a reaction.
- **GO-TO STRESS RELIEVER:** I have noticed my hobbies change with every career level. As a graduate student, I had a professor who would take us rock climbing. As a postdoc, I fell in love with trail running. Now, as a principal investigator, I am always looking for the next hiking trail. I have even started getting my research group involved in my adventures.

CREDIT: COURTESY OF DAVITA L. WATKINS

VITALS

SAMANTHA THERESA MENSAH

- **HOMETOWN:** Weston, Florida
- **EDUCATION:** BS, University of Central Florida, 2017
- **CURRENT POSITION:** PhD candidate, materials chemistry, University of California, Los Angeles, working in the labs of Anne Andrews and Paul Weiss
- **PETS:** I have two sphynx cats, named Ellie and Violet.
- **FUN PROJECT SHE'S BEEN WORKING ON:** I am learning how to build cosplay costumes.

Samantha Theresa Mensah is studying aptamer-based field-effect transistors with the goal of neurotransmitter detection in vivo. She is a cofounder of the #BlackinChem movement.

CREDIT: COURTESY OF SAMANTHA THERESA MENSAH

STM: Very cool. Can you talk a little bit more about your collaborations? They seem like a big part of your branching out, no pun intended.
DW: Through collaborations, we work with computational chemists for predicting the self-assembly and properties of our materials. We work with people who are based in bioimaging, molecular biologists who can help with the design strategy. Then, of course, we work with spectroscopists because we do a lot of imaging of conjugated materials. All of those questions can be answered collaboratively by having individuals who are interested in applying the skills they have.

DW: I was going to ask you about your research because I know you're in materials chemistry, but I wanted to know exactly what part and what you are interested in.
STM: For my graduate research, it's been about developing implantable biosensors that can detect different neurochemicals and give us more information about how the brain communicates. We have tools to look at electrical firing in the brain, but we don't know as much about chemical firing because we don't have the tools to actually probe that sort of interaction at relevant time and space scales. So that's where my lab steps in. We are developing the tools based on field-effect transistors.
DW: Nice.

STM: Yeah. Field-effect transistors functionalized with an aptamer—a ligand-binding nucleic acid—are superselective for a specific neurochemical. Part of my job is to make a multiplexed sensor and get several different aptamers for different small molecules on the same micro-sized sensor. It's very difficult.
DW: Wow. That sounds really crazy and so much fun. I say that only because aptamer work is not easy, and on top of that you're trying to make actual devices. You're in the middle trying to make it work. I love that.
STM: Thank you.

STM: Who have been your main mentors, and how have they changed the trajectory of your career?
DW: A number of people pop up in my mind. My doctoral adviser, Tomoko Fujiwara, is a woman in STEM [science, technology, engineering, and mathematics]. My postdoc adviser, Ronald K. Castellano at the University of Florida, was really, really influential. He took a chance on me, and I appreciate that chance.

A lot of students have told me that I'm the first Black professor they've seen, or I'm the first Black female professor they've seen.

STM: Can you expand on Castellano's taking a chance on you?
DW: As a graduate student I really was not confident. You're dealing with a lot of impostor syndrome or you're dealing with some of your fears and anxieties. He said, "I think I see some diamonds in the rough here." He opened doors for me simply by saying, "You can actually do this."

STM: What's your mantra when you're mentoring your own students?
DW: My mentoring skills have evolved a lot. They probably have gotten better in some areas and worse in others, right? But one of the things that Dr. Castellano told me, and I think he said it in passing, was, "Be kind." I keep that with me because I think that STEM academia can be very critical. You're constantly being bombarded with criticism when it comes to your research, when it comes to your science, the way you think, and everything else.

STM: That's awesome. I think that sort of mimics my own mantra that I've tried to convey as a teaching assistant at UCLA. I hold myself to be the type of TA that I needed when I was an undergraduate student.
DW: I think I may have to steal that from you. Be the mentor that you wanted to have. I agree with that.

STM: Can you talk about the challenges you face being a woman in STEM?
DW: You still don't see a lot of women in STEM. A lot of students have told me that I'm the first Black professor they've seen, or I'm the first Black female professor they've seen. That's very shocking to them. What makes me want to protect a lot of my young women who are going into STEM is that you as a minority, and you as a woman, feel as if you have to prove you deserve to be in the room. I'm hoping that people will be inspired and know that there are actual Black women in STEM and they're in Mississippi. They're in the South and they're doing hard-core research.

DRUG DISCOVERY

KAREN AKINSANYA

Drug discovery expert has found success by advocating for patients and her own ideas

VITALS

- **HOMETOWN:** Surrey, England
- **EDUCATION:** BSc, University of London, 1989; PhD, Imperial College London, 1993
- **CURRENT POSITION:** Chief biomedical scientist, Schrödinger
- **FUN PROJECT SHE'S BEEN WORKING ON:** Remodeling my kids' bathroom with them.
- **BEST PROFESSIONAL ADVICE SHE'S RECEIVED:** Don't underestimate your ability to drive change from any level in an organization.

Karen Akinsanya was working her first job in the pharmaceutical industry, at Swiss multinational Ferring Pharmaceuticals, in 1997 when—nearly bursting with an idea—she did something bold. She reached out directly to the head of research and development and shared a white paper outlining her ideas for a new approach to drug discovery.

Her paper, she says, argued that "we should be using genetics and genomics to do drug discovery and figure out what targets to work on." At the time, drug hunters looked at pharmacology, physiology, biochemistry studies, and academic collaborations to identify potential targets for drug discovery. But Akinsanya's gamble paid off. She was promoted and moved from Southampton, England, to Ferring's site in San Diego to run a drug-target discovery group focused on finding new therapies for endocrine diseases.

This experience of speaking up in the name of science for people with diseases wouldn't be Akinsanya's last. Rather, it has been a hallmark of her 27-year career.

At Ferring, she later led the team that discovered a family of hormone-blocking drugs that use the body's own biochemistry to suppress the growth of cancer cells. These drugs include Firmagon, now a US Food and Drug Administration–approved drug used to treat prostate cancer, a disease that disproportionately impacts Black men because of disparities in medical care (*Cancer* 2020, DOI: 10.1002/cncr.32666).

Akinsanya then spent 12 years at Merck Research Laboratories, including time dosing patients with new medicines. She recalls receiving letters from people who had written their wills and said goodbye to their families before participating in drug trials. "Moments like that, hearing from patients about the enormous impact medicine can have, not just on your quality of life but actually the quantity of life, is just so inspiring and keeps me going," she says.

In 2018, Akinsanya became the chief biomedical scientist, head of drug discovery, and executive vice president at Schrödinger and took on a new challenge—accelerating drug design through computation.

Schrödinger's software, which performs atomic-level modeling of molecular interactions, removes some of the expensive and arduous trial-and-error aspects of drug discovery in the lab.

The company's software can test billions of drug candidates at once, picking out those with activity against a desired

"Moments like that, hearing from patients about the enormous impact medicine can have, not just on your quality of life but actually the quantity of life, is just so inspiring and keeps me going."

drug target. “We use these computational assays to prioritize and decide which molecules are actually going to have the highest chance of impacting the protein,” Akinsanya says. The goal, she adds, is to deliver life-saving therapies to patients faster.

Akinsanya calls her current role a culmination of what she’s learned throughout her boundary-crossing career, which spans academia, clinical development, and licensing.

The leader of a team of about 85, Akinsanya leverages Schrödinger’s technology to develop new ideas for medicines. The team is working on projects in oncology focused on understanding the genetics of cancer and the fundamentals of how cancer cells behave. It is also exploring immunology, including inflammatory diseases like psoriasis.

Akinsanya is not only an exceptional scientist, according to Schrödinger president and CEO Ramy Farid. She’s also “highly strategic, a really big thinker and a bold thinker,” he says.

Before Akinsanya’s arrival, Schrödinger focused on selling its software and doing collaborative research with pharma and biotech companies. Akinsanya “allowed us to start to work on our own internal, wholly owned drug discovery projects,” which was a factor in the company’s recent initial public offering, Farid adds.

A self-described “sentimental and emotional person,” Akinsanya is driven by helping others, including future scientists.

In the 1990s, she mentored children in London in the hope of challenging the notion of what a scientist looks like. Children often “have this image of the Einstein-type character” when they imagine scientists, Akinsanya says. In 2010, she founded My Tech Learning, an organization dedicated to ensuring that children can experiment with science and technology.

“She’s very committed to helping others understand science but also helping to drive forward the concept that science is all around us,” translational scientist Hamish Wright, a colleague at Schrödinger, says.

Young scientists often turn to Akinsanya for career advice. The mantra she shares is one that has guided her own successful path: speak truth to power.

“When you are sincere and you are bringing ideas to the organization that can make a difference,” Akinsanya says, “it doesn’t matter what level you’re on in the organization.”—MAKEDA EASTER, special to C&EN

CREDIT: STEPHANIE MEI-LING

HISTORIC TRAILBLAZERS

These Black chemists helped level the scientific playing field

ANGIE TURNER KING

Angie Turner King was born in 1905, a time when few women—let alone Black women—were scientists, and fewer still earned PhDs. She grew up in McDowell County, part of West Virginia's coal country. Her grandparents were once enslaved and her father, though uneducated himself, encouraged her to pursue education. Throughout her long career as an educator, she ensured that many others followed her father's advice.

King graduated high school at 14, then earned a bachelor's degree in chemistry and mathematics at West Virginia Collegiate Institute (now West Virginia State University). King taught chemistry and mathematics at the Teacher Training High School while working on her master's degree at Cornell University, earning her degree in mathematics and chemistry in 1931.

She then taught high school chemistry for several years before joining the faculty at West Virginia State. There she set about refurbishing the college's lab to ensure students had a working knowledge of a real lab. In 1955, she earned her PhD in general education at the University of Pittsburgh. She taught at West Virginia State for the remainder of her career and was deeply involved in the university community until her retirement in 1980.

King is remembered for her contributions to science education. During World War II, West Virginia State developed an Army Specialized Training Program, and as one of the program's instructors, she taught chemistry to soldiers. Throughout her teaching career, she mentored students who went on to accomplished careers in science, including Jasper Brown Jeffries, a mathematician and physicist who worked on the Manhattan Project; mathematician Katherine Johnson, famed for her work calculating spacecraft orbits with NASA; and Margaret Collins, an entomologist and civil rights advocate.

King died in 2004. She was a member of the American Chemical Society and the West Virginia Academy of Science.—MARSHA-ANN WATSON

JAMES ELLIS LU VALLE

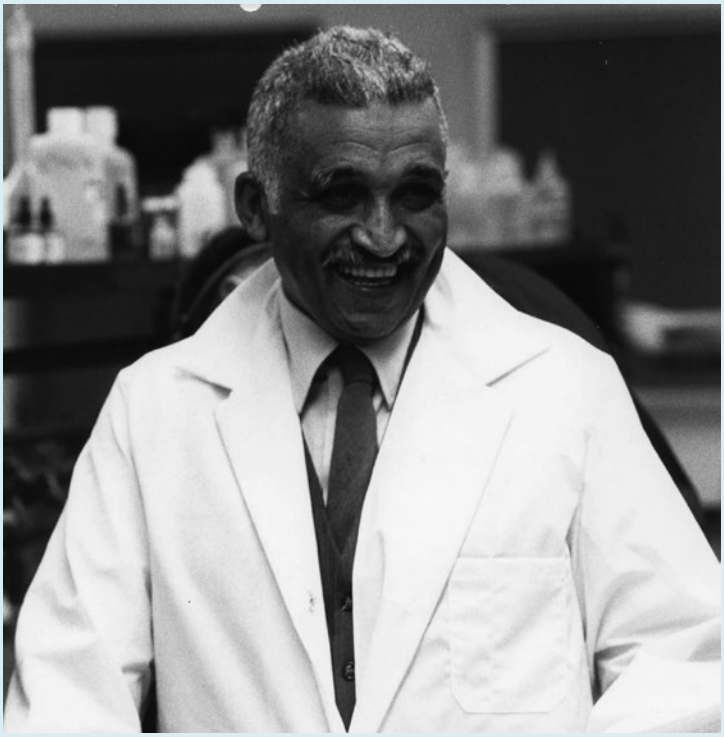
James Ellis Lu Valle was an Olympian and a chemist. During the 1936 Olympics in Berlin, Lu Valle won the bronze medal in the 400 m race. This was the Olympics in which Jesse Owens took home four gold medals while Adolf Hitler watched. That same year, Lu Valle earned his bachelor's degree in chemistry from the University of California, Los Angeles. The university later named a student center after him, making Lu Valle the first alumnus to have his name grace a UCLA building.

After earning a master's degree from UCLA, Lu Valle pursued his PhD under the guidance of Linus Pauling at the California Institute of Technology. After teaching at Fisk University, a historically Black institution, Lu Valle became the first Black person to work for Eastman Kodak. Later in his career, he became director of physical and chemical research at Smith-Corona Marchant in Palo Alto, California. When the company closed, Stanford University asked Lu Valle to lead the first-year chemistry lab, and he agreed, ending his career by returning to education and mentorship.—MEGHA SATYANARAYANA

MORE ONLINE

Get to know more trailblazing Black chemists at **cenm.ag/knowblackchem.**

CREDIT: WIKIMEDIA COMMONS (KING); ASSOCIATED PRESS (LU VALLE)



SAMUEL P. MASSIE

At the height of the Manhattan Project, Samuel P. Massie was trying to figure out how to turn uranium isotopes into liquids for use in a bomb. Before joining the project, he had gone to Iowa State University to get a PhD in organic chemistry. At the time, Iowa State University's racist policies meant he could not live on campus or work in the same labs as White students. After being denied a draft deferment, he withdrew from the PhD program and took a position working on nuclear chemistry for the Manhattan Project.

Massie eventually got his PhD from Iowa State University and then worked on finding new antimicrobial compounds. In 1982, he patented an antibiotic for treating gonorrhea. In his career, he also focused on education—teaching chemistry and taking an appointment at the National Science Foundation to shape science education across the nation. In 1966, President Lyndon B. Johnson chose him to teach chemistry at the US Naval Academy, making him the first Black person to do so. Many years later, he chaired the department, becoming the first Black person to hold that position.

Massie was always a high achiever, graduating high school at 13 and college at 18. One of his Manhattan Project contemporaries was another accomplished Black scientist, Lloyd Albert Quarterman. Massie died in 2005.—MEGHA SATYANARAYANA

JOSEPHINE SILONE YATES

Along with being a writer and civil rights activist, Josephine Silone Yates was the first Black woman to head a college science department. Born in Mattituck, New York, either in 1852 or 1859, Yates grew up living with her parents and maternal grandfather, Lymas Reeves, who was a formerly enslaved man. In grammar school, she was enthralled by physics, physiology, and arithmetic and excelled in her studies. At the age of 11, she moved to Philadelphia to pursue better educational opportunities at the Institute for Colored Youth.

She stayed at the school for a year until her uncle, Rev. John Bunyan Reeve, whom she was living with, got a job at Howard University. Yates moved in with her aunt in Newport, Rhode Island, and enrolled in Rogers High School in 1874. There, she was the only Black student. But she more than persisted—she shined. Yates developed an affinity for chemistry that impressed a professor, who encouraged her to further explore her interests through extra lab work. In 1877, just 3 years after enrolling, she graduated as class valedictorian.

Continuing on her educational journey, Yates next attended the Rhode Island State Normal School (now called Rhode Island College). There too, she graduated with honors. She passed the teacher's examination and became the first Black person to be a certified public school teacher in Rhode Island. Yates taught chemistry, physiology, and botany, as well as speaking and English literature classes, at the Lincoln Institute (now Lincoln University) in Jefferson City, Missouri.

Yates soon became the first Black woman to head a college's science department when she was put at the helm of the institute's Department of Natural Sciences. She was a civil rights activist, a writer, and a teacher until her death in 1912.—NICHOLAS ST. FLEUR, special to C&EN

CREDIT: US NAVAL ACADEMY (MASSIE); GLASSHOUSE IMAGES/ALAMY (YATES)

NANOMATERIALS

ONE ON ONE WITH LYNDEN ARCHER

Postdoc **Simone A. Douglas-Green** talks with this chemical engineer and entrepreneur about the serendipity of opportunity

Lynden Archer is known for his work with "hairy" nanoparticles. He studies structure, dynamics, and transport at liquid-solid interfaces using polymer and hybrid materials with applications in energy storage technologies. He cofounded NOHMs Technologies to commercialize novel battery materials developed in his Cornell University lab. NOHMs, which stands for nanoscale organic hybrid materials, was named one of C&EN's 10 Start-Ups to Watch in 2015. Archer is a member of the National Academy of Engineering and a fellow of the American Physical Society. Simone A. Douglas-Green spoke with Archer about how he chose his research focus and what it takes to start a successful company. This interview has been edited for length and clarity.

Simone Douglas-Green: When was the moment you felt like a real scientist?
Lynden Archer: I was about 9 or 10 years old. My mom bought me a science book, and one of the chapters extolled the wonders of brewer's yeast, which affects metabolism. My mom was entrepreneurial and raised broiler chickens as an income supplement, and she allowed me to experiment with metabolism by adding brewer's yeast to a small portion of her flock. I had some chickens as controls even though I didn't know what controls were at the time. I felt like a real scientist using the essential tools of science and discovery to answer a question, and that ultimately gave me more confidence.

SDG: As an aspiring professor, I am trying to figure out what the research focus of the Douglas-Green lab would look like one day. How did you figure out the research focus of the Archer Research Group?
LA: I think this is something aspiring professors stress themselves out too much over—the thought of coming out on day 1 with a career-defining research direction that they're going to follow faithfully throughout a career. An essential part of growing and becoming successful as a scientist is understanding your core skill set and the things that excite you and working to develop those fully. Successful professors must be able to see change coming and have the tools ready to adapt. That means you're reading the literature, you're sitting in talks at conferences that aren't in your area, and you're hearing what other communities are thinking. The graduate student and postdoc years are excellent times to identify and burnish these core skills.
SDG: This is fantastic advice to hear, especially as a new postdoc in a chemical en-

VITALS

LYNDEN ARCHER

- **HOMETOWN:** Georgetown, Guyana
- **EDUCATION:** BS, University of Southern California, 1989; MS, 1990, and PhD, 1993, Stanford University
- **CURRENT POSITION:** Joseph Silbert Dean of Engineering and James A. Friend Family Distinguished Professor in Engineering, Cornell University
- **FUN PROJECT HE'S BEEN WORKING ON:** I've learned to grow eggplants of all varieties—this is hard. I also discovered the New York Times Cooking website and have been on a virtual world tour of eggplant varieties and recipes.
- **BEST PROFESSIONAL ADVICE HE'S RECEIVED:** Closed doors provide direction.

CREDIT: COURTESY OF LYNDEN ARCHER

SIMONE A. DOUGLAS-GREEN

➤ **HOMETOWN:** Coral Springs, Florida

➤ **EDUCATION:** BS, University of Miami, 2015; PhD, Georgia Institute of Technology, 2020

➤ **CURRENT POSITION:** Postdoc, chemical engineering, Massachusettes Institute of Technology, working in Paula Hammond's lab

➤ **FAVORITE LAB TOOL:** Ethanol-resistant marker with a good tip. I like to make sure my things are labeled clearly to make my lab life easier. Multicolor lab tape is a close second for the same reason.

➤ **BEST PROFESSIONAL ADVICE SHE'S RECEIVED:** "No" is an answer. Set boundaries for yourself and people will learn to respect them. (I'm still working on this one.)

CREDIT: COURTESY OF SIMONE A. DOUGLAS-GREEN

Simone A. Douglas-Green is designing charged nanocarriers for the treatment of osteoarthritis.

gineering lab coming from a biomedical engineering background looking to expand my skill set in drug delivery design. Can you talk about the design process of your nanoparticles?

LA: It occurred to me that if one can make hairy nanoparticles that are uniformly covered with an oligomer, it should be possible to create new types of inorganic-organic hybrid materials. We discovered that if you inspected one family of the materials in an electron microscope, they look like sand, but if you observed them with the naked eye, they look like a viscous fluid. I later wrote a National Science Foundation proposal hypothesizing that an entire class of functional inorganic-organic hybrid materials can be created from the basic building blocks, but at the time I had no idea what function would emerge as useful. The connection with electrical energy storage in metal-anode batteries (*Adv. Mater.* 2013, DOI: 10.1002/adma.201303070 and *Nat. Energy* 2016, DOI: 10.1038/nenergy.2016.114), which now forms about 75% of the research in my group, emerged completely by accident after listening to a talk by a colleague working on block copolymer electrolytes for safe batteries. The lesson here is that you need to be prepared, but there's also the serendipity of opportunity. If there wasn't a need for a function in the NSF program directive, I would have likely continued studying only the fundamental aspects, perhaps with more limited impact.

SDG: Do you remember a key experiment that led to some remarkable discoveries?

LA: In polymer science, there's a well-worn principle known as time-temperature superposition, wherein studies of a material's response over a small period of time and at a range of temperatures are used to infer a response over a large range of time at a fixed temperature. We discovered that by applying strain (instead of temperature) to our hairy nanoparticles, it is possible to use measurements of their dynamic responses on timescales on the order of seconds to infer dynamical behaviors on extraordinarily large timescales (*Nano Lett.* 2009, DOI: 10.1021/nl9029847). We still don't know fundamentally where this characteristic originates, but we know that it is related to an unjamming transition produced by strain and that it is commonplace in these hybrid materials.

SDG: You cofounded NOHMs Technologies. How did you take your research on energy storage and batteries from benchtop to developing a company?

LA: I think it requires a culture in which students and postdocs who carry out the studies have an interest in commercializing their work. One postdoc made a major discovery related to sulfur (*Angew. Chem., Int. Ed.* 2011, DOI: 10.1002/anie.201100637), and there was interest in commercializing this. We filed a patent, formed the company with the postdoc as the first employee, and the company grew. A successful company is less about the product and more about the nimbleness of the people to redesign and reconfigure that product to meet current market needs. We started with this idea of making rechargeable batteries based on exceptional cathodes that would measurably improve cell-level energy density relative to today's lithium-ion technology, and the market was not ready for that. The market was still focused on improvements to lithium-ion technology. The NOHMs technical team discovered that an analogous hybrid platform (*Angew. Chem., Int. Ed.* 2010, DOI: 10.1002/anie.201004551) based on ionic liquid chemistry could be leveraged to create powerful additives for tuning important electrolyte characteristics (e.g., flammability) in today's lithium-ion batteries.

LA: I've done a bit of research on your background, too. It is clear that you're on quite a strong trajectory. If you were attempting to leverage success diversifying the undergrad student body to grad students and faculty, what are some tips you would offer?

SDG: I had the opportunity to cofound a student organization called BEAM (Biomedical Engineering Alliance for Minorities) at Georgia Tech. One lesson I learned is that student leaders can use their influence to improve departments for their own benefit. We've seen a steady increase in the number of graduate students from underrepresented groups over the past 2–3 years, and they're doing well. You also need faculty support to augment student efforts. Now that I have the experience of forming BEAM, I feel confident that I have learned best practices to take to other institutions as my career continues. I encourage trainees to take on roles to gain similar leadership experience, then go on to academic positions to help implement systemic change.

LA: I look forward to watching you excel. We have a very strong biomedical engineering department at Cornell that was founded by chemical engineers. Please keep Cornell Engineering in mind.

SDG: Thank you, and I will! It was great to hear about your work and gain more insight into your scientific journey.

CLIMATE CHANGE

ETOSHA CAVE

This adventurous engineer wants to convert greenhouse gases into useful materials and chemicals

VITALS

- **HOMETOWN:** Houston
- **EDUCATION:** BS, Franklin W. Olin College of Engineering, 2006; MS, 2011, and PhD, 2015, Stanford University
- **CURRENT POSITION:** Cofounder and chief science officer, Opus 12
- **FUN PROJECT SHE'S BEEN WORKING ON:** Lots of cooking
- **BEST PROFESSIONAL ADVICE SHE'S RECEIVED:** Spend more time working with your allies than worrying about your enemies.

Etosha Cave's sense of adventure has taken her to the McMurdo Station in Antarctica to do research and sustained her through cofounding a company in 2015.

Cave is the chief science officer of Opus 12, a start-up company specializing in recycling the greenhouse gas carbon dioxide into valuable chemicals. The company's core technology is based on her PhD research. "We convert carbon dioxide gas into useful products such as plastics, diesel fuel, and household cleaners," Cave says.

Opus 12 makes reactors that use electricity and water to convert carbon dioxide into useful chemicals; transition-metal catalysts speed up the process. The key to the company's electrochemical system is a unique ionic polymer membrane electrode. At the reactor's anode, water is oxidized to generate protons that are transported by the membrane and used in further reactions. The catalyst reduces gaseous CO_2 into molecules such as carbon monoxide, methane, and ethylene.

"Our main competitor is the status quo, as in most places it is still free and inconsequential to throw CO_2 into the atmosphere," Cave says. "We also are taking advantage of low-cost renewable electricity, which could make our method of CO_2 conversion much cheaper as time goes on."

Other companies are also striving to transform carbon dioxide into useful materials. Cave says Opus 12's key advantage is the ionic polymer membranes in its reactors, which allow for high power densities and a robust system design that operates at relatively low temperatures.

Opus 12's partners include the California utility Pacific Gas and Electric and the luxury vehicle manufacturer Daimler. The company has disclosed $25 million in funding from private sources and grants, though Cave says its capitalization is higher.

Brian Bartholomeusz, executive director of innovation transfer at the TomKat Center for Sustainable Energy at Stanford University, attributes Cave's success to her drive for innovation and determination in solving real-world problems.

"Etosha's greatest strength as a researcher has been her consistent search for practical implications of the sometimes esoteric scientific work she is undertaking," Bartholomeusz says. "I think she has always had one eye focused on what the real impact of her work might be."

The entrepreneurial engineer traces her beginnings to Houston. She credits her mother, an elementary school science

"Our main competitor is the status quo."

CREDIT: SARAHBETH MANEY

teacher, and her father, a quality-control inspector in the construction industry, for planting the seeds that grew into her passion for problem-solving. At the Booker T. Washington High School for Engineering Professions, Cave found her passion for science and math. "Engineering combined both my parents' backgrounds and seemed like a natural fit," she says.

After graduating, she enrolled at Franklin W. Olin College of Engineering, a private institution for engineering based in Needham, Massachusetts, where she was a member of the first graduating class. She felt drawn to the Boston area's high density of schools. "I wanted to surround myself with all that intellectual power," she says. "I was also looking for adventure."

Her quest for adventure has remained a constant source of inspiration in the scientist's life. Before moving to Stanford to start her doctoral program in engineering, she spent 5 months working on an atmospheric chemistry project in Antarctica at the McMurdo Station. In addition to being the trip of a lifetime, the field research also supported her career goals. "Antarctica is one of the analogs of living on Mars, and I'd like to be an astronaut someday," she says.

She notes that Opus 12's technology for converting an abundant gas into useful chemicals would be particularly useful on Mars or the moon.

Cave says she fantasizes about retiring to a martian colony one day—the ultimate adventure. "Ninety-five percent of Mars's atmosphere is CO_2," she says. "I would love for our technology to be featured on a spaceflight."—FRIEDA WILEY, special to C&EN

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ONCOLOGY

ONE ON ONE WITH KIMBERLY M. JACKSON

Grad student **Kolade Olayiwola Adebowale** talks with this chemist about her work to treat prostate cancer

Kimberly M. Jackson is studying novel therapeutic agents for prostate cancer. She is also studying the role of minority-serving institutions and the inclusion of more women of color in diversifying the science, technology, engineering, and mathematics (STEM) pipeline. She has mentored more than 40 students in her research group and is coauthor of the publication "Realigning the Crooked Room: Spelman Claims a Space for African American Women in STEM." Kolade Olayiwola Adebowale spoke with Jackson about her motivations for studying prostate cancer and her work in advancing equity in STEM. This interview has been edited for length and clarity.

Kolade Olayiwola Adebowale: Did you always know you were going to be a scientist?

Kimberly M. Jackson: No. Actually, I went to college to become a musician. I went to a few classes, and it was challenging. So I ran from the music building to the science building because I always liked science, too. I became a chemistry major because it was easier than music.

Some friends urged me to become a doctor, so the summer after my freshman year I went to the University of Oklahoma through the Health Careers Opportunity Program with a cohort of Black students. I shadowed a family physician, and I tell you—whenever someone would be sick in the office, I would become sick as well. I realized then, after that program, I did not want to become a medical doctor. But that experience was my first lesson in becoming what I call a compassionate scholar. It taught me to be thoughtful about my research and who my research may impact. Sometimes we get so caught up thinking, "Oh my god, I didn't get 10 papers out. I didn't get that grant." But in the grand scheme of things, what matters? Are we telling our stories to effect change? Are we being good citizens? Are we being that compassionate scholar?

KA: What got you interested in cancer, specifically prostate cancer?

KJ: I finished up my PhD work in cellular immunology. I went on to do a postdoc in the etiology of ovarian and prostate cancers. But then I got hooked on understanding prostate carcinogenesis because it was impacting Black men. Around that time, my parents were diagnosed with cancer—my mother with stage 1 breast cancer and my father with stage 1 prostate cancer—so I had an even greater desire to work on prostate cancer. I would say that was the biggest reason for moving toward prostate cancer—I had a family connection. Also, there was a lot of funding back then for prostate cancer.

VITALS

KIMBERLY M. JACKSON

- **HOMETOWN:** LaGrange, Georgia
- **EDUCATION:** BS, Alabama State University, 1992; PhD, Clark Atlanta University, 1999
- **CURRENT POSITION:** Chair and associate professor of chemistry and biochemistry, Spelman College
- **WORK THAT MADE AN IMPACT ON HER:** *The Museum Series*, by Carrie Mae Weems, an African American woman artist. Weems intentionally photographs herself facing famous museums like the Louvre or the Tate Modern in a long black dress (representative of a 19th-century funeral dress). These museums are places where she has not been invited to show her work. . . . As a Black woman in the natural sciences, there are many academic spaces (including museums) that question our legitimacy as scholars and academics and do not recognize our validity as leaders in the field.
- **FAVORITE LAB TOOL:** A timer. I am meeting with students and faculty nonstop between experiments. A timer allows me to stay on task.

CREDIT: COURTESY OF KIMBERLY M. JACKSON

CREDIT: COURTESY OF KOLADE OLAYIWOLA ADEBOWALE

VITALS

KOLADE OLAYIWOLA ADEBOWALE

- **HOMETOWN:** Chicago
- **EDUCATION:** BSc, Illinois Institute of Technology; MSc, Columbia University
- **CURRENT POSITION:** PhD candidate, chemical engineering, Stanford University, working in Ovijit Chaudhuri's lab
- **FUN PROJECT HE'S BEEN WORKING ON:** I've been cooking dishes from Serious Eats and trying out some new cuisines like Moroccan vegetable tagine.
- **BEST PROFESSIONAL ADVICE HE'S RECEIVED:** Seek mentors often.

KA: You were the first person to identify that DBM, dibenzoylmethane, a minor constituent of licorice, inhibits prostate cancer growth. What led you to that discovery?

KJ: I learned about dibenzoylmethane when I was a postdoc at Emory, about 20 years ago. I met a dermatologist who was working with curcumin when curcumin was really coming out on the market. And he was like, "Kimberly, you know what curcumin is?" And I said, "Yeah. It's from turmeric." He said, "Well, I have something that I've heard of that looks very similar to curcumin. Why don't you just test it out?" I said, "Oh, OK. Well, let me see if it works." So I started by trial and error testing different concentrations of DBM on standard prostate cancer cell lines. After about 6 months I started to notice there was a suppression in growth. I found there was some deregulation of the cell cycle.

KA: What are some of the things you've found, in terms of the mechanism?

KJ: We've been working to try to unpack what's happening with DBM's molecular mechanism of action and its involvement with the androgen-receptor signaling pathway for some time. First, we did some proteomics work and gene expression profiling, and we saw that one particular actor, the heat shock protein 70, is involved in chaperoning androgen to bind to the androgen receptor. We thought maybe if that particular family of chaperones is downregulated, they're not able to move the androgen to the receptor. So perhaps DBM is inhibiting activation of the androgen receptor.

More recently, I had a student who started doing computational studies, docking DBM into the androgen receptor. She then looked at the binding energies and changes to the receptor's active site. We have some fascinating data where we think that DBM is binding to an alternate site and changing the pocket of the androgen receptor. We are trying to publish that work at the moment.

I am mission driven to see that the STEM pathway is transformed.

KA: Prostate cancer is one of those cancers that involve excess deposition of extracellular matrix proteins. Have you looked into that?

KJ: Yeah. There is evidence that suggests that cancer development and progression may be influenced by the interplay between cancer cells and the surrounding tumor microenvironment, which includes extracellular matrix components [like collagen, laminin, and actin]. That's an area we're excited about now, because there are just so many proteins you can look at. I've also enlisted the help of an engineer and surface chemist to help create new matrices for cancer cell growth and DBM studies that better represent 3-D models of the microenvironment.

KA: Is there anything else that we didn't touch on that you would like to share or discuss?

KJ: I am mission driven to see that the STEM pathway is transformed. Therefore, I create networks and empower Black women in STEM fields to attain doctorate degrees in the biochemical and chemical sciences. I see my work as critical to research-intensive institutions receiving my students and further developing them into junior investigators. We have to work in tandem to expand the STEM pathway. Through me, my students develop the fundamentals of research, experience effective mentoring, and learn to facilitate their scientific thought processes. My work in advancing equity in STEM is essential work: I examine cohorts, networks, and structures that acknowledge and foster positive interactions to increase entry in and persistence in the field and launch successful scientific careers of Black women scientists. Because of my work and that of others, Spelman College is ranked by the National Science Foundation as the number 1 undergraduate institution of origin of Black women PhDs in science and engineering. Twenty-eight of my former research students have earned advanced degrees in the STEM pathway.

Kolade Olayiwola Adebowale seeks to understand the impact of matrix viscoelasticity on cancer and immune cell migration.

RECYCLING

THOMAS H. EPPS III AND LASHANDA KORLEY

Polymer chemist duo envision a more sustainable plastics industry

Thomas H. Epps III and LaShanda Korley can't seem to escape each other's gravity. The two polymer scientists first met at a conference more than 2 decades ago, as students. Soon after, they each emerged as rising stars in the field of soft matter.

Epps, an expert in synthesis and nanoscale assembly, joined the faculty at the University of Delaware and began developing functional materials such as ion-conducting membranes and self-assembling nanostructures for targeted drug delivery. Korley, who specializes in molecular design, landed at Case Western Reserve University, where she built a research program centered on crafting novel nanocomposite materials inspired by biological structures like spider silk.

The two kept in touch, and in 2018, when Korley moved to the University of Delaware, they seized the opportunity to join forces. What followed was a burst of research productivity that has cemented them as one of the most influential duos in soft matter.

"They are both excellent in their own right," says collaborator Darrin Pochan, who chairs the university's Materials Science and Engineering Department. "But I think there's a real synergy in them working together." In just 3 years, Epps and Korley have launched a string of high-profile research centers at the University of Delaware that Pochan says are tackling some of the critical, large-scale issues of our time, such as stemming the constant flow of plastic waste into the world's landfills and oceans.

Through the Center for Plastics Innovation, which is funded by an $11.65 million grant from the US Department of Energy, the pair are leading the development of strategies to upcycle plastic waste through catalytic methods into fuels, lubricants, and other high-performance materials of greater value than the original product.

"Our approach here is to start thinking about how we can take materials and depolymerize them," Korley says. Then, she explains, advanced catalytic methods can string the individual monomer units into materials of higher quality than can be made with conventional mechanical recycling. The approach could also provide a versatile way to recycle an increasingly chemically complex plastic waste stream. Epps is director and Korley is associate director of the Center for Research in Soft Matter and Polymers, a sprawling effort that, among other things, is developing technologies to convert organic waste into sustainable plastics.

Another of their projects is perhaps even more forward thinking. The Center for Hybrid, Active, and Responsive Materials (CHARM) is one of just 19 Materials Research Science and Engineering Centers currently funded by the National Science Foundation. It is bringing together about 20 faculty members—and dozens of junior scientists—to develop hybrid quantum materials for chemical sensing and to design synthetic peptides that can fold, assemble, and respond to stimuli.

The sensors might be used to detect, say, trace amounts of virus on a handrail. And Epps envisions the peptides as tiny molecular machines. "If I have a burst blood vessel," he says, "you could imagine sort of a mini, polymeric Ant-Man that could go in and basically heal that little burst vessel." That dream is still many years off, Epps says, but CHARM is developing the computational, synthetic, and characterization tools that could one day make it a reality.

In addition to those ambitious research programs, Korley and Epps have been working with collaborators at Princeton University to help young scientists from underrepresented groups prepare for the academic job market and to showcase the work of early-career soft-matter researchers from varied social, cultural, and geographic backgrounds.

Colleagues say the duo's blistering pace of research and outreach is a testament to Epps's and Korley's abilities to recognize, assemble, and cultivate a wide range of talent. The two also attribute their success to the rapport they've built over the decades.

"I think it really does come from the ability to trust and support one another," Korley says. "You want to build a team where there is shared vision, shared commitment to excellence. And the ability to do that is not something that happens in the span of a short period of time—unless you have this long history."—ASHLEY SMART, special to C&EN

VITALS

THOMAS H. EPPS III

- **HOMETOWN:** Chesterfield, Virginia
- **EDUCATION:** BS, 1998, and MS, 1999, Massachusetts Institute of Technology; PhD, University of Minnesota Twin Cities, 2004
- **CURRENT POSITION:** Director, Center for Research in Soft Matter and Polymers, and Thomas and Kipp Gutshall Professor of Chemical and Biomolecular Engineering, University of Delaware
- **FUN PROJECT HE'S BEEN WORKING ON:** Building the Lego *Millennium Falcon* #75192 set (about 7,500 pieces)
- **DREAM VACATION:** Hiking the South Island of New Zealand

VITALS

LASHANDA KORLEY

- **HOMETOWN:** Macon, Georgia
- **EDUCATION:** BS, Clark Atlanta University, 1999; BS, Georgia Institute of Technology, 1999; PhD, Massachusetts Institute of Technology, 2005
- **CURRENT POSITION:** Associate director, Center for Research in Soft Matter and Polymers, and distinguished professor of materials science, University of Delaware
- **GO-TO STRESS RELIEVER:** Running. Since I started running in graduate school, pounding the pavement has allowed me to relieve tension, push past barriers, and reflect on what is most important.
- **DREAM VACATION:** Maui, Hawaii—the captivating surroundings, amazing culinary delights, and immersive cultural experiences. Beaches, sunsets, Haleakala Crater, Road to Hana, so much more.

CREDIT: KATHY F. ATKINSON/UNIVERSITY OF DELAWARE (EPPS); KRISTON JAE BETHEL (KORLEY)

SUSTAINABILITY

ONE ON ONE WITH SHERINE OBARE

Grad student **Raymond Blackwell** talks with this nanomaterials chemist about the experiences that shaped her interdisciplinary research interests

Growing up and being exposed to a myriad of cultures overseas, Sherine Obare knew she wanted to attend a college where she would be surrounded by similar faces. She credits her time spent at West Virginia State University, a historically Black university, for instilling in her the confidence necessary to succeed. Obare is now dean of the Joint School of Nanoscience and Nanoengineering at the North Carolina Agricultural and Technical State University and the University of North Carolina at Greensboro. Raymond Blackwell spoke with Obare about working across boundaries. This interview has been edited for length and clarity.

Raymond Blackwell: What was the initial spark that drew you to the sciences? How did this journey begin for you?
Sherine Obare: When I was in middle school, I had an incredible chemistry teacher. I remember how she instilled in me the importance of understanding the properties of elements in the periodic table. The realization at a very young age that anything in the world can be made by putting elements together from the periodic table inspired my interest in science.

RB: Transitioning from undergraduate research to graduate research, you have a bit more flexibility to choose your research project, but it also sets the stage for the rest of your career. What went into that decision process for you?
SO: My graduate adviser, Catherine J. Murphy, was spectacular and had several exciting projects ongoing in the lab. It was the lab to join at the time that focused on interdisciplinary projects. I selected a project that aimed to figure out how to detect lithium ions and, further, to understand how lithium-ion gradients change in batteries. I remember spending a significant amount of time learning about the various possibilities not just for sensing lithium for battery applications but also for medical applications, since lithium is used as a treatment for mental health issues. I spent my graduate years synthesizing a variety of molecules and nanomaterials that were used as sensors to detect lithium. That work was lots of fun because I was passionate about creating new things.

VITALS

SHERINE OBARE

- **HOMETOWN:** Many different places—Cairo; Muscat, Oman; Bonn, Germany; London; Charleston, West Virginia
- **EDUCATION:** BS, West Virginia State University, 1998; PhD, University of South Carolina, 2002
- **CURRENT POSITION:** Dean, Joint School of Nanoscience and Nanoengineering, North Carolina Agricultural and Technical State University and University of North Carolina at Greensboro
- **FUN PROJECT SHE'S BEEN WORKING ON:** I enjoy growing unusual flowers—particularly lady's slipper and glory-bower.
- **BEST PROFESSIONAL ADVICE SHE'S RECEIVED:** Setbacks are a natural process of growth. But every setback should be an opportunity to reflect, learn, and determine how to get strong and have a better comeback.

CREDIT: COURTESY OF SHERINE OBARE

VITALS

RAYMOND BLACKWELL

- **HOMETOWN:** McLeansville, North Carolina
- **EDUCATION:** BS, University of North Carolina at Chapel Hill, 2016
- **CURRENT POSITION:** PhD candidate, chemistry, University of California, Berkeley, working in Felix Fischer's lab
- **FIRST JOB:** Doing yard maintenance over the summer
- **PETS:** My apartment currently has a guinea pig and two rats (the rats are from a biology lab on campus).

Raymond Blackwell researches the synthesis and characterization of graphene nanoribbons using scanning probe microscopy.

CREDIT: COURTESY OF RAYMOND BLACKWELL

RB: It seems like you had a very natural progression into nanotechnology. Expand a little bit on the journey from graduate school–postdoc to becoming a faculty member.

SO: Graduate training transforms you, and you emerge a different human being. When I was in graduate school, my work focused on developing materials to detect lithium. The work was beneficial to the lithium battery industry, but one thing that sparked my interest was what happens when we throw our batteries away. And what happens as lithium enters the environment? When I was looking for postdoctoral positions, I had an interest in doing work that would expose me to environmental chemistry. I was extremely fortunate to obtain a position in the lab of Gerald J. Meyer, who at that time was a professor at Johns Hopkins University. I worked on materials as well as nanotechnology, and all that work was focused on fundamental questions, as well as applications toward the environment.

As I embarked on my faculty role, I started really focusing on better understanding the role of nanomaterials to further their environmental potential. We started studying their role toward addressing environmental issues but also understanding what happens when nanomaterials themselves get into the environment. These are some of the topics my lab has studied over the years.

RB: What is an example of a higher-level question that you are particularly excited to answer now that you serve as a dean?

SO: I continue to be inspired by the importance of interdisciplinary research and ways of thinking and finding ways to help others work effectively across disciplinary boundaries. For example, when I was in grad school, students were supposed to be quite subdisciplinary—you could be an organic chemist or an inorganic chemist or a physical chemist or an analytical chemist. When I was a graduate student, I was fortunate to have the opportunity to work in a lab where there were no formal boundaries, and this provided me and my lab mates with important ways of thinking. Today, we see how important it is to educate and train students to work across boundaries—and not just chemistry boundaries, but across the sciences and engineering and even the social sciences. Such work, while critical, is not easy to do. But I think it adds significant value to how it can help impact transformative ways of thinking.

Today, we see how important it is to educate and train students to work across boundaries—and not just chemistry boundaries, but across the sciences and engineering and even the social sciences.

When you think about problems in the world, you have to get people from different sorts of training and educational backgrounds to be able to address them. So one of the big challenges is, what does it take to train someone who is able to understand that way of thinking? How can we ensure that they have the depth, expertise, and knowledge within their discipline to be able to understand the details of what needs to happen but also have that breadth of knowledge to be able to communicate it well?

SO: Raymond, tell me about your passion for communicating science.

RB: In college, a friend and I started reading and watching *Cosmos*, and we realized that taking science and distilling the information so that it's digestible was an art. When done well, it helps foster a more personal connection with science. So we ran with that idea and created a magazine that focused on the intersection of art and science.

SO: That is so awesome. What are you working on at Berkeley?

RB: I work in Felix Fischer's lab using scanning tunneling microscopy to characterize graphene nanoribbons for device applications. Our work focuses on unraveling the relationship between atomic and electronic structure in graphene nanoribbons and designing new ones for future devices.

SO: How awesome. Well, the next time you're in the Greensboro area, let us know. We'll definitely love to give you a tour of the joint school and get you to see what it is. We don't currently have a scanning tunneling microscope, but it's something on our wish list that we would love to get. So come visit us, and see what you think!

CONTRIBUTORS

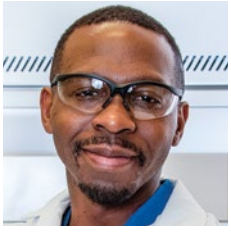
Get to know the creative minds behind this issue

Kriston Jae Bethel

Kriston Jae Bethel is an editorial and documentary photographer based in Philadelphia whose work has been featured in publications around the world. He is a member of American Reportage, a collective telling stories about US communities, and Diversify Photo, a group of BIPOC and non-Western creators working to diversify media.

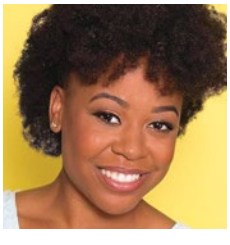
Cidgy Bossuet

Cidgy Bossuet is a visual artist-photographer currently based in Boston. Her work evolves from a journey of self-discovery and self-expression. Bossuet's work has been shown at the Pérez Art Museum Miami and the Pulse Contemporary Art Fair and published in the *Washington Post Magazine* and the *New York Post*'s *Alexa* broadsheet.



Darryl A. Boyd

Darryl A. Boyd is a research chemist at the US Naval Research Laboratory. His work focuses on developing sulfur-based optical polymers. He has won numerous awards for his research and was named to C&EN's Talented 12 class of 2018. He also runs a science-focused YouTube channel under the moniker Dr Boyd The Chemist.

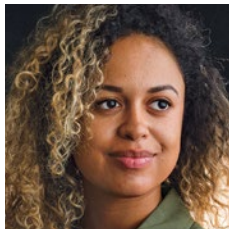


Makeda Easter

Makeda Easter is an award-winning arts journalist based in Los Angeles. Previously, she worked as a science writer at a supercomputing center, helping make technical research accessible. She graduated from Georgetown University with a degree in science, technology, and international affairs.

Octavio Jones

Octavio Jones is a documentary photographer with a passion for telling the stories of marginalized communities. He has over 15 years of experience and was most recently a staff photojournalist at the *Tampa Bay Times*. He is a proud graduate of Saint Augustine's University and a member of Alpha Phi Alpha fraternity.



Sarahbeth Maney

Sarahbeth Maney is a freelance photojournalist based in the Bay Area. Her work focuses on education, disability, and issues that disproportionately impact Black and Brown communities. Most recently, she received a grant from the Pulitzer Center to continue documenting a story about pregnancy and housing inequality during the coronavirus pandemic.

Jermey N. A. Matthews

Jermey N. A. Matthews is a PhD chemical engineer (University of Maryland) turned environmental engineering postdoc (Howard University) turned magazine writer and book review editor (*Physics Today*) turned blogger (HBSciU) turned acquisitions editor of science, technology, engineering, and mathematics books for the MIT Press. His favorite scientist is Gerald Gabrielse.

Michael A. McCoy

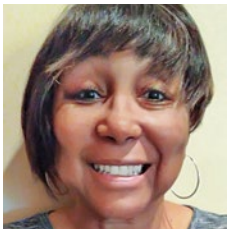
Michael A. McCoy is a Baltimore native and photographer who served two tours in Iraq and whose work appears in *Time Magazine*, the *Washington Post*, the *New York Times*, the *New Yorker*, and the *Wall Street Journal*, among others, as well as Getty Images. After his service in Iraq, "the camera is my saving sanctuary," McCoy says. "Photography crystallizes a moment in time and gives the opportunity of experiencing life through the eyes of others."

Stephanie Mei-Ling

Stephanie Mei-Ling is a Black American/Taiwanese documentary photographer based between Brooklyn and Los Angeles. Through her work she explores such layered issues as the complexity of intersectional identity, elevating the narrative of invisible communities, society's fetishization of marginalized subcultures, the universality of otherness through a global lens, and the appropriation, reappropriation, and reclaiming of cultural narratives.

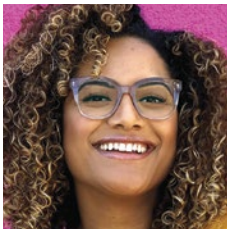
Meron Menghistab

Meron Menghistab is an Eritrean American Seattle-based photographer specializing in portraiture and photojournalism.



Melba Newsome

Melba Newsome has written about health and science for more than 2 decades, but two of her favorite stories were about the sultan of Brunei's harem and serial killer groupies. Her favorite scientist is Emmett Brown.



Ashleigh Reddy

Ashleigh Reddy is a travel, lifestyle, portrait, and event photographer from Las Vegas. Her love of photography started while taking a film photography class in high school. She attended the University of San Francisco and received a degree in psychology with minors in sociology and African American studies.

Shantal Riley

Shantal Riley worked as a newspaper reporter in the Hudson Valley region of New York before she joined the health and science program at Craig Newmark Graduate School of Journalism in 2018. Her stories covering the environment and COVID-19 have been published by Vice, *Nova*, and *Frontline*. Her favorite scientist is Neil deGrasse Tyson.

Ashley Smart

Ashley Smart is associate director of the Knight Science Journalism Program at the Massachusetts Institute of Technology and an editor at Undark. He was previously an editor at *Physics Today*.

Nicholas St. Fleur

Nicholas St. Fleur is a freelance science journalist and a children's science, technology, engineering, and mathematics author based in New York. He is currently a Knight-Wallace Reporting Fellow with Stat and previously worked at the *New York Times* and the *Atlantic*. His favorite scientist is his partner, Miranda Stratton.

Marsha-Ann Watson

Marsha-Ann is a production editor at C&EN and an occasional contributor. She has a long history in publication production from design to editing and writing. She studied advertising art at Seton Hall University and completed her master's degree in public administration at Rutgers University.

Frieda Wiley

Frieda Wiley is a licensed pharmacist and former chemist turned freelance science and medical writer. She has numerous writing credits to her name, including *O, The Oprah Magazine*; WebMD; *Costco Connection*; Pfizer; and the National Institutes of Health. Her favorite scientist is Alice Ball.

Matt Williams

Matt Williams is a portrait and ad photographer based in Phoenix. He started taking photos 10 years ago, with his newborn son as his first subject. His love for the art flourished from there.

Chrissy Yates

Chrissy believes in the power of words and wants to help others wield that power responsibly. Her 16-year media career started in journalism as a newspaper copyeditor but has included a variety of editorial roles for magazines, websites, book publishers, and even a paleontology museum. She's a serial-comma agnostic. Her favorite scientist is Mae C. Jemison.

COMMENT

Committee on Minority Affairs: Advancing the chemical enterprise through the inclusion of underrepresented groups

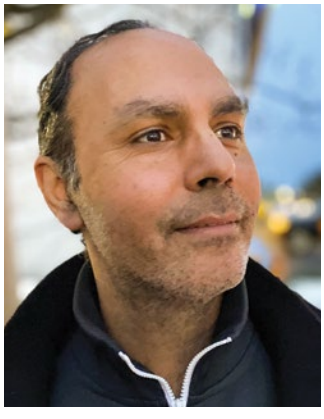
KISHORE K. BAGGA, CHAIR, ACS COMMITTEE ON MINORITY AFFAIRS

Since its inception in 1993, the American Chemical Society Committee on Minority Affairs (CMA) has worked to help increase the proportion of underrepresented groups in the chemical sciences and help those groups feel included in the society.

For example, CMA oversees and supports awards and recognition for underrepresented groups. These include the Stanley C. Israel Regional Award for Advancing Diversity in the Chemical Sciences and the Chem-Luminary Award for Best Overall Local Section Minority Affairs Committee. CMA has also nominated members for the prestigious ACS Fellows program and administers travel awards to support students from underrepresented groups in attending ACS meetings. In addition, CMA oversees the ACS Scholars and Project SEED programs. The ACS Scholars Program provides scholarships to students from underrepresented groups who are majoring in chemistry-related fields. The Project SEED program provides summer research experiences for high school students from economically disadvantaged backgrounds.

At ACS's national and regional meetings, CMA provides diverse representation through its symposia, webinars, panel discussions, speed networking events for students, and CMA luncheons with eminent guest speakers. We have organized a number of symposia where recipients of the Stanley C. Israel Award presented on the research for which they were being recognized. CMA's programming at national meetings has often been conducted with a cosponsor such as the Women Chemists Committee or the Division of Medicinal Chemistry. The committee has also been involved in leadership development workshops, which provide our members with skills that can help them transition into future leadership roles.

Committee members work together during national meetings, as well as by communicating throughout the year, to make sure we reach our strategic goals, discuss the needs of our committee, and develop action plans for the future. Our committee members are volunteers from different geographical regions. They may be in academia, industry, or the private sector, yet they all share the same passion for ACS and for our community and are committed to success through diverse representation.



I encourage you to reflect on whether there is a member of your community from an underrepresented group you feel should be recognized and ask your local section to nominate that member for an award, such as the Stanley C. Israel Award. Also consider if there is an ACS Scholar or Project SEED student you can mentor.

The above activities, as well as other goals we work toward, allow us to promote the committee's vision and mission. Our vision is to "diversify chemistry through the transforming power of inclusion and equity." Our mission is to "advance a broader, inclusive and equitable chemistry enterprise by empowering underrepresented groups, stakeholders, and marginalized peoples for the benefit of the world." This mission aligns with ACS's mission, which is to "advance the broader chemistry enterprise and its practitioners for the benefit of Earth and its people." Chemistry is for everyone and should be inclusive and available for all people.

With our mission and vision providing a framework—and with a passionate, forward-thinking outlook—we continue to work on activities that will help increase the representation of underrepresented groups in the chemical sciences. During the virtual ACS Spring 2021 meeting, CMA will be sponsoring a symposium titled "Can You Hear Us Now? Black Chemists in the Workplace," in which invited speakers will share their experiences with racial injustices in the workplace and share approaches that employers can take to improve the overall climate in professional settings. Besides this panel symposium, we will be holding other symposia and poster sessions. Be on the lookout for these in the meeting program. I invite you to attend one of our events.

I encourage you to reflect on whether there is a member of your community from an underrepresented group you feel should be recognized and ask your local section to nominate that member for an award, such as the Stanley C. Israel Award. Also consider if there is an ACS Scholar or Project SEED student you can mentor.

These are just a few suggestions on how to get involved and have your voice be heard. Please visit the Committee on Minority Affairs website, chemdiversity.org, for more information on who we are and what we do and to learn about our recent activities. Please feel free to email me at chemdiversity@gmail.com if you have any feedback or suggestions.

Views expressed are those of the author and not necessarily those of C&EN or ACS.

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Newscripts

Curating quirky science since 1943

Stylish science stores

If you're looking for a new piece of clothing to celebrate your love of science, check out Simple Science Tees and Smarty Pants Clothing. These researcher-run businesses combine science and style, and their owners want to use their stores to make science approachable.

Chemist to a tee: Brandon C. Presley, founder of Simple Science Tees, models a recent design.

Analytical chemist Brandon C. Presley, founder of Simple Science Tees, says he would often think of catchy science phrases that might look good on a T-shirt. So he set out to start his own company to share his ideas. The company launched in the middle of 2020, and one of the first designs tapped into a feeling that chemists stuck at home because of the COVID-19 pandemic appreciated at the time. It simply read "I'd rather be in the lab."

To build community, Presley interacts with customers on social media and shares pictures that show a lighter side to science. "Unfortunately, a lot of people who aren't in the sciences think that science is boring or it's too hard," he tells Newscripts. "And so we want to make a connection with people who are scientists and people who maybe aspire to be scientists."

That lighter side is also something that Raven Baxter, also known as Raven the Science Maven, believes in. The molecular biologist and soon-to-be science education PhD is known online for her musical science communication videos. Baxter tells Newscripts that people who watch her videos often ask where she gets her clothes, so Baxter launched Smarty Pants Clothing in January to share her style.

The store stocks periodic table dresses, rhinestone-covered boots, and brightly colored jackets.

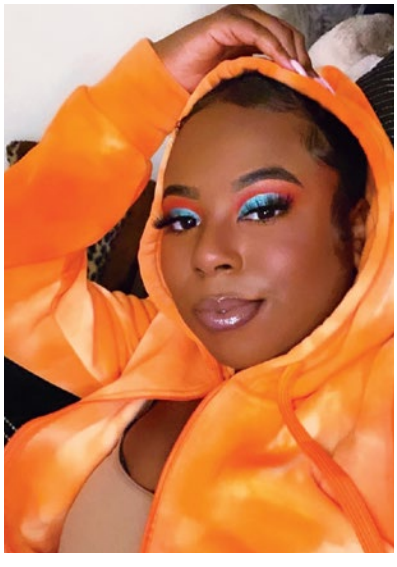
"People say 'scientist' and they imagine somebody who's very stiff," Baxter tells Newscripts. "And although I recognize that everyone's not like me, I definitely wanted to make a space for people who want to wear clothes that are decked out in rhinestones head to toe and things that are sparkly that say 'science' on it with molecules everywhere."

Science with sparkle: Raven Baxter, founder of Smarty Pants Clothing, loves style and science.

Whether you're going to pull on a T-shirt to signal you're up on your stoichiometry or model a molecule for your social media followers, these businesses show that science isn't dull or unstylish.

Making more makeup

You might remember Makeup Scientist's Sodium Fine palette from Newscripts' 2020 holiday gift ideas. The business's founder and CEO, Jess N'neka, has expanded the range of science-inspired makeup to include an "incubator" full of colored eyelashes and a makeup palette with a microscope-shaped mirror.



Made up: Jess N'neka models cosmetics from her store, Makeup Scientist.

Unlike Baxter or Presley, N'neka has a degree in hospitality and management instead of science, but she has a long-term love of science. N'neka tells Newscripts that she knew she wanted an eye shadow palette that used the pun "sodium fine" even before starting her company. This palette, shaped like an Erlenmeyer flask, launched April 4, 2020, and sold out the same day. From there, she says, the inspiration has not stopped coming.

Like the other entrepreneurs Newscripts talked to, N'neka is hands on with graphics, product design, and packaging. That work takes a lot of research, she says, but it's worth it. The Makeup Scientist store now includes science-themed lip gloss, makeup applicators, and eye shadows, with more products planned by midyear.

Laura Howes wrote this week's column. Please send comments and suggestions to newscripts@acs.org.

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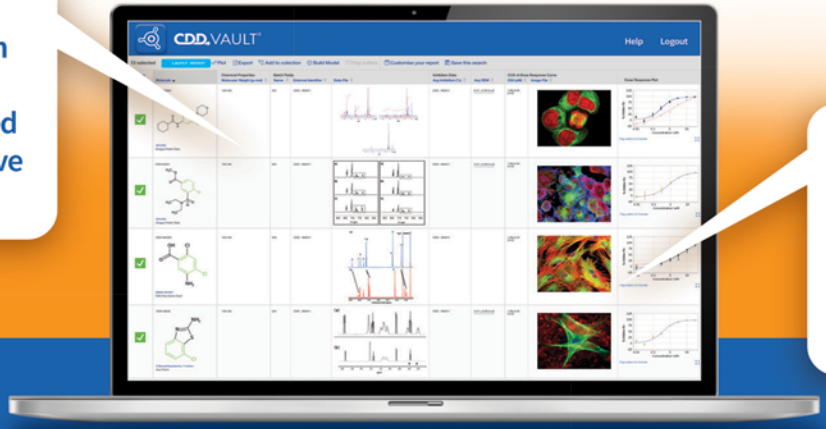

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