HAJIM SCHOOL OF ENGINEERING AND APPLIED SCIENCES
UNIVERSITY of ROCHESTER

Department of Chemical Engineering presents

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Wegmans Hall 4506 @ 3:25pm

"Understanding Heterogeneous Water Oxidation Catalysis"

Conversion of solar energy into storable fuels is essential to meet future global energy demands. Efficient, robust materials that are exclusively made of non-precious elements are imperative for a sustainable energy economy. I rationally designed first-row transition metal (hydr)oxide water oxidation nanocatalysts and realized them by pulsed-laser in liquids synthesis. My method is game changing because of its rapidity, control of size and composition, unnecessity of surfactants, and ease of preparation of multimetal nanostructures. Laser-made Co_3O_4 nanocrystals exhibited electrocatalytic activities that compared favorably to the best reported cobalt oxides.

I advanced pulsed-laser ablation in liquids into a reactive technique and prepared multimetal nanomaterials with tailored compositions by adding metal ions into the aqueous liquid; my approach enabled atomistic level understanding and concomitant optimization of highly active, robust nickel–iron layered double hydroxide nanocatalysts for water oxidation in base.

Structural analysis of these mixed-metal catalysts provided evidence that water oxidation occurred at edge-site iron centers. We discovered that interlayer anions played key roles during turnover, as incorporating anions with different basicities tuned the catalytic performance of these materials. Our nanocatalysts were regenerated and most active in alkaline electrolyte in ambient air, where ubiquitous carbonate rapidly replaced other interlayer anions. And we gained structural and mechanistic insights from spectroelectrochemistry data and identified a cis-dioxo iron(VI) reactive intermediate during water oxidation catalysis.