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CAES SEMINAR SERIES

Multifunctional Nanoscale Platform Materials for Advanced Environmental Applications

Dr. John Fortner
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Environmental Engineering, Yale University**

Wednesday, January 29, 2020

12:00 noon to 1:00 p.m.

Food and coffee will be available at 11:45 a.m.

Jones Auditorium
The Connecticut Agricultural Experiment Station
123 Huntington Street, New Haven, CT

This presentation will focus on the design, synthesis, and demonstration of tunable, nanoscale, material platforms for advanced environmental applications. First, I will present our recent work on aggregation resistant, “crumpled” graphene-based nanocomposites, which allow for a unique membrane approach (and properties) when assembled as thin films. The as-synthesized, core-shell nanostructured composites, with controllable size and functionality (including magnetic susceptibility and TiO₂ loading), show significantly enhanced aqueous stability and tunable photocatalytic activity due composite geometry, surface/graphene chemistry, and increased lifetime of photo-induced holes. In addition, crumpled graphene-TiO₂ nanocomposite films, deposited/stabilized atop a support membrane (polyethersulfone (PES)), readily reject and (photo)degrade model aqueous pollutants. Further, facile photocatalytic (photoreduction-based) in situ synthesis (and subsequent regeneration) of silver nanoparticles, which are antimicrobial, is

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demonstrated at the membrane surface under operating conditions. For the second part of the presentation, I will discuss our progress towards the development and application of monodisperse, magnetic metal oxide nanocrystals (e.g., iron oxide (Fe_3O_4), manganese oxide (Mn_xO_y), and manganese ferrite nanocrystals ($\text{Mn}_z\text{Fe}_{3-z}\text{O}_4$)) of varying size, shape, composition, and surface chemistries for optimized metal/metalloid adsorption, separation and quantification, among other applications. Specifically, I will highlight results from a matrix evaluation of serially synthesized 8-30 nm metal oxides with tailored organic surface coatings designed to target uranium (as uranyl) in varied water chemistries. Optimized materials demonstrate some of the highest uranyl sorption capacities of any sorbent to date. Mechanistically, we show that sorption enhancement is due not only to thermodynamically favorable interfacial interactions (for both particle and selected bilayer coatings), but also due to significant uranyl reduction at the particle interface itself. Further, due to high particle monodispersivity and aqueous stabilities, residues geometries can be arranged as close-packed, sub-micron thin film geometries, which minimize self-shielding and thus allow for optimal α -particle detection strategies needed for low-level uranyl sensing.