

Environmental NanoChemistry Lab (ENCL)

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The Jun group investigates **chemical** reactions at the water-energy nexus, including geologic CO_2 sequestration, underground hydrogen storage, resource recovery, water purification and reuse, and membrane process.

Based on our strong scientific understanding of nanoscale interfacial chemistry and solid nucleation, we seek for technological innovation for clean water by developing new treatment techniques and green chemistry-enabled catalysts for environmental sustainability.



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We study the following topics:

- Nucleation, growth, and aggregation of nanoparticles and their structures and reactivities in aquatic systems (from fresh water 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 <u>surface-</u> <u>sensitive techniques</u> and provide in-depth knowledge of <u>water, surface, and solid state</u> <u>chemistry</u>. We also simulate your experimental results using <u>reactive transport</u> <u>models</u>.

- CO₂ capture, utilization, and sequestration.
- Solid-liquid interfacial reaction in energyrelated subsurface operations (e.g., Underground hydrogen storage)
- Nutrient (P &N) and Critical Materials (Rare Earth Elements, Co, Ni, & Li) recovery and reuse from unconventional resources.
- Hydrogel technology for environmental applications
- Photothermal membrane development for water purification
- Photochemically-enabled green chemistry for nanostructure synthesis
- Water reuse (managed aquifer recharge) and water quality (advanced oxidation process)

Washington University in St.Louis

 Biomineralization, biomaterials, and bioinspired chemistry for novel materials development

Water: New ways to do desalination







Climate change and water scarcity



Image source: https://www.confectionerynews.com/Article/2017/08/01/

Food-Water: Support sound circular economy

Environmentally sustainable fertilizer







Phosphorus removal

CO₂ capture and utilization: Support a decarbonized future

Algal farm: energy & valuable product





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

Science & ecology

RESERV

CO2

Environmental and Geochemical Aspects of Carbon Sequestration

orine

scCO₂

PORE

silica grain

Do something that matters:

Alleviating CO₂ emission



www.acs.org

Green Materials Synthesis for Energy



Chemical Communications rsc.li/chemcomm





Two-dimensional nanomaterials





COMMUNICATION Young-Shin Jun et al. Photochemically assisted fast abiotic oxidation of manganese and formation of δ -MnO, nanosheets in nitrate solution

Bone Health for a Aging Society



Kim et al, Nature Communications, DOI: 10.1038/s41467-018-03041-1



- Academia: Tenured Associate professor at Peking University (University of Houston)

Tenure-track Assistant professors at the Technical University of Denmark, 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, 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, and the University of Chicago

- Industry: Intel and Bayer

We need 3-4 new, ambitious and enthusiastic doctoral students!



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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 CO₂ 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.
- Doyoon Kim, Byeongdu Lee, Stavros Thomopoulos, and Young-Shin Jun,* The Role of Confined Geometry of Collagen in Nucleation Energy Barriers to Intrafibrillar Mineralization, *Nature Communications*, 2018. DOI: 10.1038/s41467-018-03041-1.