SDSU College of Engineering Mechanical Engineering

Mechanical Engineering Seminar Series

November 3rd, 2026, 11:00AM

EIS 104

Title: Studying Plutonium and Other Actinide Surfaces using Scanning Tunneling Microscopy/Spectroscopy

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Abstract: Despite over 80 years of research into plutonium and other actinides, the application of transuranics remains phenomenological; we have figured out how to use these materials for some applications despit gaps in our understanding of their fundamental chmical and physical properties. Most of what is known about the electronic structure of these highly complex, correlated electron systems comes from methods limited to probing either the conduction or the valence side of the Fermi energy. This limitation introduces ambiguity when trying to determine critical properties like the material's band gap, as various techniques may yield conflicting results that cannot easily be reconciled. For example, calculations of the band gap in plutonium dioxide (PuO2) and plutonium sesquioxide (Pu2O3) have ranged from 0.9 eV to 4.1 eV and 1.38 eV to 4.46 eV, respectively. Such a wide variation highlights the difficulty in accurately modeling complex *f*-electron systems and the pressing need for unambiguous experimental data to validate and improve these theoretical models. Scanning tunneling microscopy and spectroscopy (STM/STS) are powerful surface sensitive probes able to directly interrogate the bonding and electronic structure of transuranic material, specifically plutonium intermetallics. STS can measure both the occupied and unoccupied density of states seamlessly across the Fermi energy, providing clear measurements for the subtle features in electronic structure near the Fermi energy. We have applied this technique to transuranics for the first time, including on plutonium and neptunium surface oxides and plutonium intermetallics.

Bio: Dr. Benjamin Heiner is a Seaborg Fellow at Los Alamos National Laboratory (LANL) in MST-7. He received his PhD from the University of Notre Dame and transitioned to a postdoctoral role at LANL, where he was converted to a scientist. Dr. Heiner specializes in scanning tunneling microscopy and spectroscopy (STM/S) and is currently applying the technique to study the electronic structures of plutonium oxides, plutonium intermetallics, and actinide molecular complexes.