Environmental NanoChemistry Lab (ENCL)

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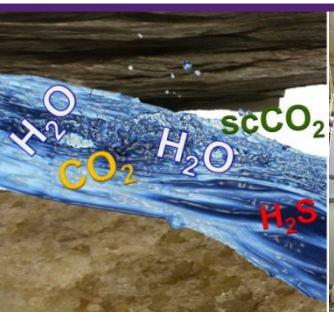
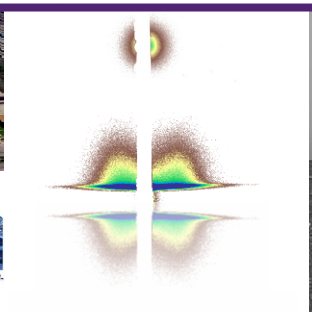
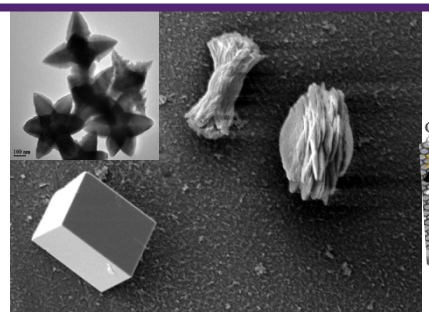
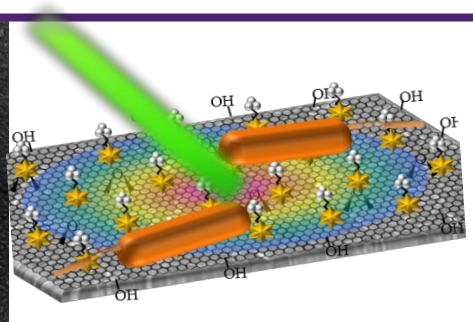
Website: http://encl.engineering.wustl.edu/; Brauer 2029 (lab)

Using **nucleation** and **nanoscale interfacial reactions,** we solve important energy and environmental challenges









We need 2 or more new, ambitious, and enthusiastic members!

We will work together to rise high!

Environmental NanoChemistry Lab (ENCL)

We study the following topics:

- ❑ **Nucleation, growth, and aggregation of nanoparticles and their structures and reactivities in aquatic systems (from freshwater systems to highly saline systems).**
- ❑ **Chemical kinetics, thermodynamics, and mechanisms of interfacial reactions at nanoscale.**

We use interdisciplinary tools

Synchrotron-Based Techniques at national synchrotron facilities (X-ray scattering, spectroscopy, and diffraction)

We work with national laboratory scientists at national facilities and travel to work with them.

We are experts who use various surface-sensitive techniques and provide in-depth knowledge of **water, surface, and solid-state chemistry**. We also simulate your experimental results using **reactive transport models**.

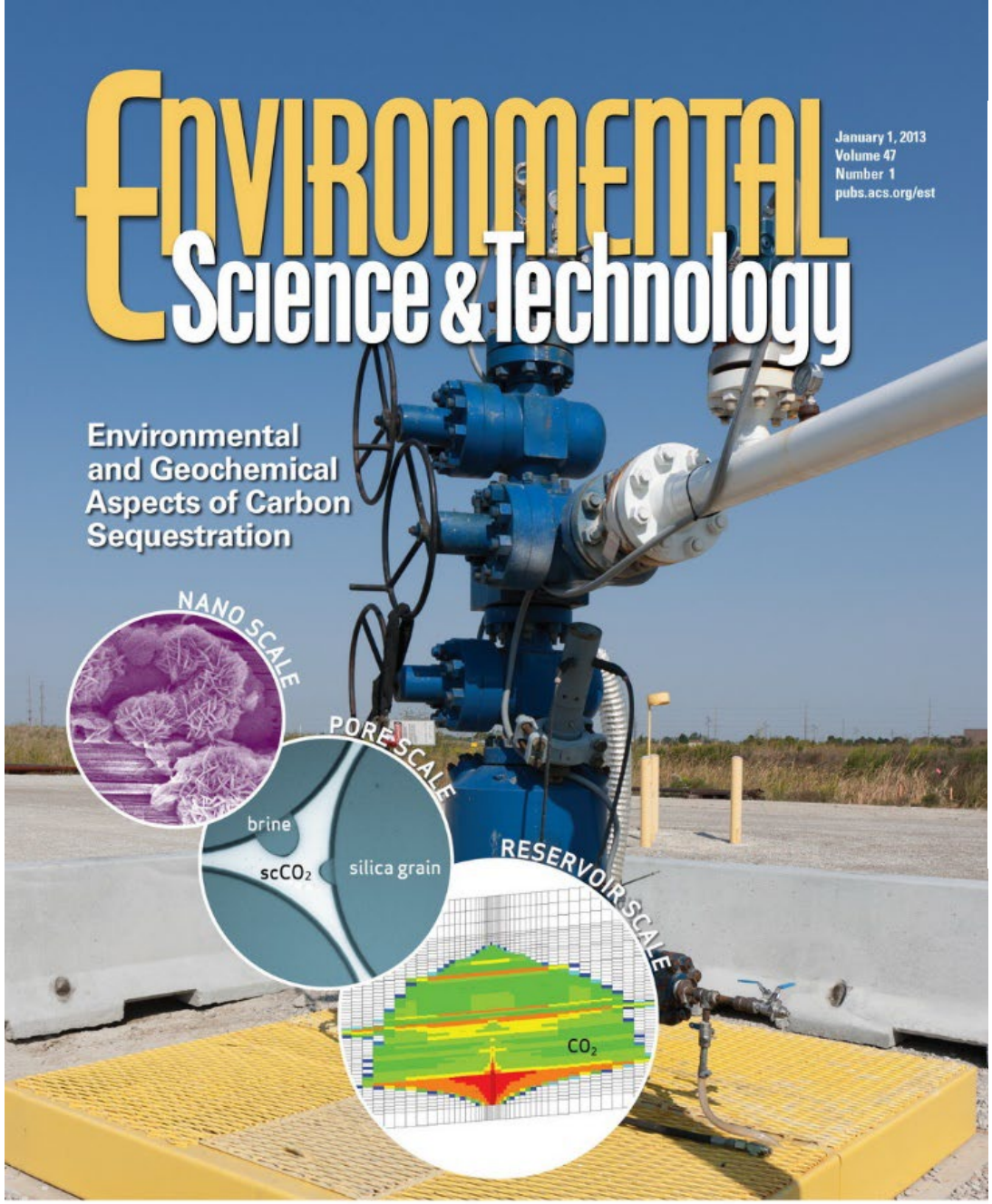
We utilize advances in nanoscale interfacial chemistry and solid nucleation to tackle important challenges in energy and the environment, focusing on three areas:

1. ***Energy-related chemical systems***, including CO_2 capture, utilization, and storage (CCUS) and subsurface engineering, such as CO_2 mineralization, geologic CO_2 storage, underground storage of hydrogen, and enhanced geothermal energy.
2. ***New resource recovery methods***. These methods encompass the recovery of critical elements (rare earth elements, nickel, cobalt, and lithium) that are essential to clean energy technologies, the extraction and recycling of phosphorus and nitrogen nutrients and carbon for a sustainable circular economy, and the generation of useful chemical stocks from water desalination.
3. ***Nanomaterials and nanotechnologies*** for purifying drinking water and remediating contaminated water and soil. These materials benefit water reuse, managed aquifer recharge, and membrane processes such as reverse osmosis and ultrafiltration. We also examine the fate and transport of these nanomaterials in the environment.

Climate change, water scarcity, and limited resources

ENCL

We will provide solutions for challenges in climate change, water scarcity, and limited resources



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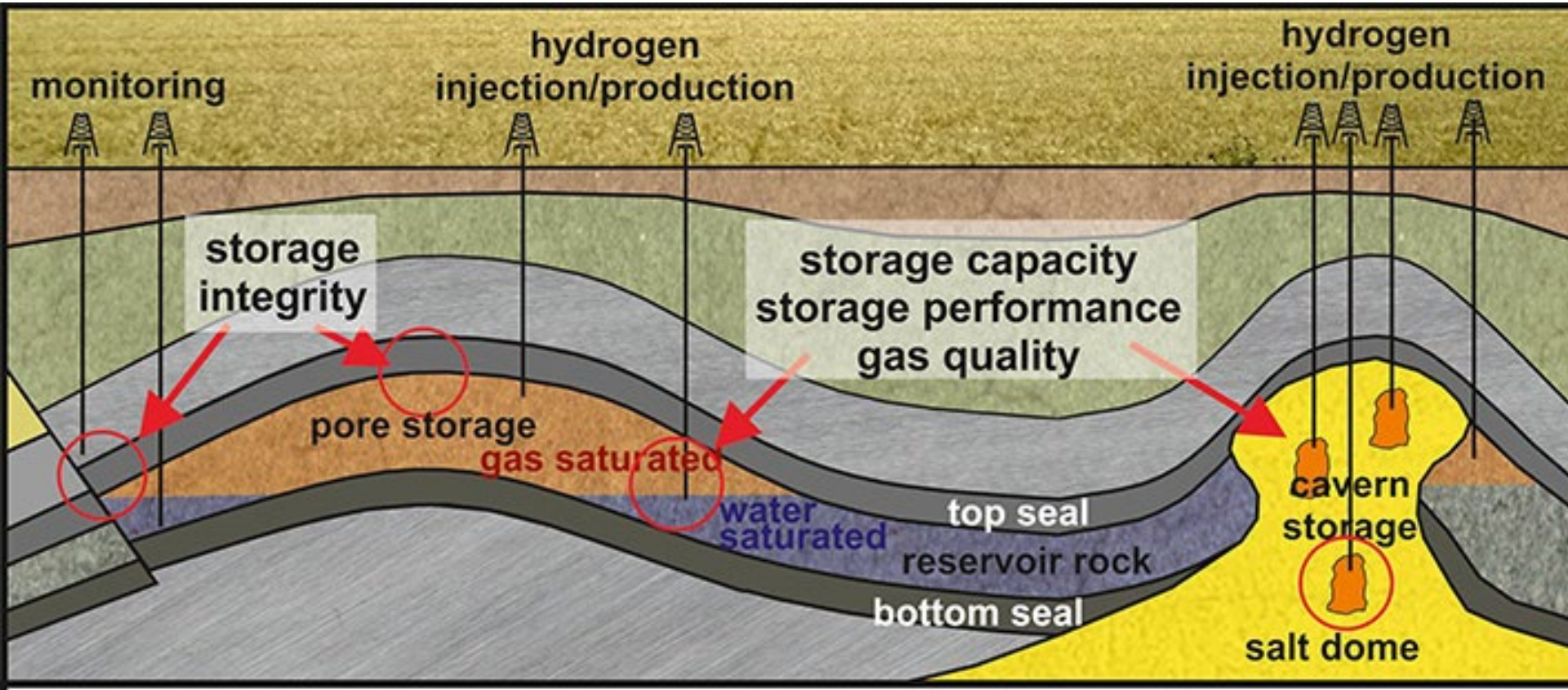
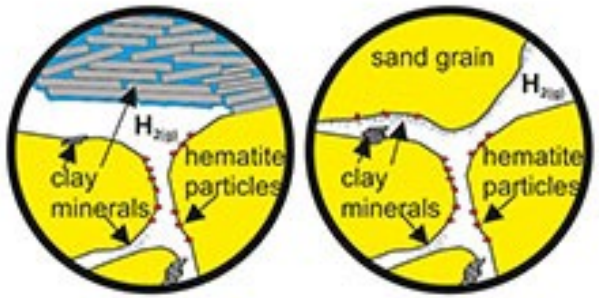
Do something that matters:

Alleviating CO_2 emission for achieving carbon neutrality

Underground storage of hydrogen

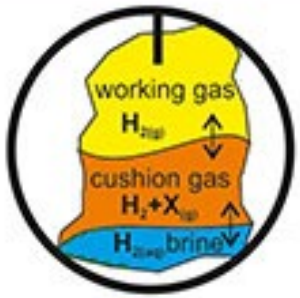


geochemical and microbial processes



H_2-mineral surface

H_2-water-mineral surface

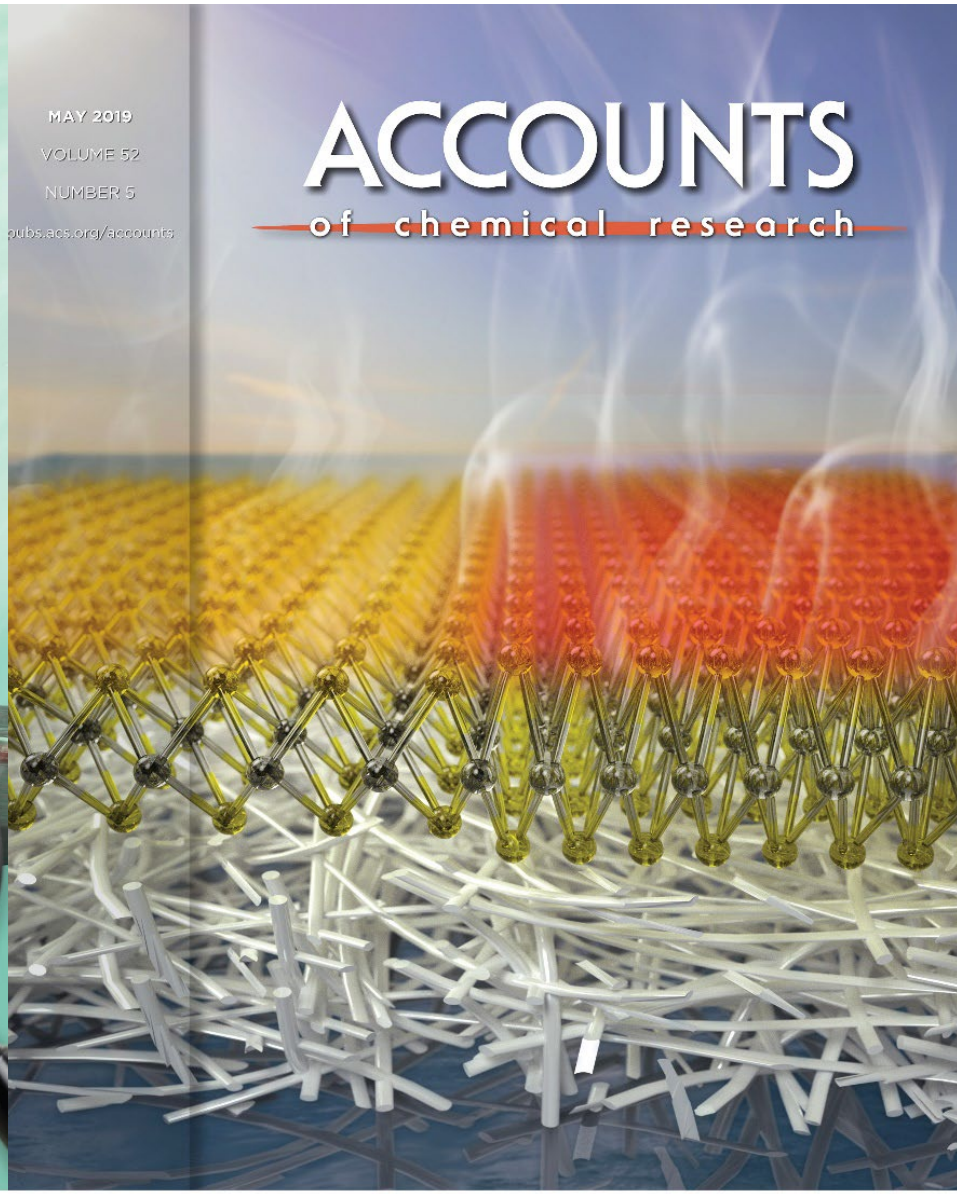


H_2-gas-brine

https://www.geozentrum-hannover.de

We need huge H_2 storage capacity.

Water: New ways to do desalination



Food-Water: Support sound circular economy

Environmentally sustainable fertilizer

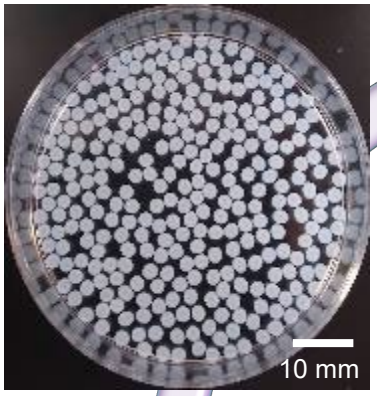
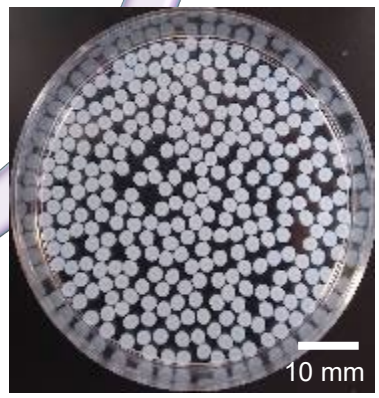


Image: NIEHS.NIH.gov

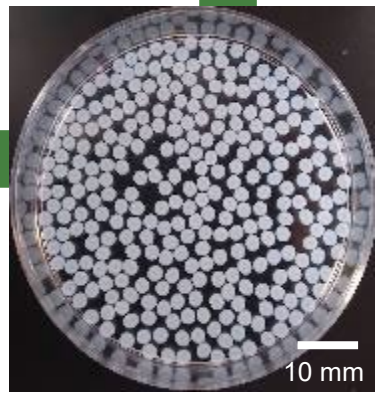
Image: USDA.gov



Phosphorus removal

CO_2 capture and utilization: Support a decarbonized future

Algal farm: energy & valuable product

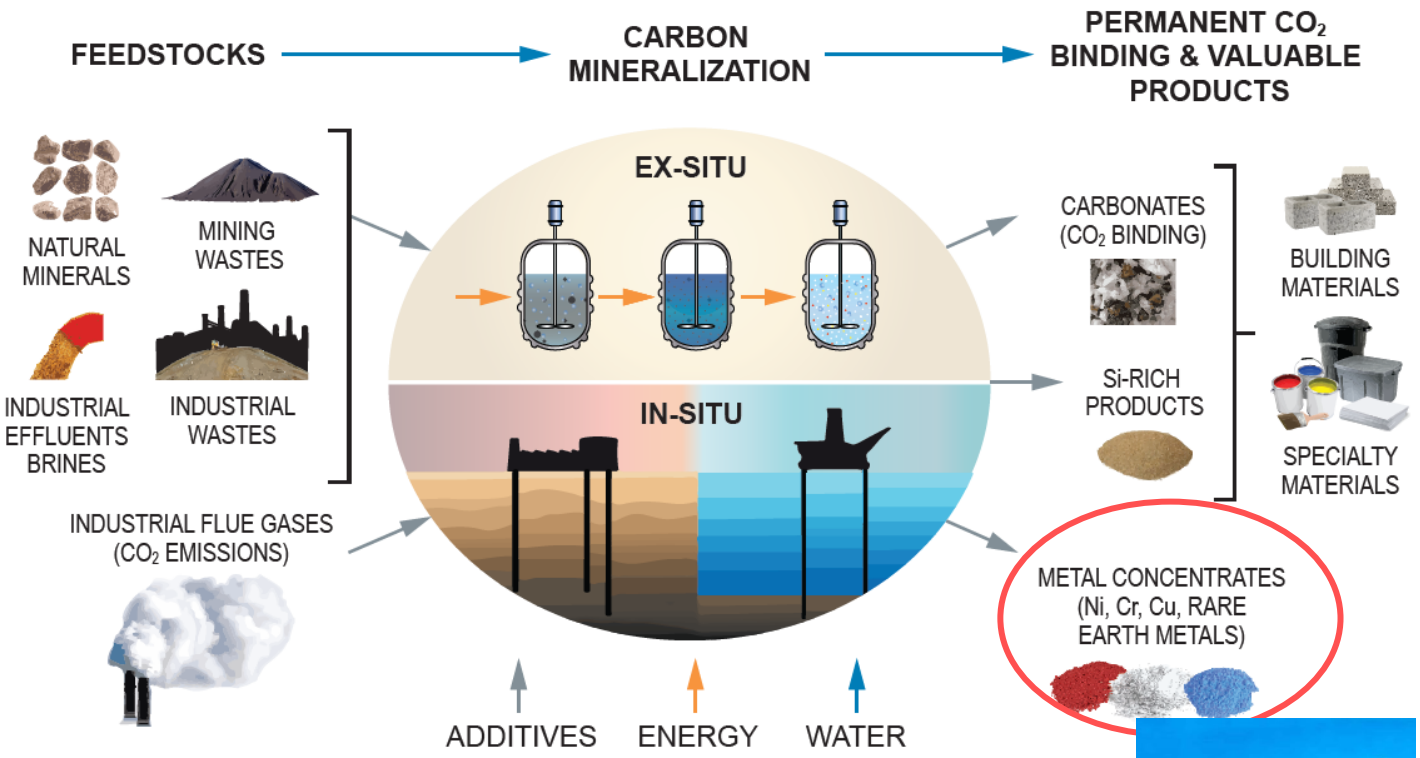


CO_2 capture and utilization

Image sources: www.iea.org/reports/global-energy-review-co2-emissions-in-2021-2
www.energy.gov/eere/bioenergy/algal-production

Resource recovery from reverse osmosis concentrates

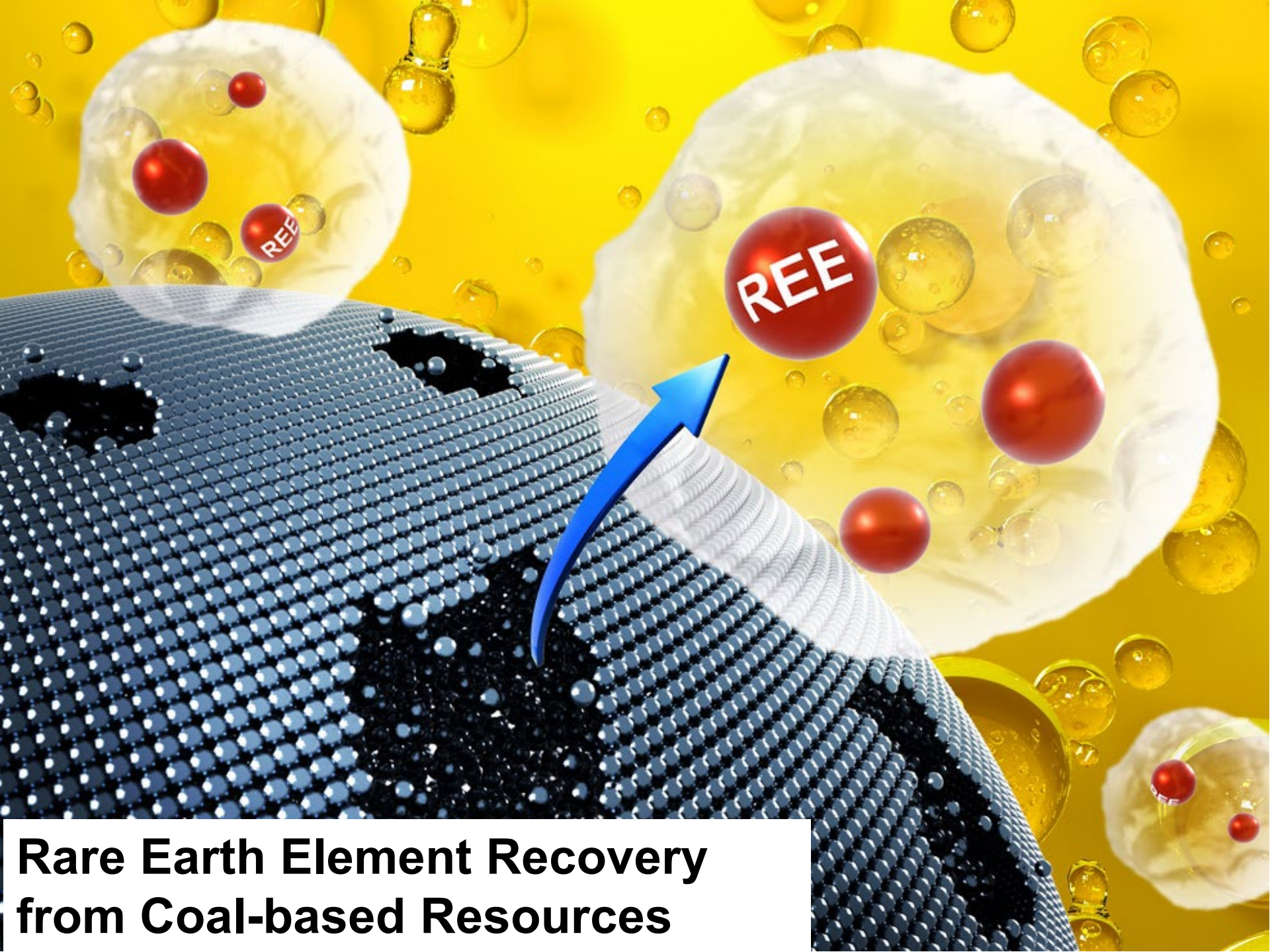
Integrating CO_2 storage into Critical Element Recovery



A Report of the National Petroleum Council December 2019
The original image is from the Park group at Columbia

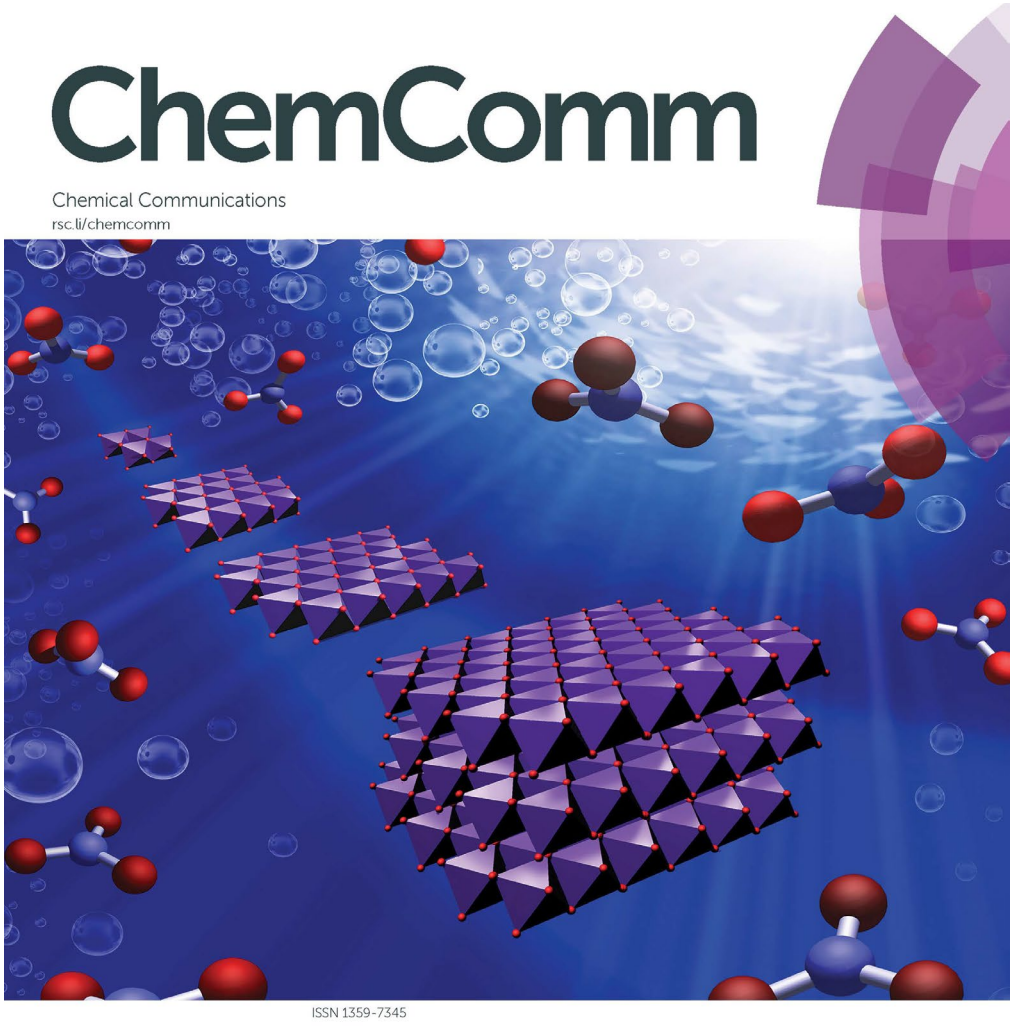
$((Mg,Fe)_2SiO_4)$ **Olivine: contain Ni, Co**
Saprolite ore: Ni
Laterite: Ni , Co

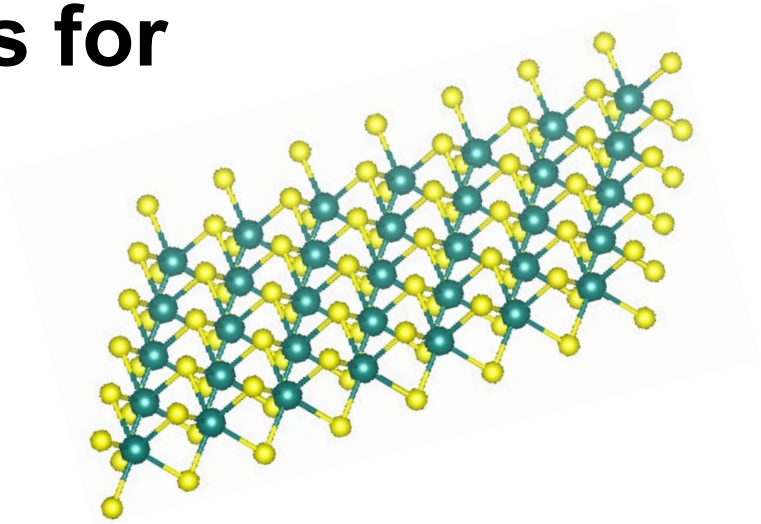
Nickel-Cobalt-Manganese (NCM) Batteries



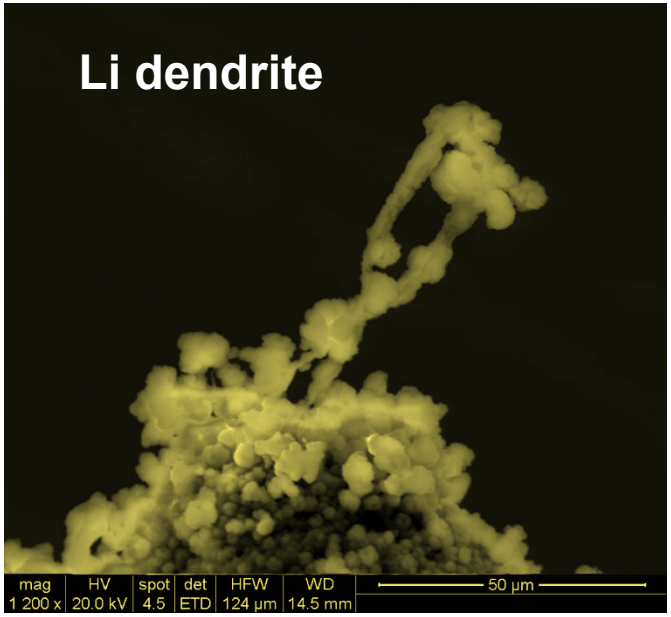
Rare Earth Element Recovery from Coal-based Resources

Green Materials Synthesis for
Water and Energy





Two-dimensional nanomaterials



What do the former doctoral students do next and where are they now?

- **Academia: Tenured Associate professors** at Peking University (formerly at the University of Houston) and at the Technical University of Denmark,
- **Tenure-track Assistant professors** the University of Washington, Changwon National University, Stony Brook University, New Jersey Institute of Technology, and Zhejiang University.
- **National Laboratory:** the U.S. Environmental Protection Agency, the National Energy Technology Laboratory, **the Los Alamos National Laboratory (Staff Scientist)**, and the Oak Ridge National Laboratory
- **Postdoctoral scholars at Universities:** Georgia Tech, MIT, the University of California-Berkeley (with Miller fellowship), the University of California-Los Angeles, the University of Copenhagen, Stanford University, Yale University, Princeton University, the Ohio State University, the University of Illinois-Urbana Champaign, and the University of Chicago
- **Industry:** 2 alumni at Intel Corporation and 2 alumni at Bayer

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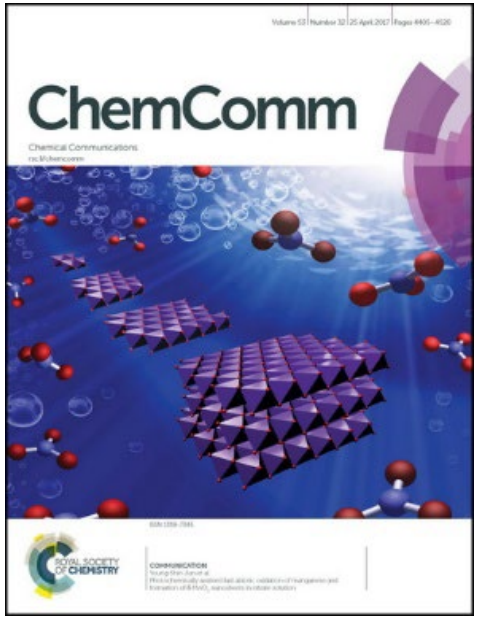

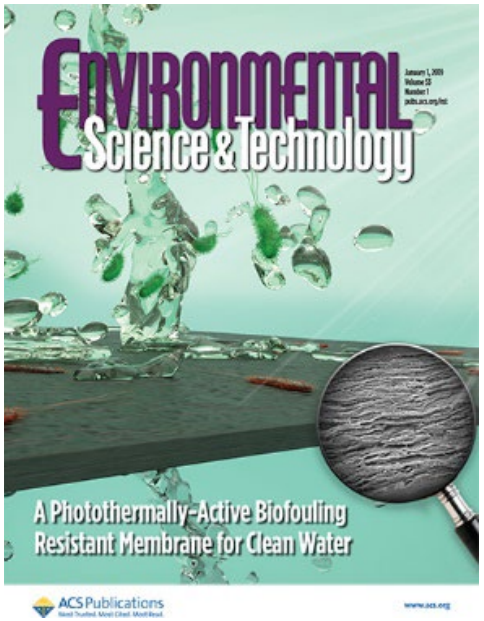

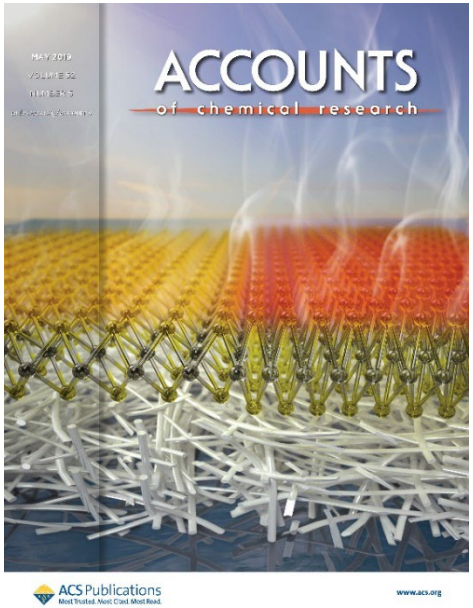

Selected papers

- **Young-Shin Jun**,* Lijie Zhang, Yujia Min, and Qingyun Li, Nanoscale Chemical Processes Affecting Storage Capacities and Seals during Geologic CO_2 Sequestration, *Accounts of Chemical Research*, **2017**, 50 (7), 1521–1529.
- **Young-Shin Jun,*** Doyoon Kim, and Chelsea W. Neil, Heterogeneous Nucleation and Growth of Nanoparticles at the Environmental Interfaces, *Accounts of Chemical Research*, **2016**, 49(9), 1681-1690,
- Chelsea W. Neil, Y. Jeffrey Yang, Don Schupp, and **Young-Shin Jun***, Water Chemistry Impacts on Arsenic Mobilization and Secondary Mineral Precipitation from Arsenopyrite Dissolution: Implications for Managed Aquifer Recharge, *Environmental Science & Technology,* **2014**, 48(8), 4395-4405. **This paper awarded to be the ES&T's Top Science Paper in 2014**
- **Young-Shin Jun*,** Xuanhao Wu, Deoukchen Ghim, Qisheng Jiang, Sisi Cao, and Srikanth Singamaneni*, Photothermal Membrane Water Treatment for Two Worlds, *Accounts of Chemical Research,* **2019**, 52, 1215-1225.
- Yaguang Zhu, Guancheng Wang, and **Young-Shin Jun***, Supercritical Carbon Dioxide/Nitrogen/Air Extraction with Multistage Stripping Enables Selective Recovery of Rare Earth Elements from Coal Fly Ashes, *RSC Sustainability*, 2023, 1, 251-260.