

Water & Environmental Research Activities at TAMUQ

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Texas A&M University at Qatar*

Water & Energy Security Workshop

February 16, 2015



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Qatar Sustainable Water & Energy Utilization Initiative (QWE)

- Formally launched **on February 1, 2010**
- **Center of Excellence** for open and cooperative research, and capacity building.
- **Strategic Advisory Board** to steer the QWE
- **Stakeholder engagement** through QWE consortium
- **Collaboration** with local, regional, and international researchers.

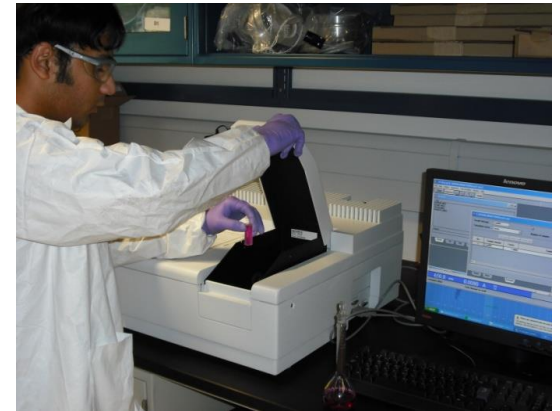
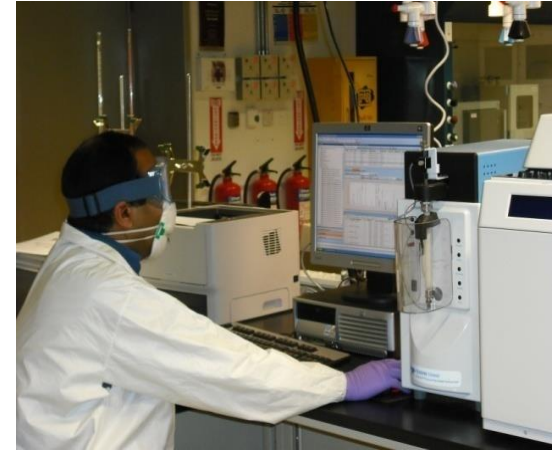


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Introduction

- More than \$15M research projects
- Address problems related to the needs of Qatari stakeholders
- Provide knowledge and technology transfer to stakeholders
- More than 30 qualified research staff
- State-of-the-art analytical equipment





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Current Research Activities

- **Advanced water and wastewater treatment processes**
 - Advanced reduction processes
 - Advanced oxidation processes
 - Electrochemical and photo-electrochemical treatment processes
- **Environmental impact assessment and management**
 - Environmental impact of cooling water and wastewater discharges
 - Regulatory revisions and recommendations of new standards
 - Design of discharge/outfall systems
- **Desalination Process Innovation**
 - Zero liquid discharge systems (ZLD)
 - Hybrid desalination systems
 - Desalination pretreatment
- **Utilizing solar energy for carbon dioxide reduction and water treatment**
 - Photo-electrochemical processes for CO₂ conversion to useful fuels
 - Photo-electrochemical water and wastewater treatment processes



Current Research Activities (cont.)

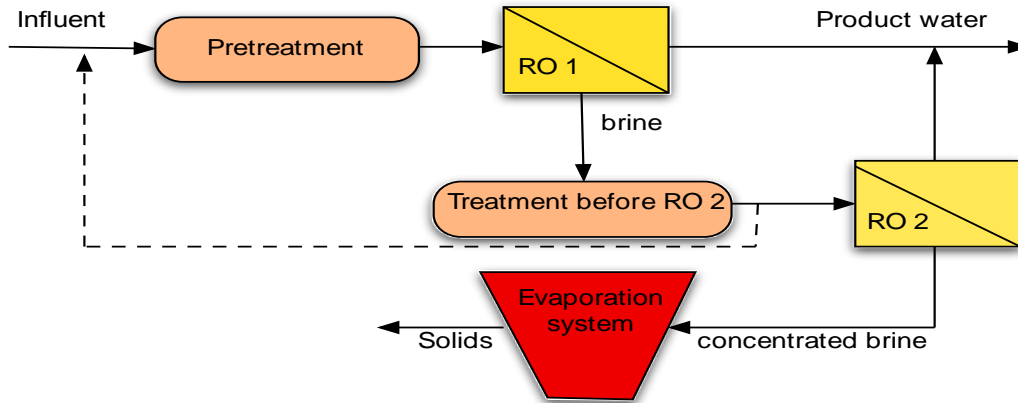
- **Industrial Energy Systems**
 - Energy integration in industrial cities
 - Renewable energy / systems integration
 - CO₂ integration
- **Heat to Power Technologies**
 - Materials and design innovation for Organic Rankine Cycles
- **Integrated water resources management**
 - Macroscopic water systems design and optimization
- **Water-Energy Nexus and Eco-Industrial Parks**
 - Co- and Trigeneration
 - Industrial ecologies around wastes and by-products



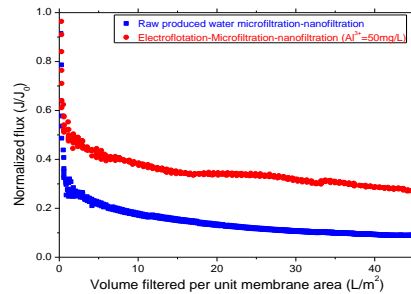
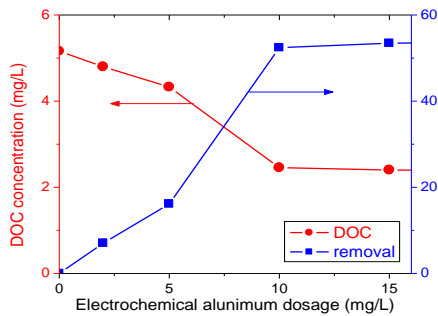
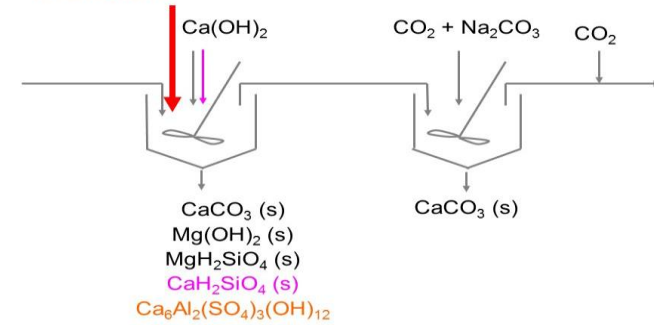
Examples of R&D Projects



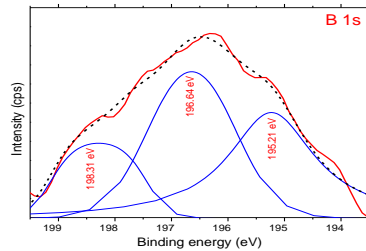
Desalination pretreatment/Brine Management/ZLD systems



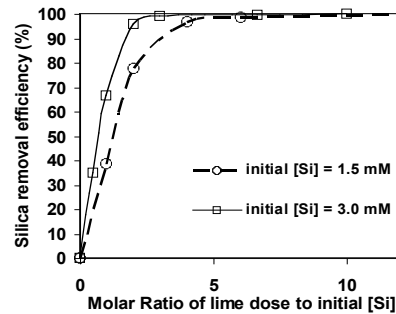
Aluminum



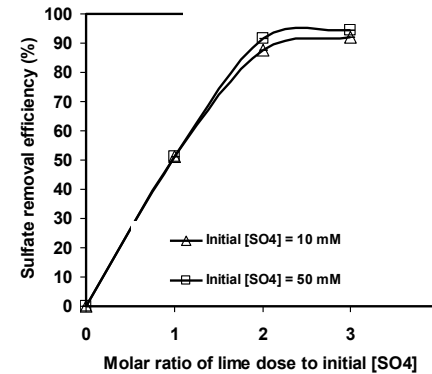
Electroflotation-microfiltration pretreatment improved flux during produced water nanofiltration.



XPS analysis of produced water electrofloated flocs showing boron sorption onto the Al(OH)₃ coagulant precipitates.



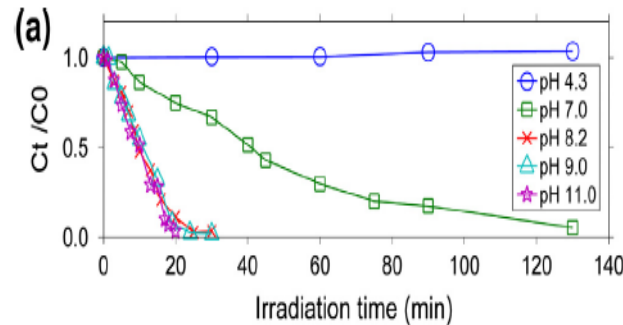
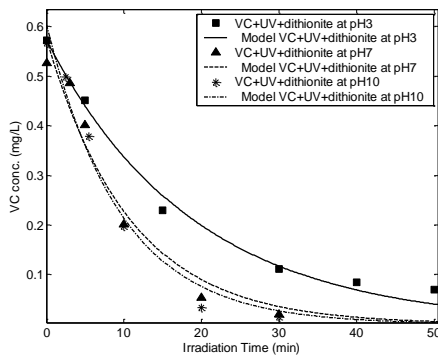
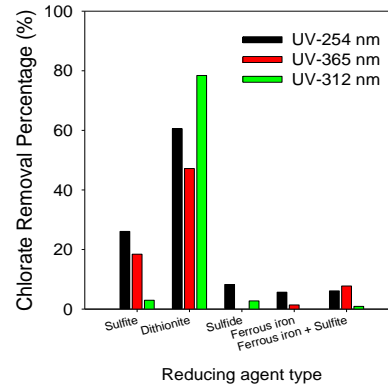
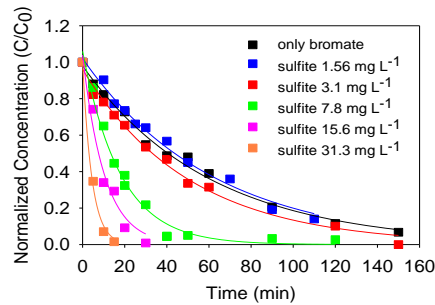
Effect of lime dose on silica removal (aluminum dose = 0.5 lime dose)



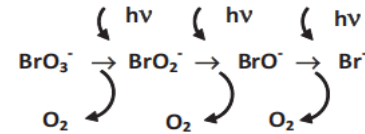
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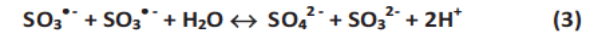
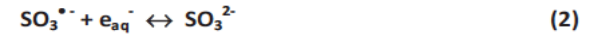
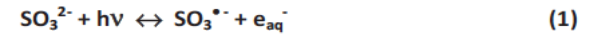
Advanced Reduction Processes



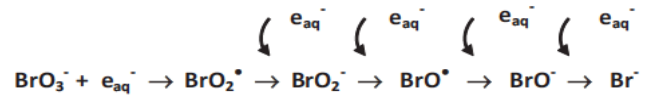
I. Bromate destruction by direct photolysis



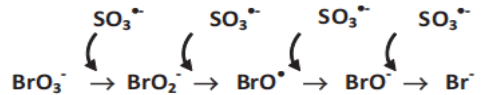
II. Sulfite photolysis



III. Bromate destruction by hydrated electron



IV. Bromate destruction by sulfite radical



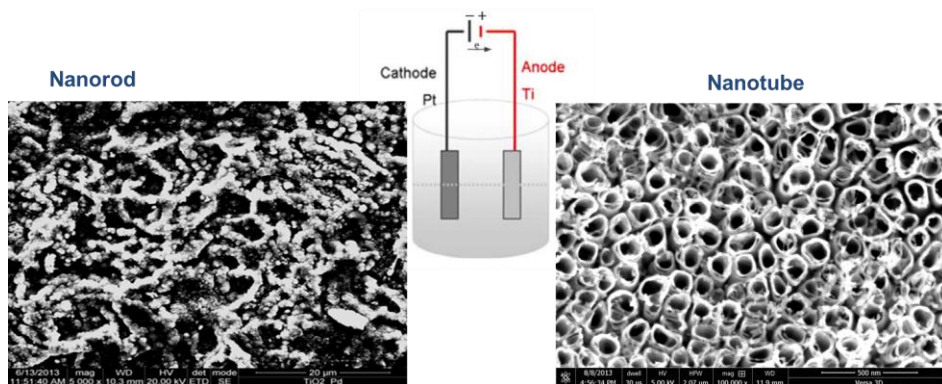
الاصدوق القطري لبرعاية البحت القاهي
Qatar National Research Fund



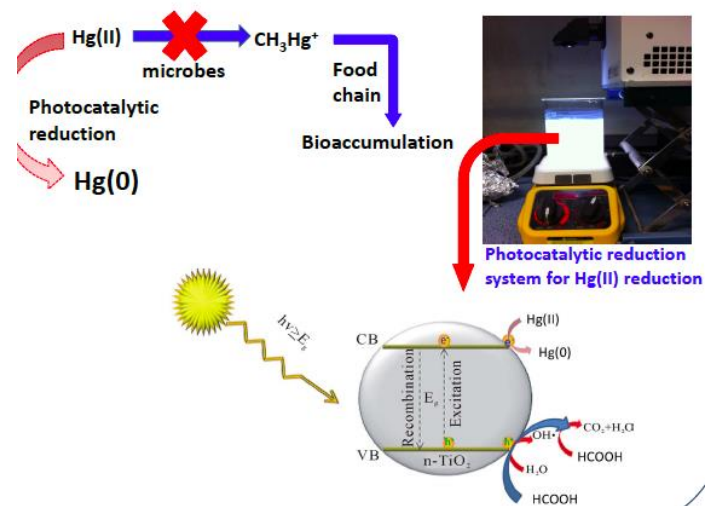
Solar-Driven Treatment Processes

Electrodes

- Anodization of Titanium metal



Approach & Methods



Experimental Results

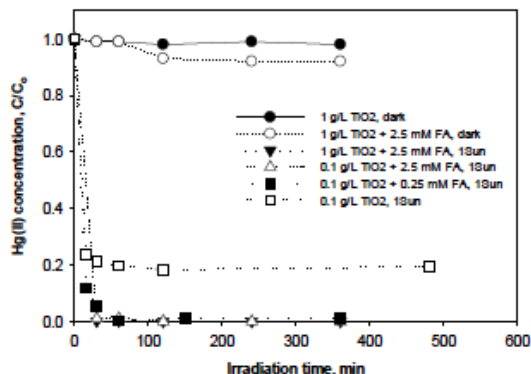


Figure 1. Photocatalytic reduction of Hg(II) using TiO₂ particle as affected by environmental conditions: Initial Hg(II) concentration = 0.49 μM, 2.5 mM FA

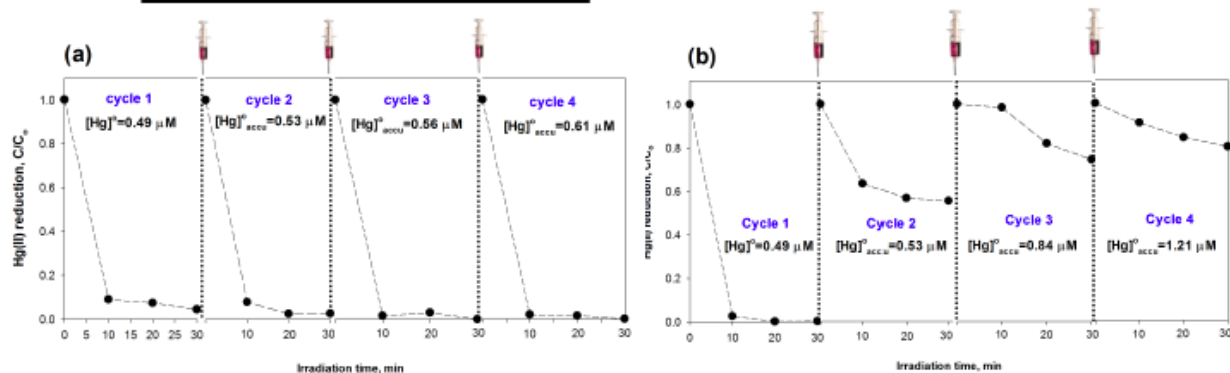
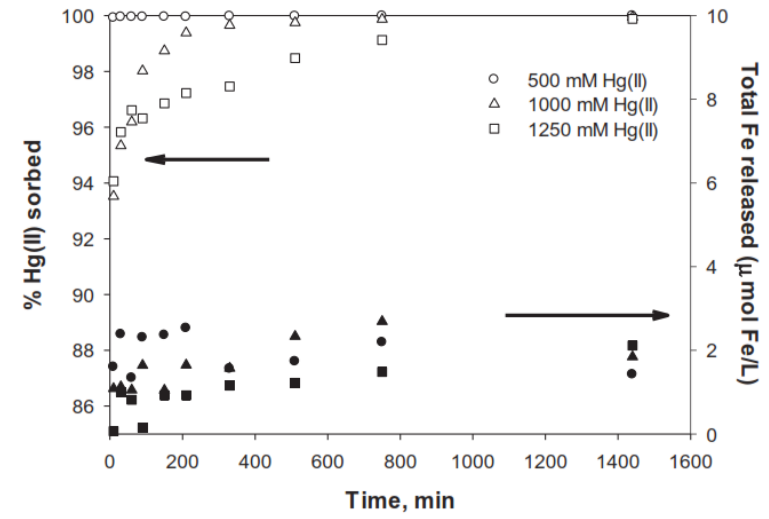
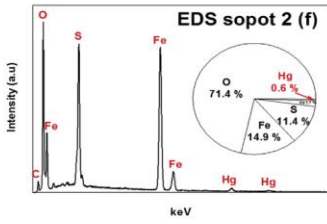
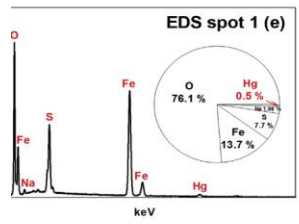
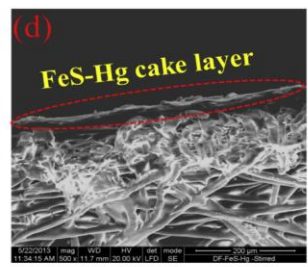
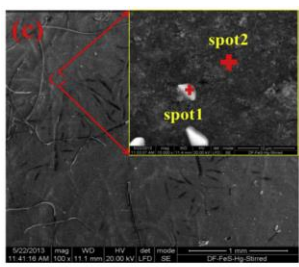
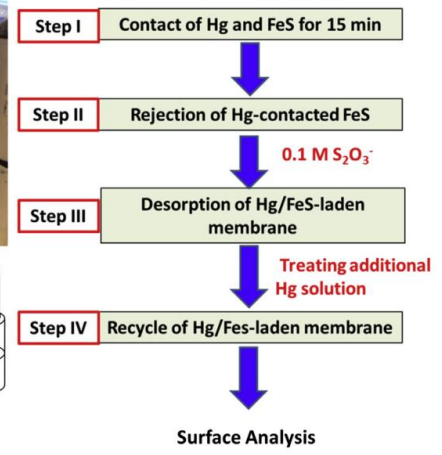
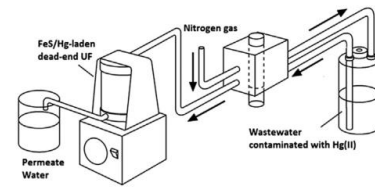
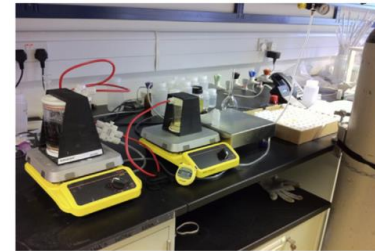
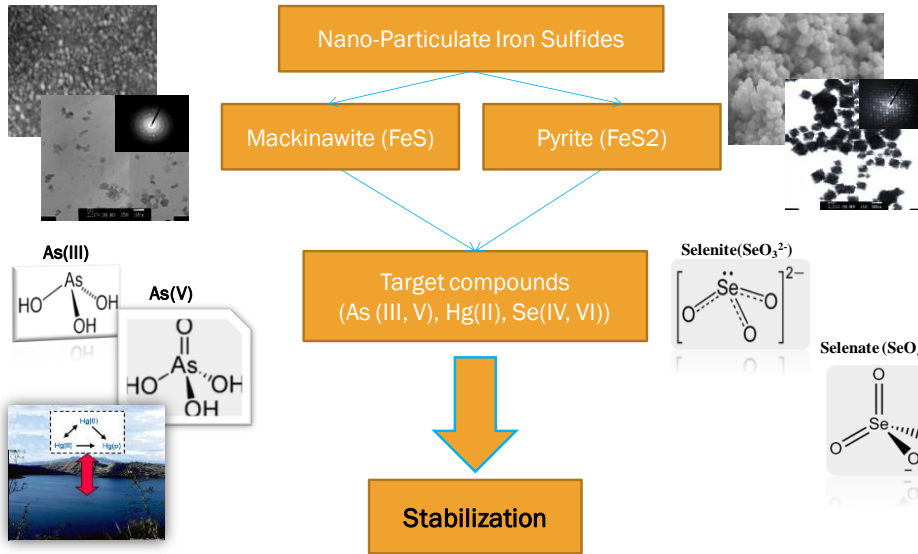


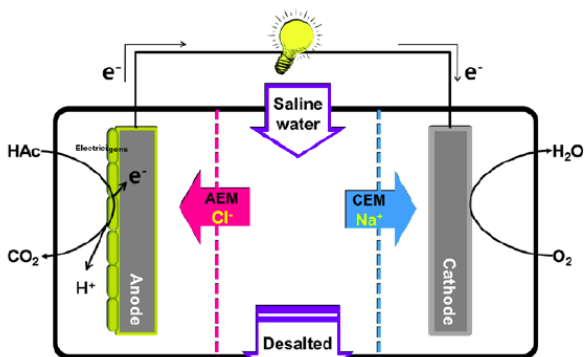
Figure 2. Cyclic photocatalytic reduction of Hg(II) using TiO₂ particle: 0.1 g/L TiO₂, acid pH (around 3.0-3.5), different initial formic acid concentration ((a) 2.5 mM and (b) 0.25 mM), initial concentration of the first injection of Hg = 0.49 μM.



Heavy Metals Removals using Reactive Adsorbents Nanoparticles



Desalination System based on Microbe-Nanostructure Hybrids



$\text{COD} \rightarrow \text{CO}_2 + \text{H}^+$	$\text{NaCl}, \text{H}_2\text{O} \rightarrow \text{H}_2\text{O}$	Electricity
Cl^-, H^+		$\text{Na}^+, \text{PO}_4^{3-}$

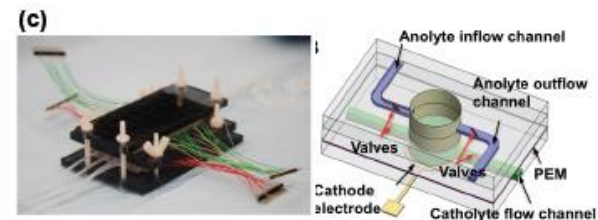
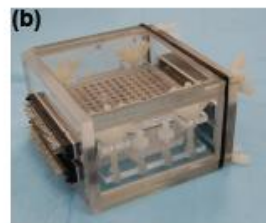
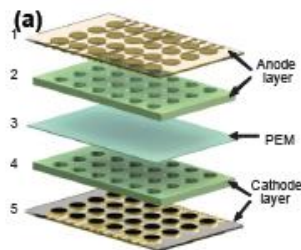
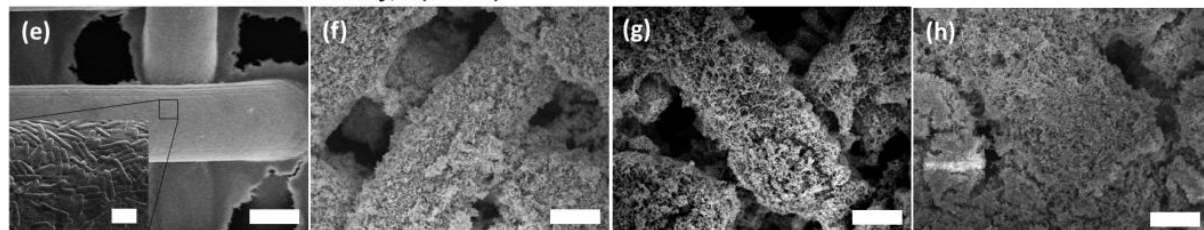
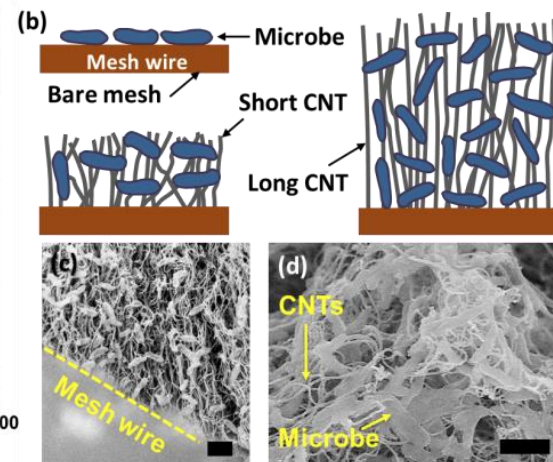
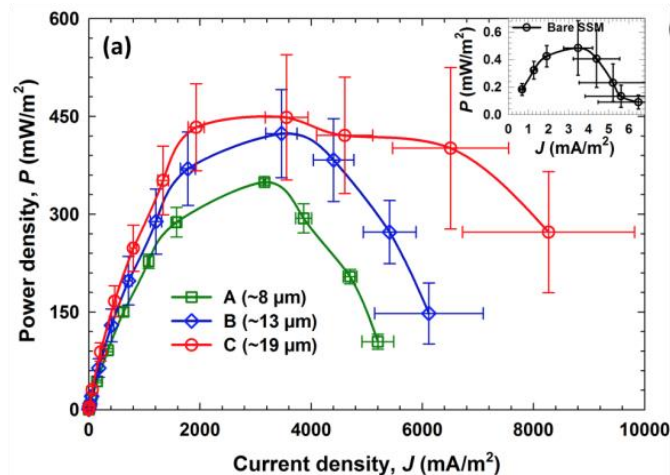
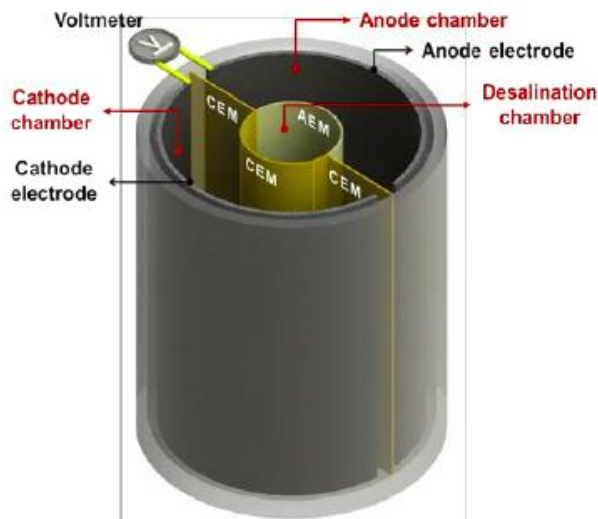
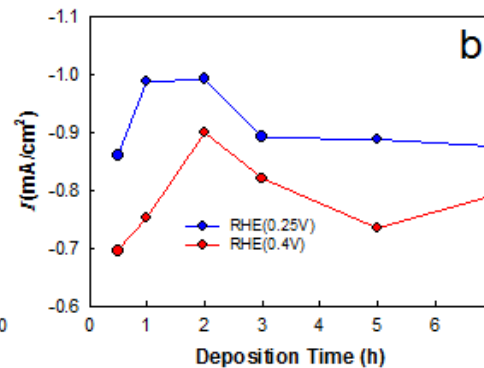
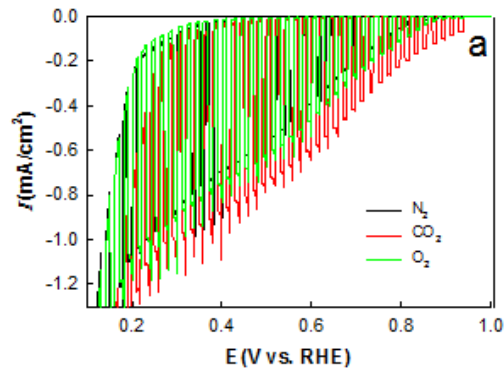
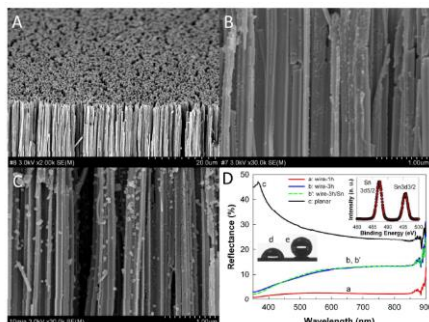
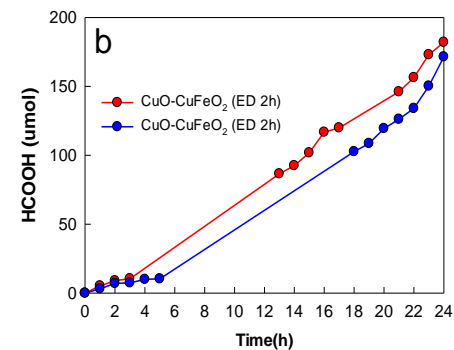
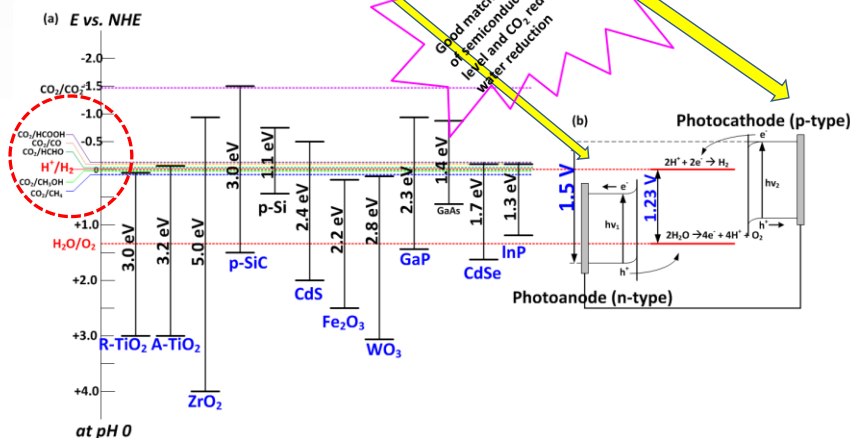
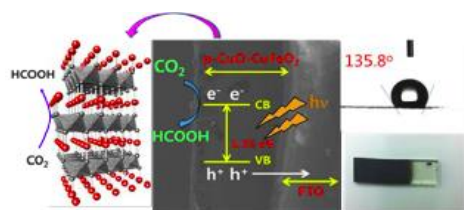
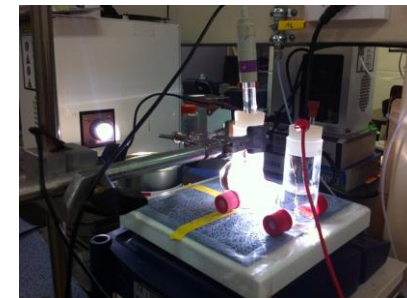
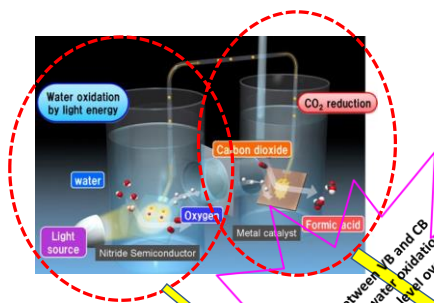
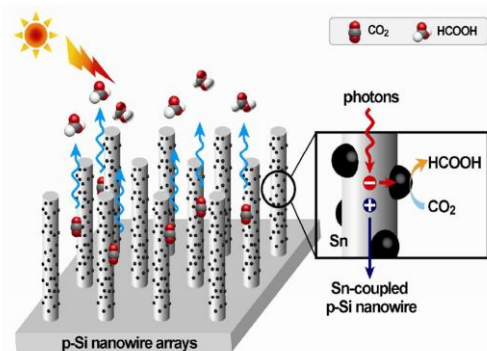
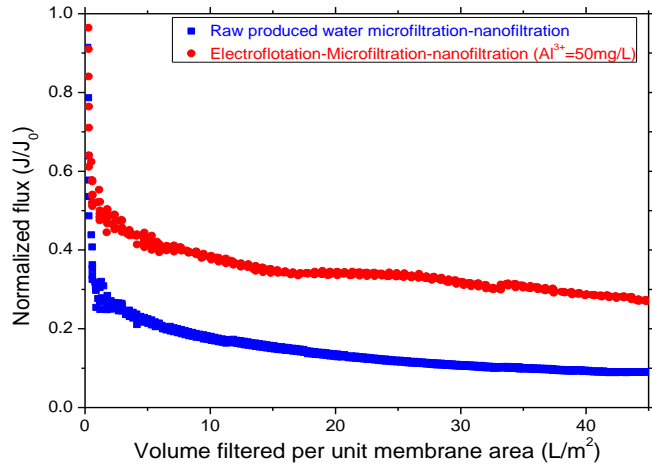


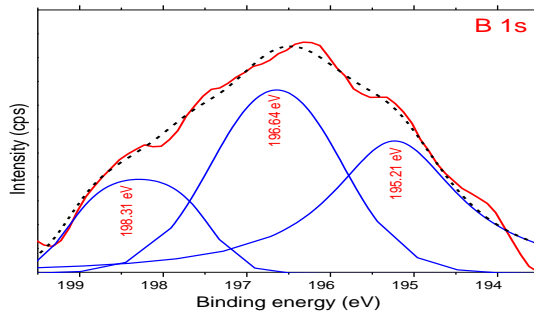
Photo-electrochemical Conversion of CO₂ to Useful Fuels



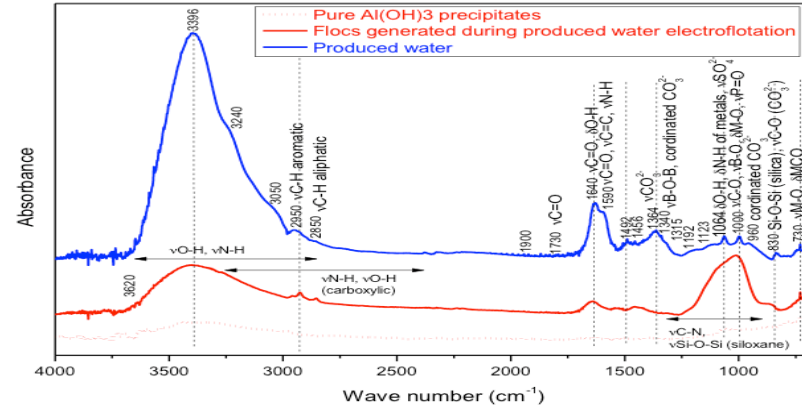
Treatment and Recovery of Produced Water



Electrofloation-microfiltration pretreatment improved flux during produced water nanofiltration.



XPS analysis of produced water electrofloated flocs showing boron sorption onto the $Al(OH)_3$ coagulant precipitates.

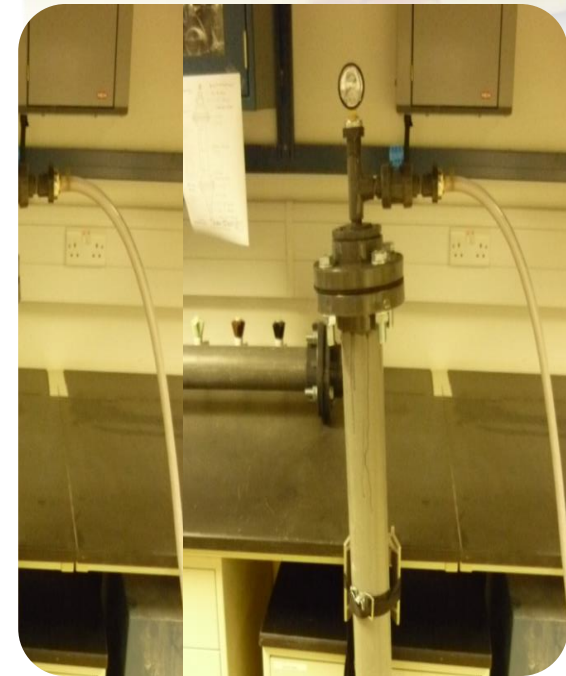


ATR-FTIR spectra of raw produced water, flocs generated during produced water electrocoagulation, and pure $Al(OH)_3$ precipitates generated during aluminum electrolysis of nanopure water.



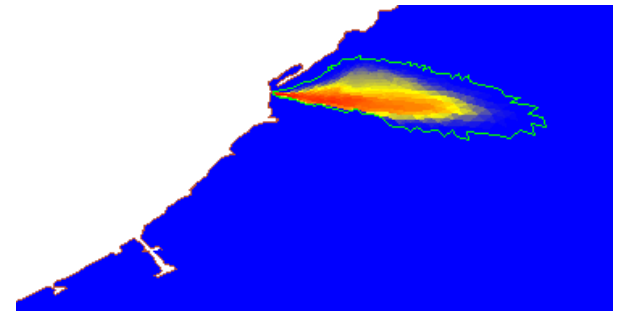
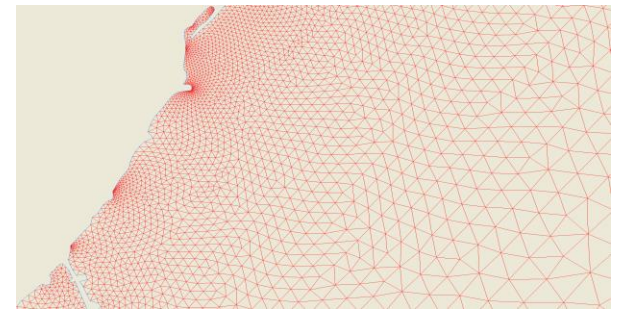
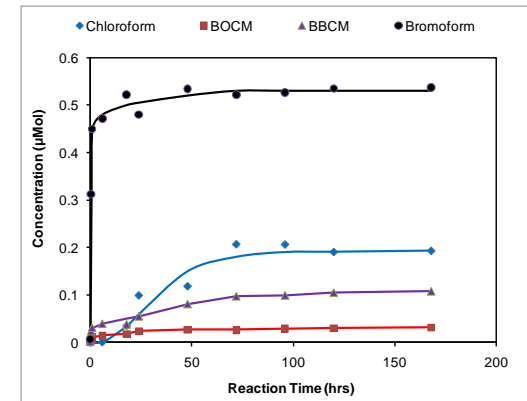
Kinetic Hydrate Inhibitor (KHI) Removal from Produced Water

- Gas Processing Companies use Kinetic Hydrate Inhibitor (KHI) during the winter season to prevent hydrate formation in the gas transfer lines from offshore platforms to onshore facilities.
- KHI remains in the produced wastewater which is injected in wastewater disposal wells.
- Laboratory tests have shown that KHI forms a viscous polymer gel in the injection zone and causes formation damage.
- Therefore, KHI should be removed from wastewater before the wastewater is injected in the disposal wells.
- This project focuses on KHI removal from wastewater.

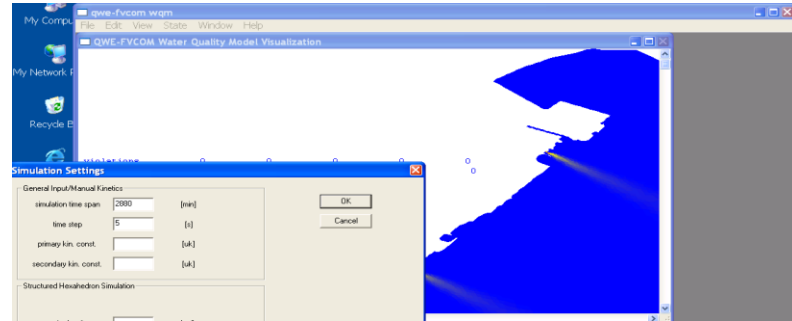
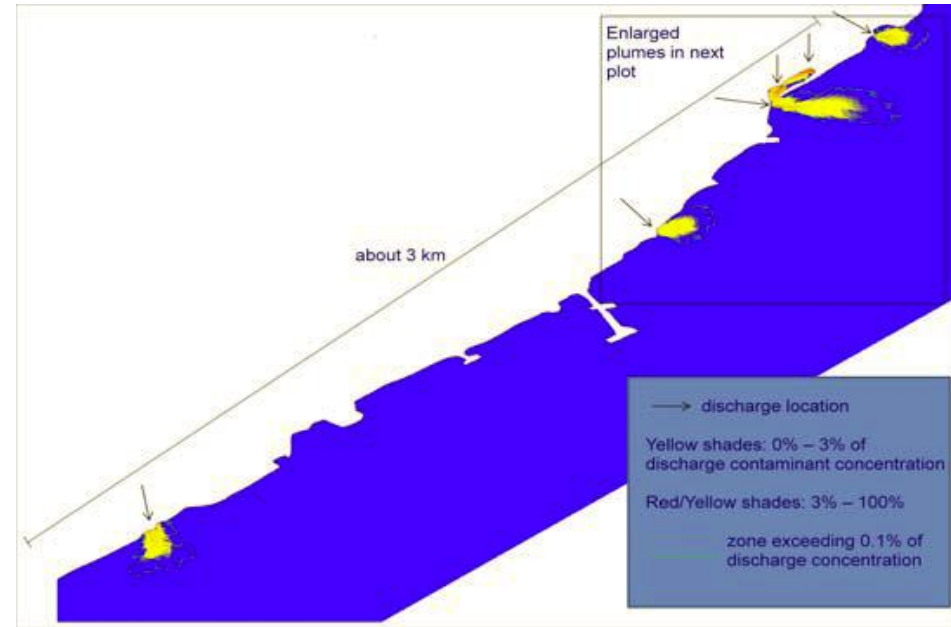
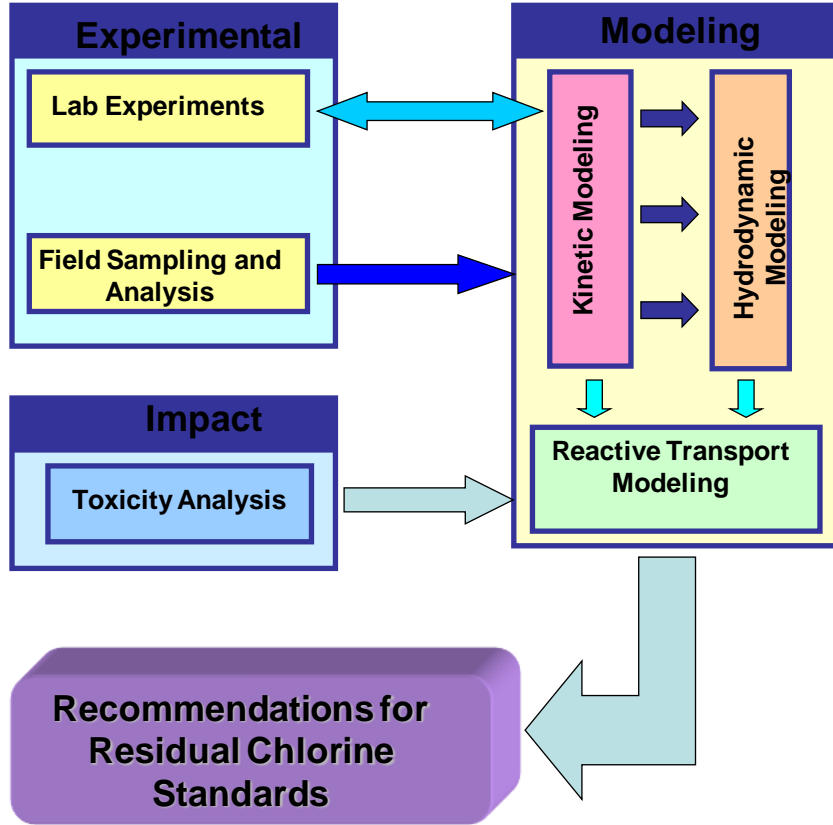


A Holistic Approach for Sustainable Use of Industrial Seawater Cooling (Sponsor: QNRF)

- Develop a scientific framework for environmental impact assessment of cooling water discharge into seawater
- Develop quantitative techniques for predicting the reaction mechanisms and kinetics of biocides and their reaction products in seawater
- Develop computational tools to predict the fate and transport of biocides and their reaction products
- Aid in developing sound regulatory policies



Study of Residual Chlorine and Chlorinated Byproducts at MIC Industrial Area (MoE, QAFCO, QAPCO, QP)



Sponsors

QATAR SCIENCE & TECHNOLOGY PARK



الصندوق القطري لرعاية البحث العلمي
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QATAR NATIONAL FOOD SECURITY PROGRAMME



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QATAR SUSTAINABLE WATER AND ENERGY
UTILIZATION INITIATIVE



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THANK YOU

To provide the scientific
and technical support needed
to achieve the sustainable
utilization of water and energy
resources in the State of Qatar.

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