

HOPE COLLEGE CHEMISTRY SEMINAR

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“Better Living Through Uranium Chemistry:
Establishing the Importance of f-electrons in High
Oxidation State Uranium Science”

Friday, October 30, 2009

4:00 pm, Schaap 1000

Abstract

For the past 150 years, studies of uranium(VI) have been generally directed towards understanding the chemical behavior and unique bonding in the uranyl ion (UO_2^{2+}). These uranium oxide-derivatives have received tremendous interest due to their involvement in mixed-oxide (MOX) nuclear fuel systems and nuclear fuel reprocessing schemes. Theoretical and spectroscopic investigations of this ion have shown that f-orbitals play a critical role in the bonding interactions between uranium and oxygen atoms; this observation is in contrast to related lanthanide chemistry where f-orbitals are not intimately involved. Such a discovery has stimulated actinide chemists to further investigate the importance of f-orbitals in actinide chemistry *via* the synthesis of isoelectronic UO_2^{2+} analogs. Recently, we reported the syntheses of isoelectronic bis(imido) $[\text{U}(\text{NR})_2]^{2+}$ (R = organic fragment) and oxo-imido $[\text{U}(\text{NR})(\text{O})]^{2+}$ ions which has allowed us to draw important parallels to the $[\text{UO}_2]^{2+}$ ion. Given their unprecedented nature, we have begun studying the reactivity, structure, and bonding of these ions to demonstrate the importance of f-orbitals in these systems. As was observed in the UO_2^{2+} ion, we have discovered that f-orbitals play a pivotal role in the multiple bonds established between uranium and nitrogen/oxygen atoms. In this presentation, we will discuss the synthesis of a family of uranium(VI)-chalcogenate complexes and demonstrate that f-orbitals also play a significant role in U-E bonds (E = O, S, Se, Te). We will also highlight recent discoveries of bis(imido) uranium complexes that possess a third multiply-bonded ligand and demonstrate with theoretical calculations that f-orbitals are not always important in high oxidation state actinide complexes.

Biography

Dr. Spencer grew up in the southern interior of British Columbia and earned his B.Sc.(Honors) degree from the University of Victoria in Victoria, B.C.. After completion of a M.Sc. degree in chemistry with Prof. Douglas Stephan in the field of olefin polymerization catalysis (University of Windsor, Windsor, Ontario), he earned his Ph.D. degree at the University of British Columbia in Vancouver, B.C. with Prof. Michael Fryzuk investigating novel approaches to catalytically transform inert molecules like N_2 into higher-ordered organic molecules. Currently he is a G.T. Seaborg Postdoctoral fellow at Los Alamos National Laboratory with Dr. James Boncella where he is exploring the chemical nature of uranium(VI) complexes to broaden our understanding of high oxidation state actinide science and potential chemical interactions in advanced nuclear fuels like uranium nitrides.