

COLUMBIA ENGINEERING CHEMICAL ENGINEERING NEWSLETTER

Congratulations to The Chemical Engineering Class of 2022!



Each year the department takes time to recognize the accomplishments of its students, staff, and faculty. We have the distinct honor of cultivating the minds of tomorrow while simultaneously developing the technologies of today.

*“There is a good reason they call these ceremonies ‘commencement exercises.’ **Graduation is not the end, it’s the beginning.**”*

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A letter from Dr. Jingguang Chen, Chair

The Department has had many exciting changes in this past year. Since Fall 2021 we have resumed in-person teaching and learning, which have brought back a sense of normalcy on campus. We hope that you will enjoy hearing about the progress.

We are excited to announce that **two assistant professors** will join our department. **Dr. Juliana Carneiro** will start in January 2023 and **Dr. Asher Williams** will join us in July 2023. Our students, faculty, and staff are looking forward to welcoming both to our chemical engineering family!



Faculty Updates

Prof. Sanat Kumar receives prestigious APS Polymer Physics Prize



Columbia Chemical Engineering was well represented at the Annual Meeting of the American Physical Society (APS), held the week of March 14, 2022. A highlight was the award of the 2022 Polymer Physics Prize to Sanat Kumar. The prestigious award recognizes outstanding accomplishments in polymer physics research. Endowed in 1960 by the Dow Chemical company, the prize is one of the longest standing high honors in soft matter research world-wide. Previous awardees include Nobel Prize winners Paul Flory and Pierre-Gilles deGennes, as

well as many other historically notable figures in soft matter research (Zimm, Debye, Ferry, Stockmayer, Edwards). Kumar delivered an award lecture entitled "Controlling Nanoparticle Ordering by Directional Polymer Crystallization" to a well-filled hall, and was later feted by the Division of Polymer Physics with a dinner at the University of Chicago with more than a hundred attendees (see attached photo of a festive Kumar with colleagues Rachel Segalman and Susanna Lodge). At the same meeting, Kumar's students and collaborators reported new research results in additional talks including: Brian Benicewicz (design of grafted polymer nanoparticles), Chris Durning (directional crystallization of polymers), Sophia Chan (nano-structural heterogeneities in grafted polymer nanoparticle composites), Robert Tannenbaum (gas transport pathways in grafted polymer nanoparticle membranes), Deboleena Dhara (dynamic mechanical properties of nanoparticle filled elastomers), Marshall Tekell (aging of polymer nanoparticle composite electrolytes), and Nico Mendez (crystallization-induced ordering in polymer nanoparticle composites).

Prof. Mijo Simunovic wins the NIH Director's New Innovator Award

This highly prestigious five-year award supports exceptionally creative early career faculty to pursue high-risk, high-reward research of considerable interest to human health. It will support Simunovic's pursuit of modeling human organ development in a lab. By combining developmental biology and biological engineering, Simunovic plans to develop ways of precisely controlling the chemical signals and gene expression in human stem cells in a way that induces highly accurate tissue patterning. Breaking away from the common tissue engineering paradigms, this new approach aims to mimic exactly how cells become specialized and find their right place along the body axis during embryonic development. Simunovic hopes that because their system overcomes the problems of spontaneous tissue organization in traditional cell culture, it will not only be possible to generate more realistic organ models, but also to create highly precise human tissues, a major



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challenge in regenerative medicine. Such progress would make the possibility of lab-grown replacement organs a reality one day. This is the department's first New Innovator Award and only the second Award in Columbia's School of Engineering and Applied Science history. In 2021 Simunovic also won an Award from the Burroughs-Wellcome Fund to advance *in vitro* models of the human embryo and to advance our knowledge of early embryogenesis, with application to improving pregnancy outcomes. In addition to awards to Simunovic, two students in the lab won the NSF GRFP.

Prof. Lauren Marbella receives the Cottrell Scholar Award

Prof. Lauren Marbella was named a Cottrell Scholar by the Research Corporation for Science Advancement for her research and educational proposal on "Tracking (Electro)chemical Reduction at Electrode/Electrolyte Interfaces with Operando NMR." This award honors early career teacher-scholars based on the quality of their research and leadership skills, with a particular emphasis on the educational portion of the program that undergoes a rigorous three-step peer review process during selection. The Cottrell Scholar Award welcomes recipients into a national, interdisciplinary community network that offers support and resources throughout each Scholar's career. This is the first Cottrell Scholar award for the department and for the School of Engineering and Applied Science and only the eighth award at the University overall.



Prof. Chris Boyce wins NSF CAREER Award and receives REU site funding

Chris Boyce was recognized with the NSF CAREER Award for his work on magnetic resonance imaging of structured granular flows. The proposed work for this project is based in part on a paper his group published in PNAS in late 2021 on structuring bubble motion in fluidized beds; this paper was subsequently featured in Scientific American. He, along with Faye McNeill and others in the department, are also starting an NSF REU Site which will create summer research opportunities in the Chemical Engineering Department for undergraduates from underrepresented backgrounds in STEM research. He is also leading a grant from the Sloan Foundation which forms a collaboration between the engineering schools of Columbia University and Tuskegee University to improve DEI and graduate-level STEM.

Prof. Allie Obermeyer wins SEAS Distinguished Faculty Teaching Award

Prof. Obermeyer was a recipient of the 2022 Distinguished Faculty Teaching Award (DFTA). This award is given by the Columbia Engineering Alumni Association following nomination by students and selection by the DFTA committee. The Obermeyer Group has worked to establish design criteria for the formation of membraneless organelles [in vitro](#) and [in cells](#). Using biomolecular engineering, they have identified how short polypeptides govern the complex coacervation of proteins with synthetic polycations and biological polyanions. Building on this fundamental understanding, Obermeyer and her group have also translated these findings for the [cellular](#) delivery of proteins. The group also published a [perspective](#) on the future outlook for sustainable production of textiles via biomanufacturing for *Chem* for the UN COP 26 issue. This work was in collaboration with Helen Lu (Columbia, BME) and Theanne Schiros (FIT, Columbia MRSEC) and highlighted bioinspired approaches across scales to transition textile materials from an extractive, linear economy to a sustainable, circular economy.

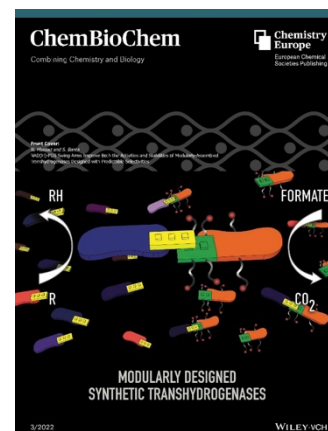
Prof. Venkat Venkatasubramanian celebrates 65th birthday at AIChE



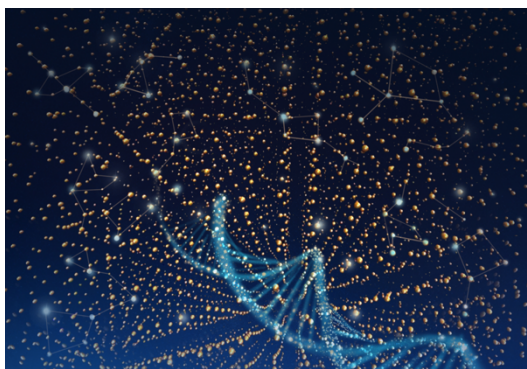
Venkat's **65th birthday** was celebrated by the AIChE process systems engineering community in a [special invited session](#) at the annual meeting in Boston on November 9, 2021 (see photo). Venkat has also been honored by the Danish Technical University with his selection as the **2022 Otto Mønsted Distinguished Visiting Professor**. This summer, he will be delivering a series of in-person lectures on AI in their campus in Copenhagen, Denmark. He was recently invited to co-edit the **first special issue** of the *AIChE Journal* focused on AI applications in chemical engineering. This special issue of 24 papers is scheduled to appear in June 2022, and his 2018 *AI perspective paper* continues to be the **most downloaded** paper at the AIChE Journal website for the fifth year in a row. Venkat's research group was awarded two large grants for the study of **AI applications in drug discovery and manufacturing** by the Federal Drug Administration (FDA) and the National Science Foundation (NSF).

Prof. Scott Banta develops Cofactor-free enzymes using "Molecular Lego"

Nadim Massad and Professor Scott Banta reported this year the creation novel transhydrogenase enzymes. These were created when an enzyme that oxidizes a cheap fuel such as formate is covalently docked onto another enzyme that can reduce compounds into valuable products such as ketones, alcohols, and other chiral intermediates. The soluble cofactors normally used by the enzymes are instead tethered to the docked complex via PEG polymer chains which eliminates the need for the addition of expensive soluble cofactors that must be separated from the products. In addition, the PEG chains increase the thermal and operational stabilities of the synthetic enzymes. [This work](#), which was featured on the cover of ChemBioChem in February 2022, demonstrates a path forward for the creation of novel cofactor-less transhydrogenases with predictable activities and enhanced stabilities.



Prof. Oleg Gang self-assembles highly engineered 3D nanomaterials



A bottom-up nanofabrication is an attractive strategy for creating complex 3D materials through self-assembly of functional nano-components for enabling engineered properties. Particularly, approaches developed in Gang's group use DNA-encoding for programming material organization and can potentially offer a tremendous level of structural and compositional control. A group already demonstrates creation designed 3D nanomaterials with optical, electrical, superconductive, biochemical and mechanical functions, and now strives to establish a comprehensive assembly by-design platform. The ability to probe these 3D large-scale architectures at the various

assembly states and for different designs is critical for the realization this assembly platform, but current volumetric characterization methods are limited. Without a detailed 3D nano-imaging with a single-

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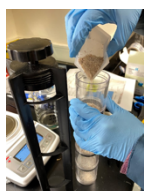
particle resolution and elemental sensitivity, it is impossible to understand how to tune assembly process and to what degree a material performance is affected by lattice imperfections, amorphous regions and grain boundaries. In the recent studies reported in [Science](#) Gang's group created a novel type of complex 3D inorganic architectures that combines ordered multimaterial nano-framework, as a continuous phase, and a lattice of discrete nanoparticles, - such structures might be useful for materials with novel catalytic, mechanical and electronic properties. Then, together with collaborators from Brookhaven National Lab, they developed 3D imaging to visualize the nanoparticle lattice, shown here, and continuous frameworks. This novel imaging allows to see in 3D the designed nanoparticle crystals with unprecedented resolution, 7 nm, that reveals the structural imperfections with details never uncovered before. The study provided insight into types of defects and their possible origins, paving the way for making fully engineered nanomaterials via self-assembly.

Prof. Aaron Moment receives ACS New York Section Teaching Award

Prof. Moment won the 2021 American Chemical Society New York Section Outstanding Four Year University with Graduate School Faculty Teaching Award to recognize highly effective teaching and inspirational leadership to students in Chemistry and Chemical Engineering. In addition, Société de Chimie Industrielle has funded a M.S. student this summer, Ally Jiang, who will be characterizing secondary metabolites from bacillus for their anti-microbial properties in the context of COPD (Chronic Obstructive Pulmonary Disease) and respiratory pathogens. We will be collaborating with the [New York Medical College](#) on this project.

Program Highlights

New lab module on particle engineering



In the spring of 2022, we introduced a new lab module on particle engineering into our undergraduate lab course (3810) that highlights particle size characterization, milling techniques to reduce particle size, and statistics. The image shows our students fractionating ground corn on sieve trays for size analysis. This activity is affectionately known as bean counting exercises.

Student Updates

Student presentations at the Annual AIChE Meeting

Two undergraduate students from the Banta Lab, Devin Golla and Matthew Lucia, presented a poster of their recent research at the 2021 AIChE Annual Meeting, held in Boston on November 8th. Their work, along with Virginia Jiang (SEAS '21) and current PhD candidate Farid Khoury, focuses on designing a longer and wider binding face for the calcium-sensitive "beta roll" peptide domain, for use as a scaffold for ion-responsive protein capture. Initially conceived during the summer of 2020 as a computational exploration of the beta roll's ion-responsive substrate binding, the project has evolved in scope, now focusing on the expression and evolution of novel widened and lengthened scaffolds. Lucia and Golla are currently working on a manuscript of their research, which presents new possibilities for the beta roll to bind a greater diversity of biomolecular targets.



Staff Highlights

Chemical Engineering welcomes two new staff members

Serxhio Hysa joined the Chemical Engineering Department on June 22, 2021 as the new Administrative Assistant. He graduated with a Bachelors in Finance from the Zicklin School of Business at Baruch College/CUNY. Before coming on board at Columbia, he was working as a Financial Analyst at a construction company for the past 4 years as he was going to school. He is applying these skills along with the day-to-day operations of the office and becoming a great addition to our department. We are very happy to welcome Serxhio to our team!

Aixa Rosado joined the Department of Chemical Engineering on July 5, 2021 as the new Operations Manager. She graduated from Monroe College with a Bachelors in Psychology. Aixa has worked for Columbia University for 10 years, 3 of which were for the Department of Mechanical Engineering here at SEAS. Aixa is a great addition to the Department as she comes with a strong background in Finance, Human Resources, and operations. We are very excited to welcome Aixa to the Chemical Engineering team.

Student Highlights

2022 PhD Candidates

The Department is eager to welcome 16 new PhD candidates to the graduate program this Fall 2022. The incoming students from top institutions around the nation selected Columbia for its research excellence and student community as showcased by an engaging Open House event organized by students, faculty, and staff. This gifted group of new PhD students includes two recipients of the coveted NSF Graduate Research Fellowship: **B. Christopher Donovan** (BS Chemical Engineering, Chemistry, and Probability & Statistics, UC San Diego) aims to create mathematical models that inform the development of sustainable energy technologies; **Yunde (Alexia) Lee** (BS Chemical Engineering, University of California Berkeley) seeks to engineer brain-on-chip technologies to model neurological and psychiatric diseases. Other incoming PhD students were recognized by prestigious Presidential and Blavatnik Fellowships from Columbia: **Shrishti Das** (BS Chemical Engineering, UC San Diego), **Ryan Lim** (BS Chemical & Biomolecular Engineering, NYU), **Nathaniel Nichols** (BS Chemical Engineering, U New Hampshire), **Cameron Temple** (BS Chemical Engineering, Howard University) and **Marcus Yu** (BS Chemical Engineering, Carnegie Mellon), whose research interests span the department's expertise in catalysis, electrochemistry, protein engineering, and soft materials. We look forward to welcoming the new PhD students this fall!

Undergraduate Institutions of new PhD-track students:

University of Delaware

University of California San Diego

University of California Berkeley

Manhattan College

New York University

Purdue University

University of New Hampshire

Northeastern University

University of Rochester

Carnegie Mellon University

University of Southern California

Howard University

Cornell University

Rice University

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WHERE ARE THEY GOING?

Waseer Mohamed , BS, J-Star Research
Indira Roy , BS, Johnson&Johnson
Siwei Chen , MS, PhD at John Hopkins
Utsavi Sevak , MS, Bristol Myers Squibb
Lilian Yang , MS, Regeneron
Angela Ye , BS, Oliver Wyman
Jenna Kornicki , BS, Langan
Emily Wang , BS, Form Energy
Dhruti Kuvar , MS, Evoqua

Every year, the Chemical Engineering Department is delighted to recognize talented undergraduate students for their achievements and accomplishments during their time at Columbia. **The Robert Edward Reiss Award in Chemical Engineering** is awarded to the student in the department who shows the greatest promise of success in applying the discipline of chemical engineering to the improvement of biological products and medical devices. This year's prize is awarded to **Nicholas Mijares**. **The Carl C. Gryte Prize** is awarded for service to the Department of Chemical Engineering. This year's recipient is **Naz Pinar Taskiran**, who is pursuing a chemical engineering position at Piramal Pharma Solutions as part of the Global Emerging Leaders Program. **The Charles F. Bonilla Medal** is an award for outstanding academic merit. It is presented to that student in the graduating class in the Department of Chemical Engineering who best exemplifies the qualities of Professor Bonilla. This year's winner is **Sajan Bar** who will be taking a position at Trinity Life Sciences in NYC as a Life Sciences Consultant.