# DEPARTMENT OF CHEMICAL & ENVIRONMENTAL ENGINEERING

# Jinyong Liu


***Postdoctoral Research Associate***

**COLORADO SCHOOL OF MINES**

**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**


## Advancing Catalytic Water Treatment Technologies Through Bioinspiration, Rational Chemistry Design, And Periodic Table Exploration


Transformative innovations are needed for water treatment technologies to address emerging and recalcitrant pollutants. This seminar presents novel rationales of developing highly active and stable catalysts for toxic oxyanion reduction in water and wastewater, and demonstrates the importance of implementing chemistry fundamentals to advance environmental technologies.

Pd-based materials have been extensively researched for the catalytic reduction of oxyanions in water; however the low reactivity and high cost of Pd limit its practical application in treating a wide scope of pollutants. To reduce the highly inert and endocrine-disrupting perchlorate ($ClO_4^-$, a common groundwater pollutant in southern California) that Pd nanoparticles cannot treat, a biomimetic Re–Pd heterogeneous catalyst was developed. In the catalyst, organometallic Re complexes rapidly abstract oxygen atoms from $ClO_4^-$, and Pd nanoparticles activate $H_2$ to provide electrons that sustain the redox cycling of the Re active site. This design provides the highest reported activity for aqueous $ClO_4^-$ reduction at ambient conditions. To address the issue of Re complex decomposition and leaching, the $H_2$-activating metals were altered to scavenge the highly destructive $ClO_x^-$ intermediates, and the Re complex reactivity was lowered by coordination chemistry design. A new Re–Rh catalyst with superior stability was then obtained by tuning the reaction pathway and changing only one atom in the Re complex. An extensive exploration on the Periodic Table further identified a series of new metals as promising catalyst components. Cross combination of these metals leads to multiple low-cost, highly reactive and even salt-tolerant catalysts for a variety of oxyanion pollutants and water treatment conditions (e.g., freshwater, ion-exchange regenerant brine and concentrated seawater). Biochemistry inspiration and key characterizations such as NMR, crystallography, and XPS used during catalyst development will be introduced.

Practical water treatment considerations led to the advancement of transition metal chemistry, including coordination sphere control, ligand exchange dynamics, redox transformation and structure-activity relationships, all of which, in turn, provide exciting directions for the development of new technologies to address environmental and energy grand challenges.


**Biosketch:** Dr. Jinyong Liu is currently a postdoctoral research associate in the Department of Civil and Environmental Engineering at the Colorado School of Mines. Dr. Liu earned his B.S. degree in Chemistry and M.S. degree in Environmental Science and Engineering from Tsinghua University (China), and earned his PhD degree in Environmental Engineering from the University of Illinois at Urbana-Champaign in 2014. Before his graduate studies, he also worked in Sony Materials Laboratories (Japan). Dr. Liu has research experience in homogeneous and heterogeneous catalysis, functional organic, organometallic and nanostructured materials, eutrophic aquatic systems, and the treatment of contaminants of emerging concern in water and wastewater. He is interested in establishing innovative connections between chemistry fundamentals/frontiers and environmental engineering challenges, and identifying new opportunities in the Periodic Table to develop technologies at the water-energy-food nexus targeting pollutant detection and treatment, as well as resource harvesting and recovery.

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**9:30—10:30** AM

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