



Environmental Engineering & Sciences

Department of Civil and Environmental Engineering
CEE 595AG Seminar

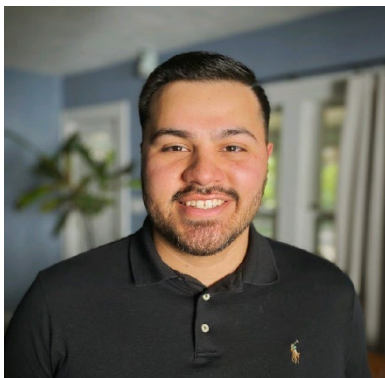
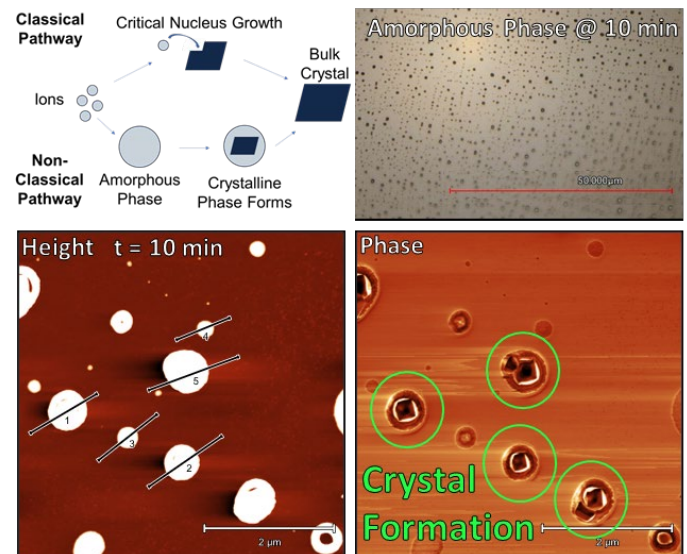
Friday, April 21, 2023 | 10:00 – 10:50 a.m. CST | 3310 Yeh Center

Elucidating Heterogenous Struvite Nucleation Mechanisms with AFM

Presented by: Sammy Aguiar (Advisor Prof. Cusick)

Phosphorus (P) is an essential but limited resource that can cause harmful algal blooms when introduced to the environment through agricultural fertilizer runoff and municipal wastewater discharge. To remove P from the liquid phase, water resource recovery facilities have deployed commercially available precipitation systems to convert soluble P to a sustainable fertilizer known as struvite (MgNH_4PO_4). However, most full-scale systems are prone to “upsets” where an uncontrollable shift in the operating mode of the crystallizer results in the nucleation of many fine crystals. These fines escape the reactor and are recycled to the plant mainline. Poor crystallizer performance in terms of P recovery (due to fines loss) has detrimental plantwide implications ranging from changes to the dominant form of P discharged from the plant to significant increases in effluent P that could cause permit exceedances. Controlling and predicting struvite nucleation is a critical component to further developing struvite precipitation systems and maximizing phosphorus recovery.

In this study we focus on elucidating the mechanism of heterogenous struvite nucleation on mica substrates using AFM and optical microscopy to image discrete points in the nucleation process. In solutions supersaturated only for struvite, we first observe the appearance of an unidentified semi-stable spherical phase. These particles grow from a few nms to ~10s of nm without significant solution pH shifts. After some time passes a fast pH drop is measured and trapezoidal prism typical of struvite crystals at equilibrium are observed distributed across the substrate. These preliminary findings indicate struvite may follow a non-classical nucleation process in contrast to all current modelling practices.



Sammy Aguiar | Advisor Prof. Cusick

Sammy Aguiar is a 4th year PhD student in the Department of Civil and Environmental Engineering (EES). Advised by Professor Ro Cusick, his research centers on precipitation based phosphorus recovery systems. His dissertation will work to improve struvite (MgNH_4PO_4) crystallization by providing mechanistic understanding and quantification of nucleation and crystal growth processes at wastewater relevant conditions. He completed his M.S. in Environmental Engineering at the University of Illinois at Urbana-Champaign and a B.S. in Chemical Engineering at Arizona State University.