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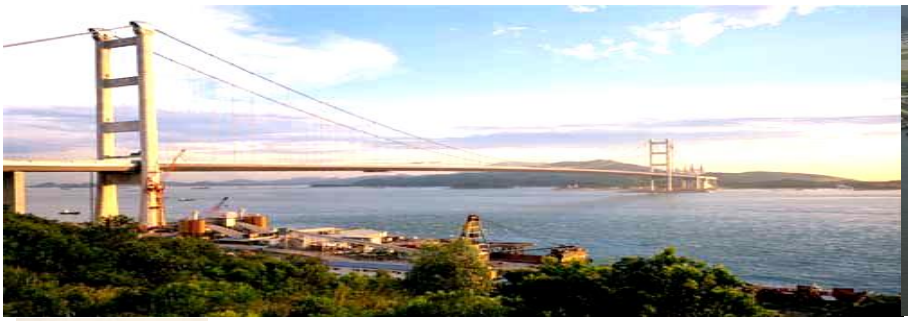

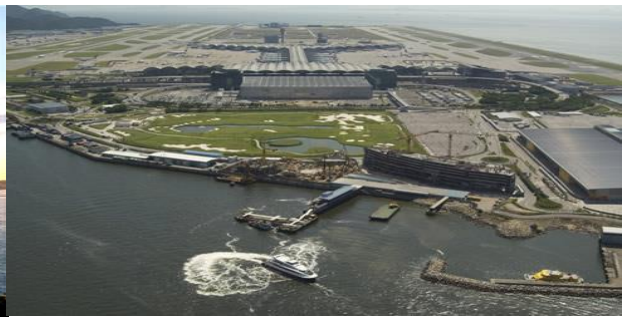

Nucleation, growth, and aggregation of environmentally-abundant nanoparticles: Mechanisms, rates, and applications

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ABSTRACT

In natural and engineered systems, nanoparticles can form in solution as homogeneous precipitation and on substrates (e.g., catalyst support, rocks, membranes, equipment and facilities) as heterogeneous precipitation. Nanoparticle precipitation starts with nucleation with subsequent particle growth and/or aggregation. The homogeneous and heterogeneous nucleation, growth and aggregation processes of nanoparticles affects the physicochemical properties of the nanoparticles (e.g., size, composition, structure, and reactivity) and controls the fate and transport of aqueous contaminants. Also, mineral scale formation affects the safety and efficiency of many subsurface operations (e.g., oil production, geologic carbon sequestration, managed aquifer recharge) and membrane water treatment processes. For example, Fe(III) hydroxide nanoparticles, which can sequestrate aqueous metal cations through structural incorporation, surface adsorption, and surface precipitation, are an essential carrier for heavy metals in many natural and engineered aqueous environments. The heterogeneous nucleation and growth of $BaSO_4$, as a representative sparingly-soluble salt, is a typical scale in oil reservoirs, water treatment membranes, and pipes. The formation and aggregation of lead phosphate controls the efficiency for lead-contaminated soil environments, and the immobilization of particulate lead in pipe systems. The formation of calcium sulfate (e.g., gypsum) on membranes also affects the operation efficiency and life-time of membranes.

Despite the importance, the mechanisms and kinetics of nanoparticle nucleation, growth, and aggregation, especially in the presence of substrates, were not well understood due to the technical difficulty to probe the nanoscale interactions. Here using synchrotron-based grazing-incidence small angle X-ray scattering technique (GISAXS), homogeneous (in solution) and heterogeneous (on substrate) nucleation and growth of Fe hydroxide, barium sulfate, and lead phosphate were quantified for the first time. The interfacial interactions among aqueous ions, substrate surfaces, and nanoparticles were explored with quartz crystal microbalance dissipation (QCM-D) and dynamic light scattering (DLS), to understand the controlling mechanisms, which were partly different for minerals that are covalently-bonded (e.g., Fe hydroxide), ionically-bonded (e.g., barium sulfate), and with mixed covalent and ionic bonding (e.g., lead phosphate).

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Time: **4:00 – 5:00 PM**

Venue: **Room Z407**

SPEAKER'S BIOGRAPHY

Dr. Yandi Hu obtained her Ph.D. in 2013 from Washington University in St. Louis, and she is currently an assistant professor in the department of Civil & Environmental Engineering at University of Houston. Utilization her expertise in geochemistry and nanochemistry, her research has been focused on solving global clean water and energy shortages. Some specific interests include: surface and subsurface geochemical reactions related to safe and efficient operations of geologic CO_2 sequestration, radioactive waste immobilization, and oil production; nucleation and growth of iron hydroxide nanoparticles and heavy metal immobilization, lead phosphate nucleation and growth and lead immobilization in soil and lead pipes, and controlling gypsum and hydroxyapatite formation for water and wastewater treatment. Research in her group has been supported by various funding agencies at U.S., including National Science Foundation (NSF), Department of Energy (DOE), and Texas Hazardous Waste Research Center (THWRC). Dr. Yandi Hu is also a recipient of the Teaching Excellence Award from Cullen College of Engineering at University of Houston.

***** All Interested Are Welcome *****

For further information, please contact Dr. Yi Jiang at Tel. 2766-6044.

Certificates of attendance will be provided to participants if they attend the whole lecture.