# CHEMICAL & BIOLOGICAL ENGINEERING

# GRADUATE PROGRAMS

Chemical and Biological Engineering
UNIVERSITY OF COLORADO **BOULDER**

## DEGREES

» PhD
» Master of Science

$160M research facility built in 2012

"ChBE at CU Boulder has not only provided me with access to world-class research opportunities and facilities, but also world-class mentors and peers who share my passion for science and engineering. Everyone here truly wants to see you succeed in grad school and beyond. It is an incredibly empowering environment for developing skills as a researcher, team member and mentor."

**-Tayler Hebner,** International Falls, MN

# RESEARCH **PARTNERS/ CENTERS**

**BioFrontiers Institute** | Human Health and Biotechnology

**Center for Hybrid Organic-Inorganic Semiconductors for Energy** | Energy-Efficient Advanced Technologies

**Center for Pharmaceutical Biotechnology** | Interdisciplinary Biotechnology Education & Research

**Joint Center for Energy Storage Research** | Transformative Battery Materials

**Membrane Science, Engineering & Technology Center** | Membrane Research

**National Renewable Energy Laboratory** | Transforming Renewable and Sustainable Energy

**Photopolymerization Center** | Photopolymerizations

**Renewable and Sustainable Energy Institute** | Energy Solutions

# AWARD-WINNING **FACULTY**

**Kristi Anseth**
*Biomaterials, stem cells, regenerative medicine, drug delivery*
Elected into the National Academy of Engineering, Science and Medicine

**Chris Bowman**
*Biomaterials, photopolymerization, reaction kinetics, polymer chemistry*
Founding director of CU's Materials Science and Engineering Program
Elected to National Academy of Engineering, Medicine, Inventors

**Stephanie Bryant**
*Functional tissue engineering, photopolymerization, biomaterials*
Inducted into the American Institute for Medical and Biological Engineering

**Jennifer Cha**
*Nanoengineering, biomaterials, surface science, colloids, self-assembly*
Research featured on front cover of *Advanced Materials*

**Anushree Chatterjee**
*Gene mutations, resistance-free antibiotics, metabolic engineering, biofuels*
ACS Infectious Diseases Young Investigator Award

**Robert Davis**
*Fluid mechanics, separation processes*
Dean Emeritus of the College of Engineering and Applied Science
Tisone Endowed Chair

**Jerome Fox**
*Biocatalysis, synthetic biology, protein engineering, biofuels, molecular recognition, biological complexity*
NSF CAREER Award, ARO Young Investigator, Army-ECASE Award

**Andrew Goodwin**
*Colloid and interface science, polymer engineering, drug delivery, cancer research*
Recipient of $2M NIH New Innovator Award to detect disease

**Hendrik Heinz**
*Simulation of biological and nanostructured materials, force field development*
NSF CAREER Award and Max Hey Medal recipient

**Adam Holewinski**
*Heterogeneous catalysis and electrochemistry for sustainability*
Catalysis work published in *Nature Chemistry*

**Christine Hrenya**
*Complex fluids: gas-particle fluidization and heat transfer, flow instabilities, particle cohesion, aerosol dynamics, granular matter*
Associate Editor of AIChE Journal (2015 – present), Chair of the 2016 AIChE Annual Meeting, 2014 AIChE PTF Lectureship Award in Fluidization

**Joel Kaar**
*Biocatalysts, enzyme stabilization, protein-polymer materials, protein-surface interactions*
NSF CAREER Award recipient, ARO Young Investigator

**Will Medlin**
*Surface chemistry, heterogeneous catalysis, renewable energy*
2015 AIChE Himmelblau Award recipient

**Charles Musgrave**
*Catalysis, electrocatalysis, photocatalysis, photovoltaics, $H_2O$ splitting and $CO_2$ reduction, machine-learning, quantum simulations*
Water-splitting and organic photocatalysis both highlighted in *Science*

**Ted Randolph**
*Thermodynamics of protein solutions, lyophilization, reactions*
Awarded $4.4M by NIH to study aggregation of therapeutic proteins

**Dan Schwartz**
*Biointerfaces, separations for energy and pharma, surface modification, catalysis/biocatalysis, single-molecule/nanoparticle studies of transport at surfaces and in porous environments*
Elected Fellow of the ACS and APS

**Michael Shirts**
*Materials modeling, molecular simulation methods, pharmaceutical design*
ACS Young Investigator Award and NSF CAREER Award recipient

**Jeff Stansbury**
*Dental and biomedical polymeric materials, photopolymerization processes*
Awarded NIH grants to develop high performance materials for 3D printing

**Al Weimer**
*Particle ALD, reaction engineering, solar-thermal processing, additive manufacturing*
2018 National Academy of Inventors

## 13 NEW FACULTY HIRES IN THE LAST 5 YEARS

**R. Kõnane Bay**
*Biofilms, living poymeric composites, biohybrid hydrogels*
MIT IMPACT Fellow (2021)

**Jason Burdick**
*Biomaterials, biofabrication, materials science, tissue engineering and regeneration*
Elected Fellow Biomaterials Science and Engineering

**Ankur Gupta**
*Transport phenomena, electrokinetics, energy storage, complex fluids, soft matter*
Hugh Hampton Young Fellow

**Ryan Hayward**
*Assembly of polymer and particle-based nanostructures, mechanics and instabilities of soft active materials, active polymer materials and interfaces, self assembly of polymers and particles*
Fellow of the American Physical Society

**Laurel Hind**
*Innate immunity, microfluidic models*
Interaction With an Endothelial Lumen Increases Neutrophil Lifetime and Motility in Response to *P aeruginosa*, ***Blood***, 2018

**Seth Marder**
*Materials science, nonlinear optical studies and applications, infrared and photo absorbing dyes*
Director of RASEI

**Michael McGehee**
*Perovskite solar cells and dynamic windows with adjustable tinting*
Materials Research Society Outstanding Young Investigator

**C. Wyatt Shields IV**
*Soft Materials, active particles, microfluidics, self-assembly, in vitro diagnostics, colloid and interface science, biosensors, drug delivery*
Dean's Award for Excellence in Mentoring from Duke University

**Wilson Smith**
*Electrochemical engineering, materials science, operando spectroscopy and microscopy*
RASEI Fellow, Senior Scientist at NREL

**Kayla Sprenger**
*Immune-based therapies for neurological and infectious diseases*
Optimizing Immunization Protocols to Elicit Broadly Neutralizing Antibodies, *PNAS*

**Michael Toney**
*Electrochemical energy storage, foundational and applied materials science of hybrid metal halide perovskite semiconductors, organic photovoltaics, clean water technologies, hydrogen storage materials*
American Physical Society Fellow

**Timothy White**
*Soft matter, responsive materials, functionality in robotics, optics and biology*
Outstanding Young Investigator – Materials Research Society, SPIE, Air Force

**Timothy Whitehead**
*Designing biological macromolecules for new and enhanced functions*
2017 PEGS Young Investigator Award

# RESEARCH **AREAS**

Chemical and biological engineering research seeks to address a variety of complex and important challenges, from renewable and sustainable energy, therapeutics and pharmaceutical development, to the creation and improvement of functional materials and more.

Our department's efforts are organized into these key research areas:

### Biological Engineering
- Tissue engineering and regeneration
- Cell delivery systems
- Microphysiological systems
- Drug delivery
- Biomaterials, Biosensing

### Biotechnology & Pharmaceuticals
- Therapeutic proteins, and vaccines and antimicrobials
- Sustainable biorefining of fuels, commodity chemicals and pharmaceuticals
- Biosensing using novel proteins, smart colloids, liquid crystals, polymerization or photonics

### Computational Engineering
- Cellular processes for biomedical applications
- Materials for catalysis, microelectronics, data storage and biomaterials
- Quantum simulation of energy conversion and storage materials

### Energy
- Design of solar cells
- New materials for the conversion and storage of energy
- High purity hydrogen production using solar-thermal reactors

### Interfaces & Catalysis
- Electrocatalysis for renewable and sustainable energy
- Directed self-assembly of polymeric films into useful, device-oriented structures
- Smart colloids that sense and react to their surroundings

### Nanomaterials & Nanotechnology
- Nanoparticle device fabrication and modeling
- Improved microfluidic devices
- Emerging nanotechnology applications

### Polymers & Soft Materials
- Polymer upcycling and sustainability
- Polymer chemistry, dynamic chemistry, crystallinity and photopolymerization mechanisms
- Functional use in optics, robotics, medicine (drug delivery, tissue engineering, dental restoratives) and electronics

### Protein Engineering & Synthetic Biology
- Genome-engineering for biofuels, pharmaceuticals and gene therapy
- Modular synthetic genetic devices for higher-order biological computation

### Transport & Separations
- Particulate matter flows including granular, gas-particle fluidization and aerosol
- Suspensions, sedimentation, filtration, aggregation, coalescence, flotation and phase separation
- Polymer membranes & molecular layer deposition (MLD)

# DEPARTMENT **FACTS**

- Two PhD programs:
  - Chemical Engineering
  - Biological Engineering
- 32 tenured or tenure-track faculty
- 169 graduate students
  - 40% female students
  - 19% international students
  - 8% Black, Latina/o/x and Indigenous domestic students
  - **All students fully supported via research funding**
- 37 postdoctoral fellows
- 409 undergraduates

# DEPT-INSPIRED **START-UPS**

**ALD Nanosolutions** Atomic Layer Deposition | Weimer

**Big Blue Technologies** | Magnesium, Metals & Ceramics | Weimer

**Colorado Photopolymer Solutions** | Photopolymers | Bowman

**Mosaic** | Tissue Regeneration | Anseth & Bowman

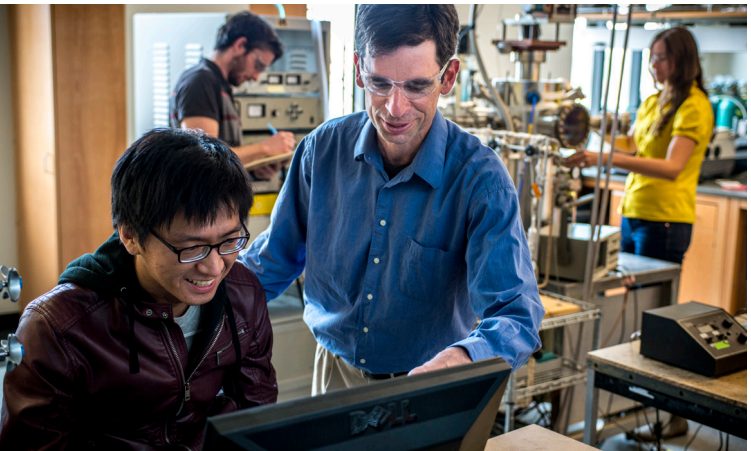
**Nanoly Bioscience** | Vaccine Stabilization | Anseth

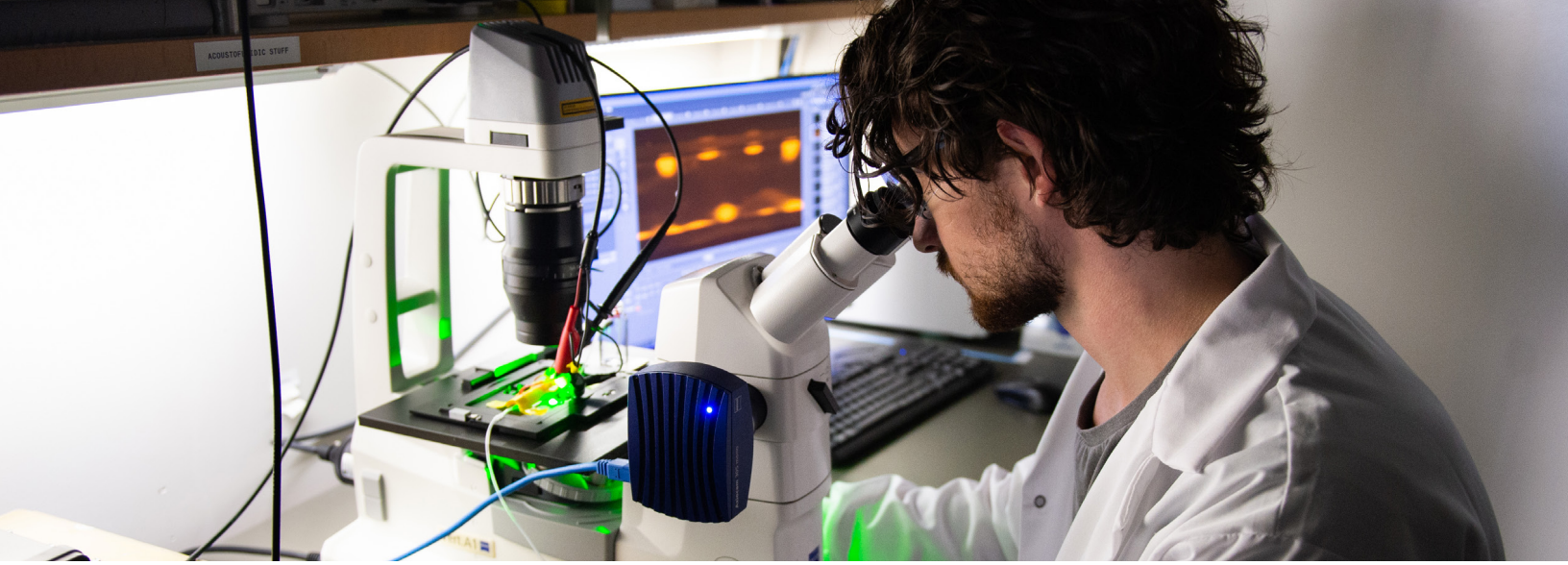
**RxKinetix** (sold to Endo Phamaceuticals) | Drug Delivery | Randolph

**Think Bioscience** | Synthetic Biology & Therapeutics | Fox

**TYNT Technologies** | Dynamic Windows | McGehee

**VitriVax, Inc.** | Vaccine Stabilization | Randolph





**2** GEM FELLOWS

**5** NIH FELLOWS

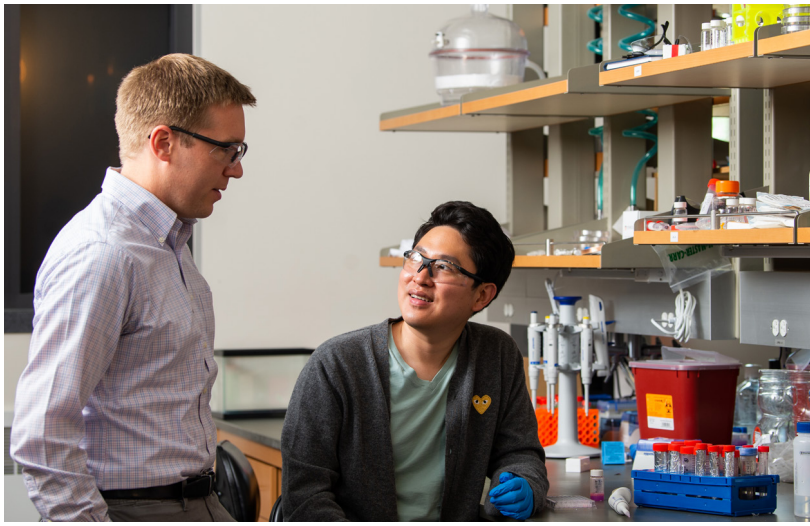
**14** NSF FELLOWS

**5** NDSEG FELLOWS

# CAREER **PREPARATION**

As a student in our department, you will benefit from the expertise and experience of world-class researchers and educators who prioritize the professional development of the next generation of chemical engineers.

Our alumni go on to successful careers across industry and academia, building off the skills and knowledge they develop here to pursue the research that challenges and inspires them.



**10th**
OVERALL RANKED CHEMICAL ENGINEERING GRADUATE PROGRAM
(*U.S. News & World Report*)

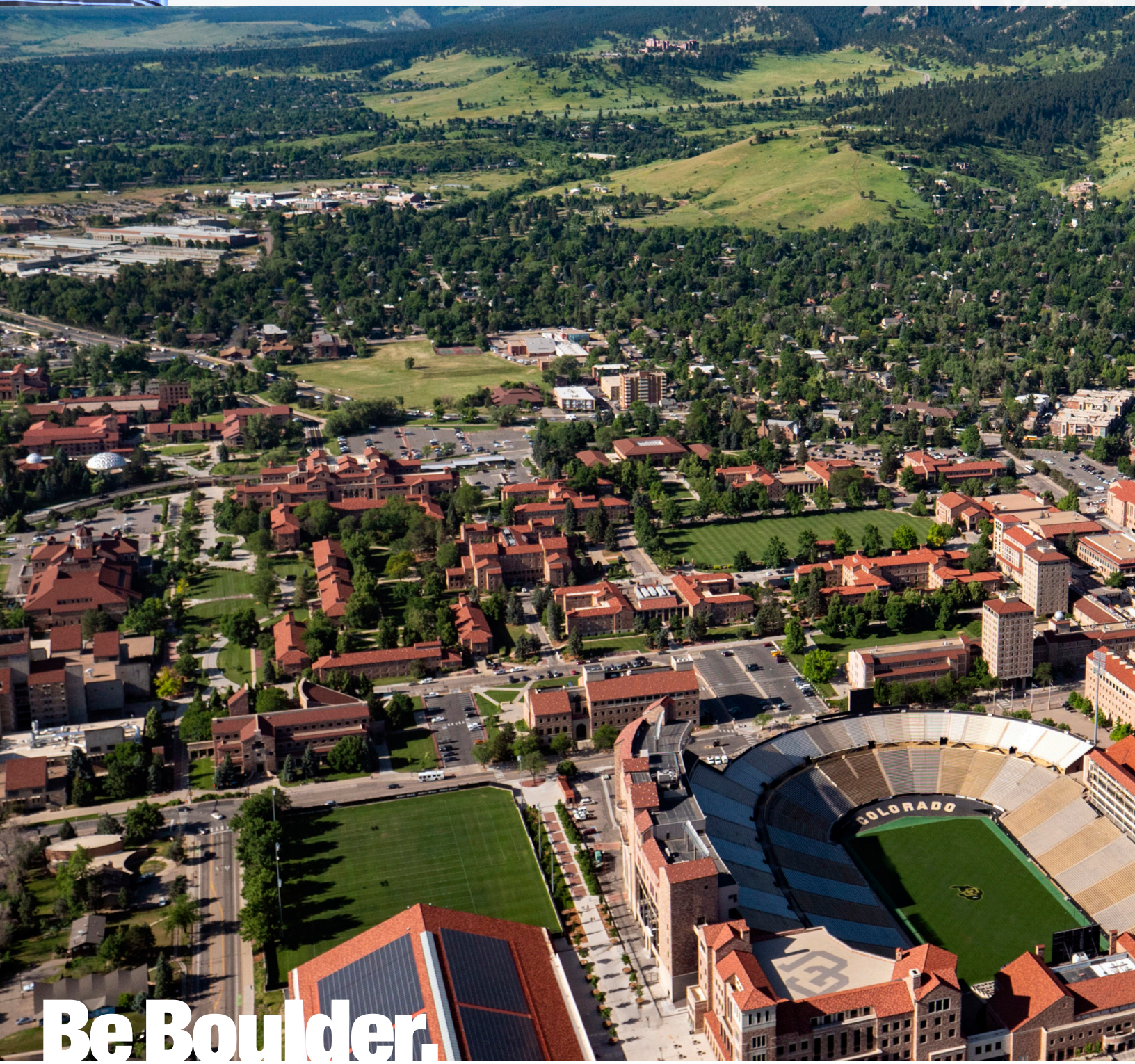
**4 National Academy Members**
**4 MRS Outstanding Young Investigators**
**2 AIChE Colburn Awards**
**1 AIChE Lifetime Achievement Award**

**$18M+**
**research awards in FY 2022**

„ChBE has helped me grow not just as a researcher but as a person. When I've run into problems, whether they be related to research or not, I've been able to get mentorship from professors who want what's best for me and truly care about me as an individual.“
**-J.J. Hernandez**, Lancaster, PA

"The Department of Chemical and Biological Engineering at the University of Colorado Boulder offers excellent research opportunities while also providing an environment dedicated to the wellbeing of students. Campus and departmental resources, as well as research facilities, ensure that graduate students have the opportunity to thrive during their studies."

**-Hayden Fowler,** Hayden, AL




# Be Boulder.

Located at the foot of the Rocky Mountains, the University of Colorado Boulder has a breathtaking view from campus. CU Boulder and its nationally and internationally recognized faculty and staff have built a global reputation for outstanding teaching, research, service and creative work across more than 150 academic fields. Together, we teach, inspire and encourage our students, faculty, staff and researchers to change the world.


| | |
|---|---|
| EMAIL | chbegrad@colorado.edu |
| PHONE | 303.735.1975 |
| WEB | colorado.edu/chbe |
| TWITTER | @cuengineering |
| INSTAGRAM | @cuengineering |