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**MULTIFUNCTIONAL NANOSCALE PLATFORM MATERIALS FOR ADVANCED
WATER TREATMENT AND ENVIRONMENTAL SENSING APPLICATIONS**

ABSTRACT

This presentation will focus on the design, synthesis, and demonstration of flexible, nanoscale, material platforms for advanced environmental applications. First, I will present recent work on aggregation resistant, ‘crumpled’ graphene-based nanocomposites, which have been developed and demonstrated to be superior aqueous photocatalysts. The as-synthesized, core-shell nanostructured composites, with controllable size and functionality (including magnetic susceptibility and TiO₂ loading), show significantly enhanced aqueous stability and photocatalytic activity due composite geometry, surface/graphene chemistry, and increased lifetime of photo-induced holes and electrons – which allow for controllable oxidative *and/or* reductive reaction pathways. In addition, crumpled graphene-TiO₂ nanocomposite films (with tunable pore size), 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 highly antimicrobial, is 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 (Fe₃O₄), manganese oxide (Mn_xO_y), and manganese ferrite nanocrystals (Mn_zFe_{3-z}O₄)) 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. For optimized materials, demonstrated uranium sorption capacities are some of the highest of any material reported 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.