Stony Brook University

Department of Materials Science and Chemical Engineering

In Person Departmental Colloquium

Wednesday
March 29, 2023
1:00 – 2:00 p.m.

Dr. Robert D. Kolasinski

Sandia National Laboratories
Plasma & Reacting Flow Science Department
Livermore, CA

Effects of high-flux plasma exposure on advanced tungsten materials

Join Us
Old Engineering Building
Room 301
West Campus

Effects of high-flux plasma exposure on advanced tungsten materials

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Abstract

Within the magnetic fusion research community, attention has increasingly focused on the technological challenges associated with the design of a demonstration reactor. One of the most pressing issues is to understand how materials are modified by the intense particle bombardment from D+T fusion plasmas, > 10^{24} (D+T) m^{-2} s^{-1}. In addition to hydrogen isotopes, the plasma contains smaller quantities of He, sputtered and desorbed impurities from the surrounding wall materials, as well as deliberately introduced species (typically N or Ne) to enhance radiative cooling. These low energy (< 100 eV) particles are shallowly implanted within the first few nm of the exposed interface, altering its surface composition and structure. The current understanding of how these processes potentially damage the surface over time is unfortunately not adequate for reliable predictions of material lifetime and tritium retention. Much of the work within our group at Sandia-Livermore focuses on experiments and modelling to better understand the effects of high-flux plasmas on tungsten materials. Our recent work emphasizes in-situ ion beam techniques and optical spectroscopies to uncover mechanisms governing surface structure and composition changes during high-flux plasma exposure. This presentation will include results from our laboratory testing of a variety of advanced tungsten materials, considered to be among the best candidate plasma-facing materials for fusion devices. One potential strategy for improving the ductility, fracture toughness, and ductile-to-brittle transition temperature of tungsten involves incorporating dispersoid particles into the material. Initial recrystallization studies and laboratory exposure of such materials to steady-state plasmas has yielded promising results. This work later motivated a recent DIII-D experiment where several different tungsten microstructures were exposed in the divertor (using DiMES) to several H-mode shots. In that work, dispersoid-strengthening appeared to dramatically improve the resilience of the surface against roughening and recrystallization, while also increasing its susceptibility to cracking. Initial findings from this experiment will also be highlighted in this presentation.

Biosketch

Robert Kolasinski is a Distinguished Member of the Technical Staff at Sandia National Laboratories - Livermore. His research activities focus on experiments related to plasma-surface interactions, materials for hydrogen storage and hydrogen energy infrastructure, and low energy ion scattering techniques for surface characterization. He is currently principal investigator for Sandia’s Department of Energy (DOE) Office of Science programs in Fusion Materials and Tritium Fuel Cycle R&D and has published over 50 papers on hydrogen interactions with materials. In 2016 he received a 5-year DOE Early Career Award to support work on “Characterizing the dynamic response of surfaces to high-flux plasma exposure.” Rob joined Sandia in 2006 as a postdoc after receiving his undergraduate degree in Mechanical Engineering from Rutgers University, and his M.S. and Ph.D. degrees from the California Institute of Technology.