Synthesis, Characterization, Electrochemistry, and Applications of Hydrogel/Metal Nanoparticle Hybrid Materials

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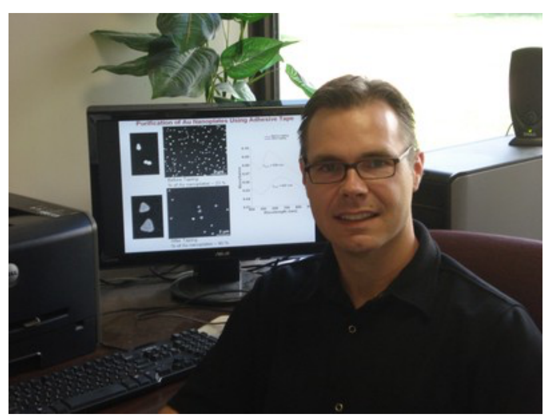
Abstract

The drop-wise addition of Na alginate to a solution of Ca^{2+} ions results in the formation of spherical Ca-alginate hydrogel beads. Metal nanoparticles (NPs) or nanoclusters (NCs) of varied size become incorporated into the hydrogel beads by adding them to the Na alginate solution prior to synthesis. The extent of NP/NC loading depends on the concentration used in the Na alginate solution while the size of the beads depends on the drop size, water content, and formation method. The synthesis of hydrogel beads with metal NPs of varied size, shape, and aggregation state leads to plasmonic hydrogels with controlled optical properties due to their different wavelengths of the localized surface plasmon resonance (LSPR) peak of the NPs in the beads. The plasmonic properties can be tuned by changing the composition (Au, Ag, Cu, Pd, alloys) of metal NPs within the hydrogel beads. Various reactions with the metal NPs occur within the hydrogels, including seed-mediated growth, galvanic replacement, thiol self-assembly, aggregation, and catalysis. Electrophoretic deposition of Na-alginate and various metal NPs leads to 2D Ca-alginate hydrogel films with the NPs incorporated into them onto electrodes. The electrochemical properties depend on metal NP loading in the film and the hydrogel provides a template for preparing porous electrodes. Hydrogels prepared on micro- and nanoelectrodes provide a mean for studying highly localized electrochemistry, including electrochemical patterning with high spatial resolution. This presentation will describe the synthesis of hydrogel/metal NP beads and 2D films, their characterization, electrochemistry, and potential applications.

Biography



Francis (Frank) Zamborini received his BA in Chemistry from Carthage College (Kenosha, WI) in 1993 before attending graduate school at Texas A&M University (College Station, TX) under the mentorship of Professor Richard Crooks. He received his PhD in Chemistry in 1998 and then conducted research under Professor Royce Murray as a Postdoctoral Research Associate at the University of North Carolina (Chapel Hill, NC) from 1998-2001. He began his independent academic career in the Department of Chemistry at the University of Louisville as an Assistant Professor in 2001. He was promoted to

Associate Professor in 2007 and Full Professor in 2011. He is currently Vice Chair of the Department of Chemistry. He has published close to 80 peer-reviewed journal articles, graduated 18 PhD students, and mentored close to 60 undergraduate students while at the University of Louisville. He has received research support from the National Science Foundation, Kentucky Science and Engineering Foundation, American Chemical Society, and Department of Energy during his academic career, studying fundamental electrochemical and optical properties of nanometals for sensing and energy applications. He won the College of Arts and Sciences and University Distinguished Faculty Award for Outstanding Scholarship, Research, and Creative Activity at the University of Louisville in 2017.