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Matter of Opinion

35+1 challenges in materials science being tackled by PIs under 35(ish) in 2023

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Here we highlight 35 (+1) global researchers approximately under the age of 35. The annual cohort was self-generated by initial seed invitations sent by the editorial team, with each contributor inviting the next in a self-selecting unrestricted (nominally supervised) manner. The final collection is an inspiring look at the challenges the current generation of materials researchers are tackling, demonstrating the interdisciplinarity of materials science.

In our December 2021 issue, we published our first "35 under 35" article.[1] We weren't the first to come up with the concept of highlighting the "next generation" of rising stars. Consider Forbes 30 Under 30 or Fortune's 40 Under 40 (which predates Forbes). In academia, the concept was adopted and adapted, resulting in annual announcements of the MIT Technology Review's Innovators Under 35 list as well as American Chemical Society's *C&EN Talented Twelve*.[2]

Why do we like to highlight the next generation? I believe the benefits are threefold. First, the next generation of any profession (be they tech entrepreneurs or academics) are a mysterious bunch, comprised of innovators, thought leaders, and disrupters, pushing the limits of a field. We don't know anything about them. Unlike the established status quo (who we all know) rehashing the same story (for better or worse), the next generation inspires new directions and new ideas. Second, more pragmatically for *Matter*, we get to interact with a new group of authors which we likely didn't interact with before. Particularly at the assistant professor level, it may be a year (or so) until one can produce that first "great" paper for submission to *Matter* (or any other high-quality journal). Collecting these contributions results in a first introduction (indeed, many of our 2021 contributors have become authors since!). Finally, as recognized by business and academia alike, "being young" has certain advantages in many fields. In addition to youthful

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Continued

exuberance, confidence, and energy, the emerging generation can take more risks, and re-invent or create a field. They are at the cutting edge … and they are more likely to reply to editorial emails.

To deviate from the existing lists, which are typically compiled via nominations and selection criteria, we decided to implement a self-generating list of invitees. The process was similar to our prior effort:[1] the editorial team at *Matter* sent an initial three invitations to three individuals to contribute both a brief description of their own research and a recommendation of the next researcher to invite (see Figure 1). These three initial invitations were sent to three global regions in three distinct fields, to attempt to limit any overlap, as well as to reflect a more diverse community (the process would be slightly quicker with three concurrent and parallel invitation chains). The end result was 36 individuals across 33 institutions (Northwestern, Cal, and University of Delaware each have two) in 7 countries, totalling 20 males and 16 females.

The primary motivation behind this self-generating list was to avoid our own selection bias. Rather than cover the same cohort that is typically highlighted by other lists based on accomplishments and recognition by the "older" generation, we let the chips fall and trusted the self-selected output. Who else would be better to suggest emerging researchers than their own peers? The result, of course, is that the inclusion on this list is not overtly an award or accolade, but rather a selection to represent the emerging generation of materials scientists. Indeed, ranking careers at their onset is a near-impossible task. So, while this list is not the "top 35," this is by design … but the individuals included are at the very least at the top of the minds of their peers. Our intent is a snapshot of contemporaries, reflecting the global variety of exciting materials science, applications, and directions. And perhaps a few *Matter* submissions in the near future.

It behooves us to note that we initially intended this group to be published at the end of 2022. However, the team at *Matter* has endured some editorial changes, and the article was sidelined for a few months before renewed efforts in the spring of 2023, from which we attained the remaining necessary contributions (the three chains terminated within the same week, so we went with a nominally extended total of 36). After a final round of bookkeeping, collating, and formatting, the resulting 36 challenges (in alphabetical order) are:

Monica Allen, University of California, San Diego

My research group builds and utilizes novel scanning probe microscopy techniques to visualize electronic behavior in quantum materials, with particular focus on two-dimensional materials, topological states of matter, and correlated electron systems. To this end, we are constructing a new microwave impedance microscope integrated into a dilution refrigerator, which will open up the capacity to image the real-space conductivity profile of quantum electronic states at low temperatures (down to 50 mK). This imaging method is ideally suited for shedding light on correlated insulator states, edge plasmons, and topological modes that propagate along domain walls and crystal boundaries.

Kwabena Bediako, University of California, Berkeley

It is imperative to meet the challenge of escalating global energy demand with the innovation of unprecedentedly efficient renewable energy conversion/storage systems as well as information and communication technologies that operate at orders of magnitude lower energy consumption. The Bediako Lab designs and synthesizes atomically thin precisely tailored two-dimensional materials in which the collective behavior of electrons can be studied and controlled. We leverage these materials to uncover the principles that underlie efficient manipulation of electron transport within solids—the basis for ultralow-power electronic devices—and across solid-liquid interfaces—enabling the next-generation of fuel cells and electrolyzers for energy conversion.

William J. Bowman, University of California, Irvine

Our lab applies and develops advanced scanning and transmission electron microscopy methods to study electroceramics and nanomaterials. We work to understand, design, and synthesize the nanoscale structures, chemistries, and defects governing their behavior during energy conversion and storage, as well as carbon capture and utilization. For example, atomic-resolution imaging and spectroscopy of interfaces within and between ion-conducting ceramics elucidates mass and charge

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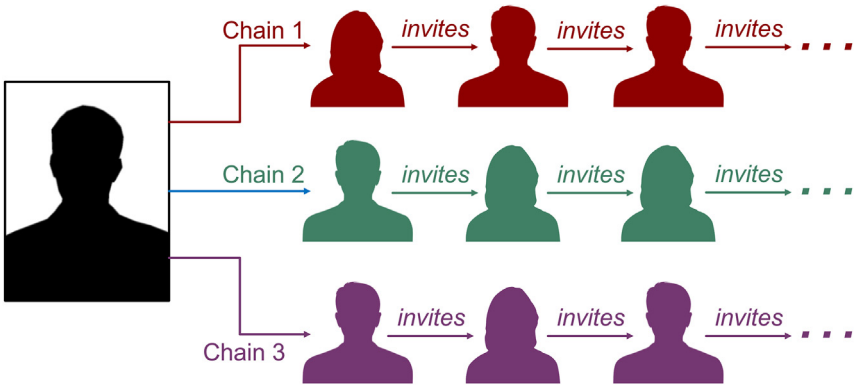

Figure 1. Pay-it-forward invitation chains
To recruit the 36 contributions for this article, *Matter* invited only three individuals, who each suggested the subsequent invitee, thus extending the chain.

transport processes in solid oxide fuel/electrolysis cells and solid-state batteries. Additionally, *in situ* microscopy reveals reaction dynamics governing the capture and release of carbon dioxide by earth-abundant sorbents used to remove emissions from the atmosphere and exhaust gases.

Michelle Calabrese, University of Minnesota

My lab develops new instruments, sample environments, and analyses in rheology and neutron/X-ray scattering to address a range of fundamental and applied problems in polymer and soft materials engineering. Our goal is to understand the microstructural basis of complex flow phenomena and subsequent performance in materials including polymers, proteins, and colloids; this approach then enables design of new materials with improved mechanical properties and flow stability. We are currently using this approach in several areas: injectable medications and drug delivery, field-directed assembly of polymeric materials, flow instabilities in self-assembled fluids, sprayable coatings, and sustainable rheological modifiers.

Lucas Caretta, Brown University

Modern technologies require materials with dynamic and tunable functional properties. For example, the on-demand control of the electrical, optical, and magnetic properties of thin film materials is instrumental for next-generation memory and logic, sensing, quantum computing, and even energy conversion. Oxide materials are as rich in their physical phenomena and potential functionalities as they are ubiquitous in nature, while also providing a powerful playground for innovation. My research focuses on the atomic-scale synthesis and *in situ* characterization of designer oxide thin films with the goal of manipulating their functional properties.

Rose K. Cersonsky, University of Wisconsin-Madison

Many of the most interesting problems—including those related to optical circuitry, batteries, drug delivery, and gas storage—constitute multi-component, often complex, chemical systems that are difficult and costly to model computationally. Thus, it is even more crucial to extract any information within the computed data, often by leveraging tools of data science and machine learning (ML). My group develops physics-inspired representations to encode such "messy" systems numerically, expanding successful practices from the atomistic modeling community to include aspects of anisotropy and hierarchy. This approach enables us to use simpler and more interpretable ML models, opening previous black boxes toward future understanding.

Wen Chen, University of Massachusetts Amherst

The increasing demand for structural materials serving under extreme environments calls for the development of emerging metal alloys with increasingly complex compositions. However, processing of complex alloys via traditional routes (e.g., casting) is challenging. Additive manufacturing is a disruptive technology for creating materials and components in a single print. My group focuses on development of new materials with engineered structures and outstanding mechanical properties by harnessing the vast compositional design space of complex alloys and the far-from-equilibrium processing signature of metal additive manufacturing. Meanwhile, we develop high-throughput additive manufacturing techniques to accelerate the pace of compositionally complex alloy discovery.

Santiago Correa, Columbia University

The immune system is broadly implicated in human health—it is involved in infectious disease, cancer, aging, and a stunning array of auto-immune disorders ranging from arthritis to neurodegeneration and chronic pain. To leverage the immune system and overcome these diseases, we require tools that allow us to study and ultimately reprogram the immune system. My group is approaching this grand challenge by applying concepts from nanomedicine to design nanostructured scaffolds that can communicate more coherently with biological matter. Our approach uses biomaterials that self-assemble from bio-inspired multifunctional nanoparticles to mimic the complex interactions that govern the immune system.

Rachel Davidson, University of Delaware

My group aims to overcome constraints of typical design and synthesis in

materials discovery by bridging knowledge across disciplines to enable precise structuring of matter across length scales. Our efforts include coupling principles of crystal growth and nanomaterial design with electrochemical additive manufacturing, leveraging scanning electrochemical probes to spatially confine deposition. By tuning crystallographic structure and composition across three dimensions, we aim to design functional materials such as battery electrodes with defined crystallographic orientation, plasmonic arrays, and surfaces with spatially controlled wettability. Across these efforts we integrate data-driven approaches into traditional synthesis workflows to enable deterministic navigation of design spaces.

Leora Dresselhaus-Marais, Stanford University and SLAC National Accelerator Laboratory

My group develops X-ray and visible-light microscopes with computer-vision tools to quantify the science that can enable sustainable manufacturing. Using these tools, we can quantifies how nanoscopic defect structures inside macroscopic materials dictate their performance—in metals processing, in material properties, in extracting metals from ores, and in 3D printing technology. We recently used this approach to study decarbonization in steelmaking (8% of global CO_2) by changing from coal to hydrogen in the "ironmaking" reactors that reduce iron ores into molten iron. We showed how the nanoscopic grains native to the process create alternate phases and sintering that cause reactors to fail. To decarbonize critical technologies like steelmaking requires insights like these for reactor design and optimization.

Carissa N. Eisler, University of California, Los Angeles

Our generation is faced with the formidable challenge of addressing energy usage and production to simultaneously meet increasing global energy demands and mitigate anthropogenic climate change. Because the efficiency of every optoelectronic device is dictated by the angular distribution of light and energy, the goal of my group's research is to elucidate the interplay of surface chemistry and directional photophysics in nanomaterials. Our fundamental studies in time-resolved momentum spectroscopy allow us both to understand why certain nanocrystals display extraordinary optical phenomena and to design nanomaterials optimized for ultra-high-efficiency LEDs, solar cells, and next-generation quantum computing and communication.

Ariel Furst, Massachusetts Institute of Technology

Electron transfer is the basis of the most fundamental cellular processes, ranging from photosynthesis to cellular respiration. Over billions of years of evolution, these natural systems have acquired critical advantages that engineered systems have yet to replicate. My lab seeks to understand these fundamental biological electron transfer processes to improve engineered systems. Specifically, we develop and deploy equitable technologies for human health, environmental remediation, and sustainability. Global inequality is the highest in recent history, and disenfranchised groups are disproportionately burdened by pollution while receiving little benefit from the industrial infrastructure causing it. Inequities are exacerbated by limited access to healthcare, contributing to lower life expectancies and preventable deaths. My group seeks to address these inequalities by developing materials inspired by biological electron transfer.

Ting Ge, University of South Carolina

We are interested in investigating the microscopic origin of the macroscopic behavior of various polymer and soft matter materials. A combination of molecular simulations and theory is employed in our research activities. Topics currently investigated include (1) the effects of polymer topology on the thermodynamics, rheology, and mechanics of polymeric materials, (2) the transport of nanoscale objects in complex polymeric environments, and (3) the scale-bridging physics in the large deformation and fracture behavior of thermoplastics, elastomers, and gels.

Andrew Hook, University of Nottingham

My group seeks to assess and harness the bioinstructive properties of glycosaminoglycans (GAGs) for biomaterial applications. Individual GAG saccharides can undergo modifications at various positions via the action of enzymes, rather than template control. As a result, GAGs are highly complex and play diverse roles in many biological processes. However, their analysis is particularly challenging. I seek to analytically capture the full complexity of GAGs within biomaterial and tissue samples in a rapid, high-sensitivity, and spatially resolved manner utilizing mass spectrometry imaging together with multivariate analysis, while exploring the complex biological-material interactions using high-throughput screening methodologies.

Yi-Ting Hsu, University of Notre Dame

Topological superconductors (Tsc) are exotic quantum matters that transmit current with zero resistance and host a special type of excitation called "Majorana modes" on the boundaries. Since Majorana modes could exhibit non-abelian braiding statistics, Tsc are considered candidate platforms for performing topological quantum computation. However, despite the extensive efforts made over the past decades, unambiguously confirmed Tsc materials remain extremely rare. My group currently focuses on accelerating the material discovery for Tsc by (1) theoretically deriving guiding

principles for material predictions from fundamental understandings of Tsc and (2) predicting new experimental signatures that can be used to identify Tsc materials.

Chunjing Jia, University of Florida

Understanding the fundamental physics behind emergent phenomena, such as high-temperature superconductivity and quantum spin liquid, is a significant challenge in condensed matter physics with profound implications for energy science and quantum information science. My research group is committed to developing cutting-edge numerical algorithms that advance theoretical modeling of quantum materials. Those algorithms empower us to unravel the intricate nature of these emergent phenomena. In particular, by integrating AI techniques with numerical simulations, we hope to bridge the gap between fundamental theory, materials synthesis, and characterization. Ultimately, our collective vision is to chart a path toward designing advanced quantum materials with exceptional electronic and magnetic properties.

Jianfeng Lu, Wuhan University of Technology

Controllable doping of organic semiconductors is essential for the development of optoelectronic devices such as perovskite or organic solar cells. Conventional doping by the addition of impurities can modify their electronic properties. However, the stability and doping efficiency remain conspicuously low, which threatens the commercialization of these devices. My group strives to develop alternative doping strategies for organic semiconductors, which allow for the printing of stable thin films with good optoelectronic properties. Particularly, we are now designing new chemical reactions to pre-dope organic semiconductors, hoping to provide approaches for fabricating more efficient and cheap solar cells.

Alessandro Lunghi, Trinity College Dublin

The protection of spin lifetime from the effect of solid-state vibrations is a crucial challenge in quantum science, magnetic resonance, spintronics, and many other fields. In my group, we combine advanced electronic structure theory with open quantum system theory to predict spin-phonon relaxation in realistic materials and provide a detailed picture of its origin. We envision that a further combination of *ab initio* spin dynamics with machine-learning methods and high-throughput simulations will make it possible to design new solid-state magnetic materials with application-tailored properties.

Marco S. Messina, University of Delaware

Modern medicine relies on the molecular integrity of clinical samples to diagnose disease and therapeutics for their treatment. Nowhere is this situation better illustrated than the COVID-19 vaccines that have changed the landscape of the pandemic, yet these and other biologics suffer from temperature sensitivity that preclude long-term storage at ambient temperatures. We seek to create functional three-dimensional polymer-based materials platforms to enhance the stability of biologic therapeutics and clinical specimens with long-term goals to discover universal stabilizers that can be applied across distinct sample types such as antibody therapeutics, vaccines, and mammalian cell lines.

Ivan A. Moreno-Hernandez, Duke University

The Moreno-Hernandez Laboratory utilizes liquid phase transmission electron microscopy techniques to understand the nanoscale structural dynamics of electrochemical materials in realistic environments. Our goal is to understand how fundamental atomic-scale interactions culminate as continuum-scale properties such as device efficiency and stability. We synthesize nanocrystals with meticulous control of nanoscale features and precisely monitor their structural dynamics at near-atomic resolution during electrochemical transformations. We envision that this information will be critical for the design of next-generation electrochemical materials that meet the challenges of the renewable energy sector.

Eva Nichols, University of British Columbia

Our society is faced with a pressing need for technologies that mitigate dependence on fossil fuels. Among these is the need to develop efficient, stable, and selective catalysts that convert CO_2 into value-added chemicals using renewable and abundant inputs. Taking loose inspiration from biological systems, my research group synthesizes molecular and interfacial CO_2 reduction electrocatalysts, with a particular emphasis on design of local reaction environments. Using a combination of electrochemical, acoustic, and spectroscopic techniques, we interrogate our catalysts under operating conditions. These experiments provide information about how properties of the catalyst and its environment influence kinetics, product selectivity, and reaction mechanisms.

Reshma Rao, Imperial College London

Electrochemical conversion of renewable energy to fuels such as hydrogen and high-value chemicals is critical to accelerate our transition to a net-zero society. Such technologies are currently limited by the activity, stability, and selectivity of catalysts employed in them. Rational design of next-generation catalysts relies on gaining molecular-level understanding of their active sites and reaction mechanisms. My group uses X-ray, vibrational, and optical spectroscopy to study complex, polarized catalyst-electrolyte interfaces under operating conditions to improve our understanding

of these energy conversion processes and accelerate the discovery of new catalysts.

Martin Seifrid, North Carolina State University

Organic mixed ionic-electronic conductors are a class of materials with potential applications in a wide range of areas including healthcare, sensing, energy storage, and neuromorphic computing. These materials are relatively poorly understood. Achieving optimal performance requires carefully balancing order and disorder via molecular design, formulation, and processing. My research group operates at the intersection of materials science, machine learning (ML), and automation. Our aim is to catalyze a transformative shift in materials research through automated experiments guided by ML, known as self-driving labs (SDLs). We approach this challenge bottom-up by exploring self-assembly of sequence-defined conjugated polymers, and top-down by leveraging robots for complex material formulations and processing. Simultaneously, we develop and demonstrate the power of SDLs and data-driven research.

Katherine Emily Shulenberger, Brandeis University

Semiconductor nanocrystals show immense promise for thin-film device applications such as LEDs, tunable on-chip lasers, and photovoltaics. However, devices operating at high current densities introduce many-body interactions which can have an adverse effect on device performance. The primary aim of my group is to understand how variations in nanocrystal chemical, material, and surface properties impact these multiply excited and charged states. We leverage my expertise in photon counting and ultrafast spectroscopy to develop techniques which enable us to build comprehensive models of excited state processes within nanocrystal thin films.

Alexandr N. Simonov, Monash University

Global electrification has changed the world and the way we live. Now, it is time for the energy and chemical industry sectors to undergo deep electrification—the ambition that drives our research on chemical transformations directed by electric current. The electrochemical processes of key interest, for example water splitting and nitrogen reduction to ammonia, can be achieved, at high efficiencies, in model laboratory setups, as demonstrated in our own work. However, translation of these processes into the operational environment of practical devices, even on a small scale, produces new, sometimes unexpected, challenges in achieving the desired performance. Addressing this, in particular through the use of specialized cells, modeling tools, and *in situ* characterization under practically relevant conditions, is one major focal point of our current research.

Xiao Su, University of Illinois Urbana-Champaign

Separations are indispensable for solving global challenges, including waste recycling, energy and food security, and water purification. Stimuli-responsive materials are a powerful platform for selective separations. My group seeks to advance the molecular-level design of electro-responsive materials to achieve precise selectivity toward specific molecules. We have studied redox-active materials and integrated them into reactive separation systems for diverse applications, ranging from resource recovery to waste treatment. Our fundamental goal is to understand and control the equilibrium and dynamic behavior of these stimuli-responsive materials and to elucidate the underlying mechanisms for selective interactions.

Dayne F. Swearer, Northwestern University

The production of chemicals is central to modern society but is also responsible for a significant fraction of anthropogenic emissions and remains one of the most difficult to decarbonize sectors. In the Swearer Lab, we develop materials that combine the latest insights in catalytic active site design with the engineered photonic nanostructures to capture and transfer radiant electromagnetic energy (i.e., light) to decarbonize chemical reactions of industrial and societal importance. We are developing various platforms that harness photonic energy, such as dilute plasmonic alloys and functionalized photocatalytic metasurfaces, that take advantage of the high-energy, out-of-equilibrium dynamics afforded by photoexcitation.

Evelyn Tang, Rice University

Why are living or autonomous systems able to exhibit timescales much longer than those of the underlying components, e.g., in the circadian rhythm or in stable memories? My group investigates these questions and how the emergent behavior remains robust under perturbations and external cues. By developing new conceptual and analytical tools, we pinpoint how such dynamics arise that are necessary for system regulation, growth, and motility. Our work provides design principles for targeted dynamics in synthetic systems or in the engineering of reconfigurable materials, e.g., through dissipative self-assembly.

Mercedes K. Taylor, University of Maryland

Dwindling freshwater, along with the skyrocketing demand for critical minerals, highlight our need to efficiently separate ions from aqueous mixtures. Separating a desired ion from a mixture is a long-standing chemical problem because of the similarities in size, shape, charge density, and coordination geometry of many transition metals and rare earth elements. My research group uses porous materials, which can act like molecular sponges, to capture toxic contaminants or valuable minerals from water. By using simple

building blocks to assemble dynamic materials with selective binding sites, our research pushes the boundaries of ion selectivity and capacity in solid-state adsorbents.

Helen Tran, University of Toronto

My research program centers on understanding how to make electronics harmonious with the body and environment. Team Tran leverages the rich palette of polymer chemistry to design electronic materials encoded with information for self-assembly, degradability, and mechanical softness. We encode sequence specificity, labile chemical motifs, and architectures for emergent properties. Beyond the molecular design of the polymers, we are interested in understanding the processing parameters to achieve morphologies suited for high electronic performance as well as seamlessly integrating materials for device fabrication.

Gustavo F. Trindade, National Physical Laboratory

My research focuses on identifying accurately what a molecule is and where it is. However, the information is mutually exclusive. This is needed to understand chemistry/biology at the nanoscale in various fields, including protein function within cells, nanoparticles functionalized for drug delivery, molecules in inkjet-printed 2D materials, and interfacial phenomena in OLEDs. We have been overcoming this at micro/nanoscale using advanced mass spectrometry imaging, OrbiSIMS. Our recent findings indicate we can measure not only mass/charge but also detect molecular structure. Challenges lie in understanding phenomena behind it to achieve structural detection, spatially resolved at nanoscale from small to large molecules such as peptides/proteins.

Ryan Truby, Northwestern University

In living organisms, intelligence emerges both cognitively and physically. We call living machines' passive adaptability, capacity for morphological computation, and resilient body-environment interactions physical intelligence. Conversely, engineers build computationally intelligent machines. Robots today often require contrived environments to robustly perform, failing in real-world scenarios. To augment robots with physical intelligence, our team in the Robotic Matter Lab creates artificial muscles, sensors, and control strategies for soft, bio-inspired machines. We engineer processing and manufacturing methods to create robotic materials that give robots distributed, energy-efficient, and controllable sensorimotor capabilities. From molecule to machine, we advance machine intelligence through materials design, creating deployable robots that will help us tackle myriad global challenges.

Hendrik Utzat, University of California, Berkeley

Recent years have seen staggering advances in our ability to prepare, manipulate, and detect light fields in nanoscale structures and with non-classical (quantum) properties. Translation of these developments into materials science and chemistry holds the key to new ultra-sensitive optical spectroscopy, new materials for optical quantum technologies, and novel functionality in optoelectronics. Our group designs nanophotonic materials systems and develops suitable techniques in optical spectroscopy to establish how nanoscale fields and quantum light interact with electronic materials and biological analytes and how these interactions can be used in applications.

Ying Yang, University of Nevada, Reno

Living cells and tissues exhibit highly unusual viscoelastic properties compared to synthetic materials. They are strong enough to withstand substantial mechanical loads. They also actively adjust the stiffness and remodel in response to the changing mechanical environment. Drawing inspirations from mechanobiology, our group works on designing synthetic polymers that emulate the mechano-sensing and adaptation of biological systems. We are interested in gaining insights on how sophisticated molecular designs can be used to achieve complex nonlinear mechanics in dynamic polymer systems, and thus creating new active materials.

Daryl Yee, École Polytechnique Fédérale de Lausanne

My group seeks to understand how to integrate chemical synthesis, materials science, and advanced manufacturing to design materials over multiple length scales. Currently, we are engaged in the following research directions: democratizing the manufacturing of advanced materials via the development of accessible chemistries and processing strategies for additive manufacturing; understanding how to use dynamic bonds with architected materials to create "living" materials that can grow and adapt to their environment; and integrating self-assembly and additive manufacturing to design hierarchical materials. In doing so, we hope to engineer advanced functional materials that can tackle societal challenges in healthcare, energy, and climate change.

Shenlong Zhao, National Center for Nanoscience and Technology

The development of electrocatalysts is key for renewable energy technologies and other important industrial processes. Metal-organic frameworks (MOFs) possess many "super genes" like periodic structure and controllable components for both high-performance electrocatalyst design and fundamental mechanism study. However, their low electron transfer capacity, poor stability, and metal inaccessibility are challenging for their application in electrocatalysis. My research aimed at construction of novel MOF-based electrocatalysts by

developing effective design strategies like coordination regulation, surface functionalization, and defect engineering. Also, we established strategies that combine operando characterization with computational analysis to reveal the intrinsic interfacial reaction mechanisms.

Conclusion

Thirty-six challenges and problems being tackled in materials science ranging from topological quantum materials to data science/machine learning to electrochemical additive manufacturing to *ab initio* spin dynamics. Those who are a little more established can likely remember the youthful exuberance of starting out—labs to equip, students to recruit and train, proposals to write, manuscripts to draft and submit. Societal problems to solve. Science to discover. In the years to come, some of the listed challenges may be solved, some may stagnate, some may lead to even more challenges, like the head of a hydra (chop one off, two grow back). Like the self-selecting list of talented individuals presented here, the next generation of scientific problems (and opportunities) will grow in a self-sustaining manner, and we can only take a snapshot once in a while.

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