Toxicant Sensing to Ice Modulation and Everything in Between: A Journey of an Organic Chemist into the World of Materials

Seminar

Monday

April 7, 2025

3:00 – 4:00 p.m.

Beaupre Center, Room 105

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and Director

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The presentation will illustrate a journey that bridges advanced chemical sensor design with the emerging field of ice modulation under the overarching theme of 'How a fundamental view of chemistry enables molecular design for seemingly disparate applications'. The first segment of this talk will focus on innovative chemical sensor probes tailored for toxicant detection (from ions to nerve agents). The talk highlights the synthesis and application of those materials in sensor platforms (electrochemical and photochemical), including a MIP-202-based MOF sensor for detecting nerve agent surrogates, bipedal molecular tweezer-type scaffolds for perchlorate sensing, and ferrocene-based architectures for fluoride detection. Additional approaches, such as rare earth complexes grafted onto brochosome structures, graphene-based systems for toxicant binding, MIP-202-based applications for PFOA capture, and strategies for harmful algal bloom mitigation using alginate beads and electrospun MOF polymers, will be discussed, illustrating a versatile array of molecules that were developed to tackle critical environmental and security challenges in military relevant space.

In the second segment, the narrative of this talk shifts to the realm of ice modulation–a unique area of interest where molecular-based structural variations have profound implications in ice formation (shaping of crystals, ice grain growth, nucleation, and supercooling). An introduction to the various microstructures of ice, such as hexagonal and other forms of ice, sets the stage for discussing the importance of controlling ice properties and how the microstructures of ice play a role in these experiments. The presentation explores why ice is considered a "hot" material and how ice can be utilized as a potential structural component in engineered systems. Emphasis is placed on a series of assays, including ice recrystallization inhibition splat assays, dynamic ice shaping assays, ice nucleation assays, and differential scanning calorimetry for monitoring nucleation events in aqueous solutions, that provide insights into heterogeneous ice behavior and guide the identification of promising candidates for ice modulation.

Overall, this talk encapsulates the dynamic interplay between organic chemistry and materials science, offering a comprehensive overview of how targeted molecular design can lead to breakthroughs in both toxicant sensing and ice modulation.