Development of f-Block Polyoxometalates for Applications in Quantum Information Science and Nuclear Energy

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Chemistry Seminar on ***The use of f-block element in Quantum Information Sciences (QIS)***

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Abstract: Physical inorganic chemistry research in the Carter Radiochemistry group is focused on probing the role of spin in inorganic chemistry. This presentation will provide overviews of two of our projects that are focused on quantum information science (QIS) and radiation chemistry. Our QIS research is concentrated on the design electron spin-based qubits that feature atomic clock transitions as they species offer unmatched promise if long coherence times can be realized. This is a multifaceted challenge as electron spin superpositions are very sensitive to magnetic and environmental noise, which can result in decoherence via multiple pathways. To generate a mechanistic crystal field driven understanding of decoherence within f-element qubits, we have designed families of polyoxometalate (POM) complexes wherein we probe the effects of changing the identity of metal-ions in encapsulated in Lindqvist complexes. Moreover, we have modified the charge balancing and heteroatom cations included with POM complexes so that cation size and interactions differ, thereby changing the ground state wavefunctions for analogous complexes.

Radiation chemistry efforts are focused on developing an understanding of chemical behavior of systems under high radiation fields where α- and γ-radiolysis is known to occur. While there are significant ongoing efforts evaluating the radiolysis of solvents and extractants in separations schemes, much less is known about how the presence of actinides impact radiolysis and degradation pathways. We have initiated a research program to investigate actinide-free radical interactions in both small molecule complexes and POM clusters and here I will highlight our findings related to the stabilization of reactive oxygen species within uranyl materials.

About the speaker: Korey Carter is an Assistant Professor in the Department of Chemistry at the University of Iowa where he leads the Carter Radiochemistry group. Research in the Carter Radiochemistry lab combines physical and synthetic inorganic chemistry to develop f-block materials that can address fundamental challenges in quantum information science, nuclear medicine, radiation chemistry, and separations science. He earned his BS in physics from Michigan State University and his PhD in chemistry from the George Washington University. After working as a postdoctoral fellow at Lawrence Berkeley National Laboratory, Korey launched his independent research career at Iowa in 2021. His research has been recognized with the DOE Early Career Award in 2023 and his group's research is funded by the US Department of Energy, the Department of Homeland Security, the Centers for Disease Control and Prevention, and the Roy J. Carver Charitable Trust.