Engineered nanomaterials (ENMs) are manufactured with particle sizes between 1 and 100 nm (nm) and designed to have specific chemical and physical properties that are different than their conventional counterparts. Their extremely small size and high surface area to mass ratio allow quantum effects to be used to control their physical and chemical properties. Nanotechnology currently is a multimillion dollar industry that is expected to grow into the billions within the next few years. Engineered nanomaterials used in a wide variety of products and new applications are continuing to be developed. The most common ENMs are nanoscale metal oxides (e.g., titanium dioxide, and iron and aluminum oxides), nanoscale polymers, and polymeric nanocomposite materials that are used in the building, electronics, computer, pharmaceutical, and medical industries and manufactured in large quantities. Emerging ENMs such as quantum dots, nanoshells, nanocages, and nanobranches are currently being used in next-generation photovoltaic cells, as drug delivery nanovehicles, or immunological sensing devices.

Food, energy, and water (FEW) security is a major concern as the global demand for food, energy, and water continues to increase and the linkages (or nexus) among the three components become increasingly complex. For example, the interdependence of population growth, food shortage, water scarcity, and the lack of energy resources significantly affects sustainable development as conceptualized by the Sustainable Development Goals (SDG) proposed by the United Nations. To contribute to the SDGs, developing advanced water treatment processes capable to remove organic chemicals or highly resistant microorganisms that threatens public health exposed to water contaminated with these type of pollutants is a highly significantly research task. Our group has been working with the development and application of nanomaterials for water decontamination and disinfection using advanced oxidation processes for the last 15 years. This presentation is intended to summarize the current achievements and discuss knowledge gaps as well as further research opportunities with the audience.