

# Negative Emissions Science

The Second Annual Scialog Conference  
November 4-5, 2021

**scialog2021**<sup>®</sup>



Alfred P. Sloan  
FOUNDATION

RESEARCH CORPORATION  
*for* SCIENCE ADVANCEMENT



## Objectives

Engage in dialogue with the goal of accelerating high-risk/high-reward research.

Identify and analyze bottlenecks to advance fundamental understanding of negative emissions science and develop approaches for breakthroughs.

Build a creative, better-networked community that is more likely to produce breakthroughs.

Form teams to write proposals to seed novel projects based on highly innovative ideas that emerge at the conference.

## Process

Brainstorming is welcome; don't be afraid to say what comes to mind.

Consider the possibility of unorthodox or unusual ideas without immediately dismissing them.

Discuss, build upon and constructively criticize each other's ideas – in a spirit of cooperative give and take.

Make comments concise to avoid monopolizing the dialogue.

## Diversity, Inclusion and No Harassment

Research Corporation for Science Advancement fosters an environment for listening and considering new ideas from a diverse group, with respect for all participants without regard to gender, race, ethnicity, sexual orientation, age or any other aspect of how we identify ourselves other than as fellow scientists.

RCSA does not tolerate any form of harassment, which could include verbal or physical conduct that has the purpose or effect of substantially interfering with anyone else's participation or performance at this conference, or of creating an intimidating, hostile, or offensive environment; any such harassment may result in dismissal from the conference.

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# Scialog: Negative Emissions Science

## From the President

Welcome to the 2021 *Scialog: Negative Emissions Science* meeting, cosponsored by Research Corporation and the Alfred P. Sloan Foundation. This is the second of three Scialog meetings on this theme.

The goal of this Scialog is to catalyze theorists, computational and data scientists, observers and experimentalists across multiple disciplines to collaborate on developing new and innovative projects to accelerate fundamental science to drive advances in understanding the underlying science that will allow negative emissions technologies to become efficient, affordable, and scalable.

Scialog's overarching purpose is to advance cutting-edge science of great significance to humanity by catalyzing innovative, basic research leading to fundamental discoveries. Our focus is on scientists in the early years of their independent careers. Through the unique Scialog process, we seek to lay the foundation for an ongoing, highly creative, cross-disciplinary community of scientists that will prove adept at identifying exciting areas for research advances for decades to come.

To that end, under the guidance of Research Corporation Program Directors **Richard Wiener, Andrew Feig,** and **Silvia Ronco** and **Evan Michelson** of the Sloan Foundation, we hope you will be engaged in passionate discussions with colleagues, many of whom you will have met for the first time at Scialog. The process may even push you out of your comfort zone with the goal of stimulating new and better ideas. The result, we expect, will be a meeting unlike others that you attend. We are confident that you will find the next few days to be extremely worthwhile.

This is your opportunity to air that wild idea you have been reluctant to share with others, or to discuss a nagging hunch that does not yet have sufficient supporting data, or to take a leap on a high- impact/high-risk project instead of concentrating all your effort on somewhat more "incremental" studies. This is the time to come up with, and be open to, completely new ideas that may truly change the world.

We hope this first meeting on this topic yields a crop of outstanding team proposals, which will make our job of determining who receives funding very challenging. I wish you every success in exploring new and compelling ideas over the next few days.

Have a terrific meeting!

**Daniel Linzer**

President

Research Corporation for Science Advancement

## From the Program Director

This year Research Corporation and the Alfred P. Sloan Foundation are cosponsoring the second annual meeting of *Scialog: Negative Emissions Science*. Research Corporation's highly interactive Scialog meetings have the goal of catalyzing new collaborations based on blue-sky ideas among Scialog Fellows who constitute a highly select group of exemplary early career U.S. and Canadian scientists. The emphasis is on dialogue, networking, and building new collaborations to pursue novel, high-risk discovery research.

Research Corporation and the Alfred P. Sloan Foundation chose to focus on *Negative Emissions Science* because we believe this critical area of science requires major breakthroughs in fundamental understanding of capturing and utilizing or sequestering carbon and other greenhouse gases in the atmosphere and oceans that will lead to a sustainable future. Just as firmly, we believe these breakthroughs can be accelerated by chemists and engineers and those in related fields working collaboratively on novel, high-risk projects, particularly combining multiple research approaches, such as modeling, data science, and experiments.

We have an outstanding keynote speaker to set the stage for breakout discussions:

**Jennifer Wilcox**, Principal Deputy Assistant Secretary for the Office of Fossil Energy and Carbon Management, U.S. Department of Energy.

We have a team of terrific discussion facilitators: **Roger Aines** (Lawrence Livermore National Laboratory), **Sarbajit Banerjee** (Texas A&M University), **Joan Brennecke** (University of Texas at Austin), **Jordi Cabana** (University of Illinois at Chicago), **Emily Carter** (University of California, Los Angeles), **Christopher Jones** (Georgia Institute of Technology), **Jeffrey Long** (University of California, Berkeley), **Alissa Park** (Columbia University), **George Shields** (Furman University), **Ellen Stechel** (Arizona State University), and **Aleksandra Vojvodic** (University of Pennsylvania).

We have representatives on hand as observers from several organizations with a strong interest in climate issues and science philanthropy. Please see the Conference Attendees section below for a complete list.

Scialog meetings focus on dialogue and team building with the goal of creating novel strategies and collaborative approaches. An important feature is the opportunity for Scialog Fellows to form teams and write proposals to pursue particularly creative ideas that emerge through the dialogue. We hope this competition is exciting, but regardless of which proposals are funded, the primary purpose is to catalyze a deeper and more meaningful exchange of ideas than ordinarily occurs at scientific conferences. Our intent is for this process to help participants gain new insights and connections that significantly advance fundamental science.

We hope each participant finds the Scialog experience of great value. Please do not hesitate to provide feedback on how to make the conference better. **Evan Michelson**, Program Director from the Sloan Foundation, my fellow RCSA Program Directors, **Andrew Feig** and **Silvia Ronco**, the RCSA staff, and I are here to help make the meeting a great experience!

### **Richard Wiener**

Senior Program Director  
Research Corporation for Science Advancement

# Scialog: Negative Emissions Science

## Conference Agenda (Optional activities in green) November 4–5, 2021

### Thursday, November 4 (all times listed in Pacific time zone)

8:00 – 8:30 am	<b>Early login, Informal dialog, BYO breakfast/lunch</b>	Zoom Main Room & Breakout Rooms
8:30 – 8:40 am	<b>Welcome</b> Dan Linzer, President, RCSA Adam Falk, President, <i>Sloan Foundation</i>	Zoom Main Room
8:40 – 8:55 am	<b>Conference Overview &amp; Desired Outcomes</b> Richard Wiener, <i>RCSA</i>	Zoom Main Room
8:55 – 9:30 am	<b>Small Group Ice Breakers</b>	Zoom Breakout Rooms
9:30 – 10:05 am	<b>Keynote Presentation &amp; Discussion</b> <i>The Role of Carbon Management in Helping to Achieve Net-Zero by Mid-Century</i> Jennifer Wilcox, DOE	Zoom Main Room
10:05 – 10:20 am	<b>Break</b>	
10:20 – 10:30 am	<b>Directions for Breakout Sessions</b>	Zoom Main Room
10:30 – 11:45 am	<b>Breakout Session I</b>	Zoom Breakout Rooms
11:45 am – 12:15 pm	<b>Report Out</b>	Zoom Main Room
12:15 – 12:30	<b>Directions for Mini Breakout Sessions</b>	Zoom Main Room
12:30 – 1:30 pm	<b>Break Lunch/Snack &amp; Optional informal discussions</b>	Zoom Main Room
1:30 – 2:15 pm	<b>Mini Breakout Session I (Fellows only)</b>	Gather Rooms
2:15 – 2:30 pm	<b>Break</b>	
2:30 – 3:15 pm	<b>Mini Breakout Session II (Fellows only)</b>	Gather Rooms
3:15 – 5:00 pm	<b>Break</b>	
5:00 – 7:00 pm	<b>Social Mixer</b>	Gather Rooms

### Friday, November 5 (all times listed in Pacific time zone)

8:00 – 8:30 am	<b>Early login, Informal dialog, BYO breakfast/lunch</b>	Zoom Main Room
8:30 – 8:40 am	<b>Check in regarding Thursday Sessions</b>	Zoom Main Room
8:40 – 9:00 am	<b>Discussion of Team Formation/Proposals</b>	Zoom Main Room
9:00 – 10:15 am	<b>Breakout Session II</b>	Zoom Breakout Rooms
10:15 – 10:45 am	<b>Report Out</b>	Zoom Main Room
10:45 – 11:00 am	<b>Break</b>	
11:00 am – 12:15 pm	<b>Breakout Session III</b>	Zoom Breakout Rooms
12:15 – 12:45 pm	<b>Report Out</b>	Zoom Main Room
12:45 – 1:00 pm	<b>Wrap-up</b>	Zoom Main Room
1:00 – 2:00 pm	<b>Break Lunch/Snack &amp; Optional informal discussions</b>	Zoom Main Room
2:00 – 2:45 pm	<b>Mini Breakout Session III (Fellows only)</b>	Gather Rooms
2:45 – 3:00 pm	<b>Break</b>	
3:00 – 3:45 pm	<b>Mini Breakout Session IV (Fellows only)</b>	Gather Rooms
3:45 – 5:00 pm	<b>Break</b>	
5:00 – 7:00 pm	<b>Social Mixer</b>	Gather Rooms

## Keynote Presentation

# The Role of Carbon Management in Helping to Achieve Net-Zero by Mid-Century

## Jennifer Wilcox

*Principal Deputy Assistant Secretary for Office of Fossil Energy and Carbon Management, U.S. Department of Energy*



**Abstract:** President Biden has laid out a bold and ambitious goal of achieving net-zero carbon emissions in the U.S. by 2050. The pathway to that target includes cutting total greenhouse gas emissions in half by 2030 and eliminating them entirely from the nation's electricity sector by 2035. Investment in technology research, design, development, and deployment (RDD&D) will be required to achieve the president's objectives, including investments in both carbon capture at point sources in addition to carbon dioxide removal approaches that target the accumulated pool of carbon in the atmosphere. Both will be required to achieve net-zero carbon emissions in time, and they will require increased deployment in order to move down the cost curve. These efforts combined with effective policy will make these approaches economically viable.

These approaches are critical and must be deployed in parallel. Deployment of these technologies at the scale required will necessitate the use of resources including land, water, and in some cases, low-carbon energy, while ensuring the secure and reliable storage of carbon dioxide (CO<sub>2</sub>) on a timescale that impacts climate. Therefore, CCS and CDR deployment must be implemented strategically in terms of regional goals and requirements.

The Office of Fossil Energy and Carbon Management will play an important role in the transition to net-zero carbon emissions by reducing the environmental impacts of fossil energy production and use—and helping decarbonize other hard-to-abate industrial sectors—through investments in technology solutions including CCS, direct air capture, and the deployment of carbon capture technologies to produce low-carbon products and fuel, including hydrogen.

# Scialog: Negative Emissions Science

## 2021 Proposal Guidelines and Collaborative Awards

### Scialog: Negative Emissions Science

1. Awards are intended to provide seed funding for teams of two to three Scialog Fellows formed at this conference for high-risk, high-impact projects.
2. Two-page proposals should describe the project and the role of each team member. No budget is necessary. A third page may be used for references.
3. Awards will be in the amount of \$50K direct funding per team member, plus a small percentage for overhead. Grant duration will be one year
4. No Scialog Fellow can be a member of more than two teams. If a Scialog Fellow is a member of two teams, other members of the teams must be different. No team can submit more than one proposal.
5. No Scialog Fellow who previously has won a Scialog NES Collaborative Award can be a member of more than one team. The other team members must be different from the members of the previously awarded team.
6. Teams cannot include members who have previously collaborated with one another. If you are unsure of your status (e.g., prospective team members were part of a large collaboration but did not significantly interact), please check for clarification with an RCSA program director.
7. Teams are encouraged (but not required) to:
  - a. Include members with different research approaches and methods.
  - b. Include members from different disciplines.
8. Proposals must be submitted electronically by 11:59 p.m. PST on **November 12, 2021**. Instructions for submission will be provided at the meeting.
9. Awards are anticipated to start on **February 1, 2022**.

## 2020 Collaborative Awards

### ***Electrifying Humidity-Swing Adsorption for DAC by Modulation of Redox-Polymer Hydration***

**Shaama Mallikarjun Sharada**, Chemical Engineering and Materials Science,  
University of Southern California

**Burcu Gurkan**, Chemical and Biomolecular Engineering, Case Western Reserve University

**Xiao Su**, Chemical and Biomolecular Engineering, University of Illinois at Urbana-Champaign

### ***Using Electrochemistry to Improve Selectivity of Plasma-Assisted CO<sub>2</sub> Reduction*** **William**

**Bowman**, Materials Science and Engineering, University of California, Irvine

**Eva Nichols**, Chemistry, University of British Columbia

**Robert Coridan**, Chemistry and Biochemistry, University of Arkansas

### ***Integrated Low-Temperature Electrified Process for CO<sub>2</sub> Direct Air Capture and Transformation to Solid Carbon***

**Kathryn Knowles**, Chemistry, University of Rochester

**Carlos Morales-Guio**, Chemical and Biomolecular Engineering, University of California, Los Angeles

**Robert Coridan**, Chemistry and Biochemistry, University of Arkansas

### ***Investigation of the Carbonation Dynamics of Synthetic Silicates: Guiding the Development of Net- Negative Production Process and Deployment in Enhanced Rock Weathering***

**Rafael Santos**, School of Engineering, University of Guelph

**Pratik Dholabhai**, Physics and Astronomy, Rochester Institute of Technology

**Andrea Hicks**, Civil and Environmental Engineering, University of Wisconsin-Madison

### ***Bricks from The Ocean: Hybrid Microbial-Electrochemical Mineralization of CO<sub>2</sub>***

**Nanette Boyle**, Chemical & Biological Engineering, Colorado School of Mines

**Shu Hu**, Chemical and Environmental Engineering, Yale University

### ***Solar-Augmented Direct Air Capture of Methane Using Methanotrophic Bacteria***

**Nanette Boyle**, Chemical and Biological Engineering, Colorado School of Mines

**Chong Liu**, Chemistry and Biochemistry, University of California, Los Angeles

### ***Envisioning a Low Carbon Built Environment through Innovative Electrochemical and Chemical Processing of Construction Materials and Enhanced Circular Reuse***

**Greeshma Gadikota**, Civil and Environmental Engineering, Cornell University

**Venkat Viswanathan**, Mechanical Engineering, Carnegie Mellon University

### ***Electrochemically Driven Reactive Capture of CO<sub>2</sub> from Air Using Azolium-Carboxylates***

**Wilson Smith**, Chemical and Biological Engineering, University of Colorado Boulder

**David Kwabi**, Mechanical Engineering, University of Michigan

**Robert Gilliard**, Department of Chemistry, University of Virginia

# Scialog: Negative Emissions Science

## Scialog Fellows

**Kandis Leslie Abdul-Aziz** [klabdulaziz@engr.ucr.edu](mailto:klabdulaziz@engr.ucr.edu)

University of California, Riverside,  
Chemical and Environmental Engineering  
*Dr. Abdul-Aziz leads the Sustainable Catalysis and Materials Group, which focuses on developing sustainable processes and catalytic schemes for the full utilization of waste (carbon, plastics, biomass) to value-added fuels and chemicals.*

**Ashleigh Baber** [baberae@jmu.edu](mailto:baberae@jmu.edu)

James Madison University, Chemistry and Biochemistry  
*Exploration of bifunctional and multifunctional catalysts for the conversion of carbon dioxide into value added fuels.*

**Praveen Bollini** [ppbollini@uh.edu](mailto:ppbollini@uh.edu)

University of Houston,  
Chemical and Biomolecular Engineering  
*Adsorption-heterogeneous catalysis-reaction engineering.*

**William J. Bowman** [will.bowman@uci.edu](mailto:will.bowman@uci.edu)

University of California, Irvine,  
Materials Science and Engineering  
*My lab applies and develops advanced electron microscopy methods for materials characterization. We study inorganic oxide ceramics for energy storage, conversion, and CO2 capture.*

**Nanette Boyle** [nboyle@mines.edu](mailto:nboyle@mines.edu)

Colorado School of Mines,  
Chemical and Biological Engineering  
*Studying carbon fluxes in biological organisms and complex consortia so that we can engineer them more efficiently.*

**Fikile Brushett** [brushett@mit.edu](mailto:brushett@mit.edu)

Massachusetts Institute of Technology,  
Chemical Engineering  
*I am interested in advancing the science and engineering of new electrochemical systems for a sustainable energy future.*

**Rob Coridan** [rcoridan@uark.edu](mailto:rcoridan@uark.edu)

University of Arkansas, Chemistry and Biochemistry  
*Structured, nanomaterials-based composite structures for solar-to-fuels applications.*

**Pratik Dholabhai** [pratik.dholabhai@rit.edu](mailto:pratik.dholabhai@rit.edu)

Rochester Institute of Technology,  
Physics and Astronomy  
*Computational materials scientist with expertise in application and development of atomistic simulation methods to design novel materials and technologies.*

**Greeshma Gadikota** [gg464@cornell.edu](mailto:gg464@cornell.edu)

Cornell University, Civil and Environmental Engineering  
*Sustainable energy and resource recovery.*

**Betar Gallant** [bgallant@mit.edu](mailto:bgallant@mit.edu)

Massachusetts Institute of Technology,  
Mechanical Engineering  
*Study and design of non-thermal CO2 capture technologies for improved versatility, modularity, and efficiency at scale.*

**Rebecca Gieseking** [gieseking@brandeis.edu](mailto:gieseking@brandeis.edu)

Brandeis University, Chemistry  
*Quantum mechanical modeling of photochemical and electrochemical electron transfer; plasmon-enhanced catalysis.*

**Matt Green** [mdgreen8@asu.edu](mailto:mdgreen8@asu.edu)

Arizona State University, Chemical Engineering  
*The Green lab designs sorbents (primarily polymeric sorbents), sorbent form factors, and systems to capture carbon dioxide from air.*

**Burcu Gurkan** [burcu@case.edu](mailto:burcu@case.edu)

Case Western Reserve University,  
Chemical and Biomolecular Engineering  
*Reactive CO2 separations by solvents (ionic liquids and deep eutectic solvents); hybrid materials for direct air capture; facilitated transport membranes.*

**Kelsey B. Hatzell** [kelsey.hatzell@princeton.edu](mailto:kelsey.hatzell@princeton.edu)

Princeton University,  
Mechanical and Aerospace Engineering  
*Electrochemical systems, energy conversion.*

**Marta Hatzell** [marta.hatzell@me.gatech.edu](mailto:marta.hatzell@me.gatech.edu)

Georgia Institute of Technology, Mechanical Engineering  
*Design of cost effective separations and catalytic systems for CO2 sequestration and conversion.*

**Andrea Hicks** [hicks5@wisc.edu](mailto:hicks5@wisc.edu)

University of Wisconsin-Madison,  
Civil and Environmental Engineering  
*Environmental impacts and sustainability implications of emerging technologies, using tools such as life cycle assessment and techno economic analysis.*

**Caleb Hill** [caleb.hill@uwyo.edu](mailto:caleb.hill@uwyo.edu)

University of Wyoming, Chemistry  
*The development and application of analytical methods to characterize the chemical and physical behavior of individual nanoscale entities.*

**Adam Holewinski** [adam.holewinski@colorado.edu](mailto:adam.holewinski@colorado.edu)

University of Colorado Boulder, Chemical Engineering  
*Electrochemistry, catalysis, biomass conversion, kinetics, spectroscopy.*

Scialog Fellows Continued**Katherine Hornbostel** [hornbostel@pitt.edu](mailto:hornbostel@pitt.edu)

University of Pittsburgh, Mechanical Engineering  
*Direct ocean capture; carbon capture membrane modeling; metal organic frameworks for direct air capture; novel system modeling for direct air capture.*

**Shu Hu** [shu.hu@yale.edu](mailto:shu.hu@yale.edu)

Yale University, Chemical and Environmental Engineering  
*Photocatalysis utilizing natural resources, light-driven fuel production and organic synthesis, in situ multi-modal characterizations, and reactor engineering.*

**Jimmy Jiang** [jiangjb@ucmail.uc.edu](mailto:jiangjb@ucmail.uc.edu)

University of Cincinnati, Chemistry  
*Our research interest is centered on molecular catalysis for small molecule conversion, with a primary focus on the elucidation of catalysis mechanisms.*

**Feng Jiao** [jiao@udel.edu](mailto:jiao@udel.edu)

University of Delaware, Chemical and Biomolecular Engineering  
*I am interested in science and engineering research related to carbon capture and utilization, electrochemical systems, and catalysis.*

**Katie Knowles** [kknowles@ur.rochester.edu](mailto:kknowles@ur.rochester.edu)

University of Rochester, Chemistry  
*Synthesis, electrochemistry, and photophysics of first-row transition metal oxide nanomaterials.*

**David Kwabi** [dkwabi@umich.edu](mailto:dkwabi@umich.edu)

University of Michigan, Mechanical Engineering  
*Electrochemical separation (CO<sub>2</sub> capture, desalination, nitrogen recovery), energy storage at grid-scale (redox-flow batteries), multi-physics modeling.*

**Siona Liguori** [sliguori@clarkson.edu](mailto:sliguori@clarkson.edu)

Clarkson University, Chemical and Biomolecular Engineering  
*My research interests are focused on the synthesis, development and application of inorganic membrane and membrane reactors, where the interactions between catalysis and separation lead to process intensification allowing for clean energy conversion and carbon capture.*

**Feng Lin** [fenglin@vt.edu](mailto:fenglin@vt.edu)

Virginia Polytechnic Institute and State University, Chemistry  
*Electrochemical energy chemistry and advanced synchrotron characterization.*

**Zhou Lin** [zhoulin@umass.edu](mailto:zhoulin@umass.edu)

University of Massachusetts Amherst, Chemistry  
*Developing versatile computational methods combining quantum mechanics and machine learning to model significant chemical reactions in energy, materials, and environmental sciences. Interpreting rigorous quantum mechanical behaviors of molecules in various energy and time scales.*

**Chong Liu** [chongliu@chem.ucla.edu](mailto:chongliu@chem.ucla.edu)

University of California, Los Angeles, Chemistry and Biochemistry  
*Electrochemistry, connecting inorganic nanomaterials with microorganisms, CO<sub>2</sub>/N<sub>2</sub>/CH<sub>2</sub> activation.*

**T. Leo Liu** [leo.liu@usu.edu](mailto:leo.liu@usu.edu)

Utah State University, Chemistry and Biochemistry  
*My group's research interests broadly cover energy and catalysis sciences applied to sustainable energy and chemical conversions.*

**Yayuan Liu** [yayuanliu@jhu.edu](mailto:yayuanliu@jhu.edu)

Johns Hopkins University, Chemical and Biomolecular Engineering  
*Our lab develops electrochemical methods for carbon dioxide separation and utilization with efforts spanning from fundamental understanding to materials design and prototyping.*

**Yuanyue Liu** [yuanyue.liu@austin.utexas.edu](mailto:yuanyue.liu@austin.utexas.edu)

University of Texas at Austin, Mechanical Engineering  
*My research focuses on developing and applying atomistic simulation methods to study electron transport and electrochemistry especially catalysis.*

**Oana Luca** [oana.luca@colorado.edu](mailto:oana.luca@colorado.edu)

University of Colorado Boulder, Chemistry  
*Sustainable electrochemical methods for capture and conversion of abundant gases.*

**Jarad Mason** [mason@chemistry.harvard.edu](mailto:mason@chemistry.harvard.edu)

Harvard University, Chemistry and Chemical Biology  
*The Mason Group applies the tools of synthetic chemistry and nanoscience to design materials that address basic science challenges in energy and medicine, with a particular emphasis on manipulating entropic effects, phase transitions, and porosity in metal-organic materials.*

**Ellen Matson** [matson@chem.rochester.edu](mailto:matson@chem.rochester.edu)

University of Rochester, Chemistry  
*The Matson Lab studies the synthesis and reactivity of metal oxide clusters with interests in energy storage and conversion.*

## Scialog Fellows Continued

**Charles McCrory** [cmccrory@umich.edu](mailto:cmccrory@umich.edu)

University of Michigan, Chemistry

*My research program focuses on using careful electroanalytical studies to elucidate the mechanism of electrocatalytic systems, then using this mechanistic understanding to inform the rational design of next-generation catalyst materials.*

**Jose Mendoza** [jmendoza@msu.edu](mailto:jmendoza@msu.edu)

Michigan State University,

Chemical Engineering and Materials Science

*My research focus on the development of theoretical and computational techniques for Quantum Simulations, Machine Learning and Multiscale simulations to study structural, electronic, transport and optical properties of materials, low-dimensional systems and nanostructures.*

**Phill Milner** [pjm347@cornell.edu](mailto:pjm347@cornell.edu)

Cornell University, Chemistry and Chemical Biology

*Uncovering new reversible chemical reactions that enable separations of greenhouse gases within porous framework materials.*

**Gary F. Moore** [gary.f.moore@asu.edu](mailto:gary.f.moore@asu.edu)

Arizona State University, Molecular Sciences

*My research aims to understand and advance the fundamental molecular sciences required to unleash a range of renewable energy and chemical manufacturing technologies.*

**Carlos Morales-Guio** [moralesguio@ucla.edu](mailto:moralesguio@ucla.edu)

University of California, Los Angeles,

Chemical and Biomolecular Engineering

*Our research is focused on the understanding of electrocatalytic technologies at multiple scales to close the gap between atoms, electrodes, devices and process plants.*

**Eva Nichols** [enichols@chem.ubc.ca](mailto:enichols@chem.ubc.ca)

University of British Columbia, Chemistry

*We study the local environment's role in homo/heterogeneous electrocatalytic CO<sub>2</sub>/CO reduction and use IR spectroscopy to probe mechanisms.*

**Michael Nippe** [nippe@chem.tamu.edu](mailto:nippe@chem.tamu.edu)

Texas A&M University, Chemistry

*We are working on developing on new design elements for electro- and photo-catalysts for small molecule conversions and have experience in carbon dioxide reduction, formate conversion, and nitrogen reduction.*

**Valentina Prigiobbe** [vprigiob@stevens.edu](mailto:vprigiob@stevens.edu)

Stevens Institute of Technology, Civil, Environmental, and Ocean Engineering

*My work focuses on the development of a bio-carbon mineralization process for CO<sub>2</sub> storage and mining.*

**Lina Quan** [linaquan@vt.edu](mailto:linaquan@vt.edu)

Virginia Polytechnic Institute and State University, Chemistry

*Our research is interested in developing efficient semiconductors for clean energy applications such as photovoltaics and related technology.*

**Ananya Renuka Balakrishna** [renukaba@usc.edu](mailto:renukaba@usc.edu)

University of Southern California,

Aerospace and Mechanical Engineering

*We develop novel mathematical models to predict and understand how materials respond to external stimuli.*

**Fateme Rezaei** [rezaeif@mst.edu](mailto:rezaeif@mst.edu)

Missouri University of Science and Technology,

Chemical and Biochemical Engineering

*My research interests are novel sorbents and intensified separation processes for energy and environmental applications.*

**Emily Ryan** [ryanem@bu.edu](mailto:ryanem@bu.edu)

Boston University, Mechanical Engineering

*Meso-scale modeling of multi-phase reactive systems.*

**Rafael Santos** [santosr@uoguelph.ca](mailto:santosr@uoguelph.ca)

University of Guelph, Engineering

*I am working on realizing the full potential of enhanced rock weathering towards climate change mitigation. This includes identifying the best minerals, understanding how they weather and the fate of the sequestered carbon, and finding conditions that accelerate weathering.*

**Caroline Saouma** [caroline.saouma@utah.edu](mailto:caroline.saouma@utah.edu)

University of Utah, Chemistry

*We are interested in improving CO<sub>2</sub> reduction catalysis through catalyst design, mechanistic studies, thermodynamic understanding, and combining carbon capture with recycling.*

**Kristen Schell** [kristenschell@cunet.carleton.ca](mailto:kristenschell@cunet.carleton.ca)  
 Carleton University,  
 Mechanical and Aerospace Engineering  
*My research interests are in developing machine learning and optimization models to inform the design of low energy negative emissions technologies (NETs).*

**Marcel Schreier** [mschreier2@wisc.edu](mailto:mschreier2@wisc.edu)  
 University of Wisconsin-Madison,  
 Chemical and Biological Engineering  
*The Schreier group takes a bottom-up approach to understand and tune electrocatalytic interfaces on the molecular level, widening the scope of electricity-driven reactions that can be driven by electricity.*

**Linsey Seitz** [linsey.seitz@northwestern.edu](mailto:linsey.seitz@northwestern.edu)  
 Northwestern University,  
 Chemical and Biological Engineering  
*Catalyst synthesis, reaction mechanisms, degradation processes, in situ spectroscopy, and reactor design for electrocatalytic processes.*

**Shaama Sharada** [ssharada@usc.edu](mailto:ssharada@usc.edu)  
 University of Southern California, Chemical Engineering  
*Developing and applying quantum chemistry methods towards catalyst design for sustainable chemistry.*

**Wilson A Smith** [wilson.smith@nrel.gov](mailto:wilson.smith@nrel.gov)  
 National Renewable Energy Laboratory,  
 University of Colorado Boulder, Materials, Chemical, and Computational Science/Chemical Engineering  
*I am interested in scaling electrochemical processes that can contribute to negative emissions science, with a focus on integrating systems for optimized balance of plant operation.*

**Xiao Su** [x2su@illinois.edu](mailto:x2su@illinois.edu)  
 University of Illinois at Urbana-Champaign,  
 Chemical and Biomolecular Engineering  
*My research focuses on the design electrochemical interfaces with a high degree of molecular specificity for applications in chemical and environmental separations.*

**Andrew Teixeira** [arteixeira@wpi.edu](mailto:arteixeira@wpi.edu)  
 Worcester Polytechnic Institute, Chemical Engineering  
*Microreaction engineering using dynamic multiphase reactor design, porous media, catalysis, and transport phenomena.*

**Jesús Velázquez** [jevelazquez@ucdavis.edu](mailto:jevelazquez@ucdavis.edu)  
 University of California, Davis, Chemistry  
*Synthesis and electronic structure characterization of multidimensional solid-state materials and thin films for energy conversion and environmental remediation.*

**Venkat Viswanathan** [venkvis@cmu.edu](mailto:venkvis@cmu.edu)  
 Carnegie Mellon University, Mechanical Engineering  
*Electrochemical routes for sustainable synthesis, electrochemical cement production, electrocatalysis.*

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*My group's research is mainly focused on electrochemically converting atmospheric molecules such as CO<sub>2</sub>, O<sub>2</sub> and N<sub>2</sub> into valuable fuels and chemicals.*

**Luisa Whittaker-Brooks** [luisa.whittaker@utah.edu](mailto:luisa.whittaker@utah.edu)  
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*Heat recovery, CO<sub>2</sub> capture. Synthesis and morphology control of 2D and 3D coordination polymers. Understanding electrochemical processes via in situ spectroscopy and diffraction.*

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*CO<sub>2</sub> capture and concentration, direct air, electrochemical methods, CO<sub>2</sub> as a feedstock to fuels.*

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*My research interest is on the development of nanoscale and sub-nanoscale catalytic materials with atomically precise surfaces, interfaces and ordered architectures that enables emerging applications in energy and environmental sustainability.*

# Scialog: Negative Emissions Science

## Discussion Facilitators

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Atmospheric, Earth, and Energy Division,  
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*I seek to understand, develop, and implement technologies for the removal of carbon dioxide from the atmosphere—so-called negative emissions technologies, especially in the context of real limitations of societal acceptance and resource limitations.*

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*Ionic liquids, thermodynamics, gas separations, supercritical fluid technology, environmentally benign chemical processing.*

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Chemical and Biomolecular Engineering/Provost  
*Development and application of efficient, accurate quantum mechanics techniques for the discovery and design of molecules and materials for sustainable energy and carbon dioxide utilization, including converting sunlight to electricity and producing chemicals and fuels.*

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Chemical and Biomolecular Engineering  
*Direct air capture materials and processes, catalytic CO<sub>2</sub> conversion.*

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Chemistry and Chemical and Biomolecular Engineering  
*Our research focuses on the synthesis and characterization of new porous materials for potential applications in gas storage, molecular separations, catalysis, and energy storage.*

**Alissa Park** [ap2622@columbia.edu](mailto:ap2622@columbia.edu)

Columbia University, Earth and Environmental Engineering and Chemical Engineering  
*Our research focuses on the development of novel materials for CO<sub>2</sub> capture including direct air capture and their integration into different CO<sub>2</sub> conversion pathways such as carbon mineralization and CO<sub>2</sub> electrochemical conversion to chemicals, materials and fuels.*

**George Shields** [george.shields@furman.edu](mailto:george.shields@furman.edu)

Furman University, Chemistry  
*Computational chemistry applied to important societal problems.*

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*Computational-driven materials design for chemical transformations and energy conversion with the focus on transition metal compounds.*

## Guests

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*Energy system transformation and deep decarbonization*

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*Natural processes of carbon sequestration*

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Alfred P. Sloan Foundation,  
Energy and Environment Program  
*I oversee a research program that aims to inform the societal transition toward low-carbon energy systems in the United States by investigating economic, environmental, technological, and distributional issues.*

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University of Arizona, College of Science  
*I am interested in all aspects of getting toward zero and negative emissions, particularly with the help of geology/geochemistry.*

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U.S. Department of Energy,  
Fossil Energy and Carbon Management  
*Investing in strategies that minimize environmental and social impacts of our dependence on fossil fuels, e.g., methane mitigation, carbon capture, carbon removal, and dedicated storage*

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Climate Pathfinders Foundation, Grants  
Early-stage grant funding for negative emissions

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