Seminar Announcement – Friday December 26th, 10:30AM
South Building 4, Room 421

Prof. Michael Short (MIT)

Seminar Title: "Development of fouling resistant materials through multiscale experimentation and simulation"

Time: Friday December 26th, 10:30AM, South Bldg. 4-421

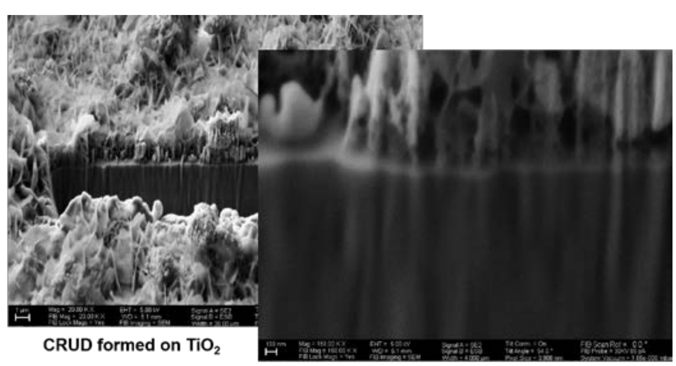
Abstract: The formation of fouling deposits (CRUD) on fuel cladding in pressurized water reactors (PWRs) presents problems for heat transfer, axial power shift, chemistry control, and worker dose. One solution may be to modify the cladding surface to prevent CRUD adsorption. A combination of two approaches, one chemical and one geometrical, may yield the most promising solution to CRUD, and quite possibly to fouling in general. Understanding what makes a surface CRUD resistant should translate well to other areas that suffer from fouling, such as oil & gas pipelines, refineries, nuclear steam generators and condensers, and high power heat exchangers in general.

A CRUD-resistant surface modification would ideally be thin, corrosion and wear resistant, and would not interfere with neutronics or heat transfer. Rather than applying a coating, which could debond or flake off, a microstructurally graded surface modification of ~100 nm is desired. This is thin enough to let neutrons and heat pass through, almost regardless of its composition.

Several candidate materials fabricated by thin film techniques are undergoing a battery of tests to determine the quality and nature of their CRUD resistance. These include well-characterized materials (Au, Ag), prototypical materials (native ZrO_2), and new materials (ZrN, ZrC, ZrB_2 and their Ti-analogues, ceria, diamond like carbon, and graphene). Pool boiling in simulated PWR coolant containing H_3BO_3, LiOH, and nanoparticles of NiO, Fe_3O_4, and $NiFe_2O_4$, commonly found in PWR CRUD deposits, is being performed to screen materials for fouling resistance. AFM force-spectroscopy (AFM-FS) using CRUD-functionalized cantilevers directly measures the interfacial adhesion strength of the CRUD-clad bond, as a function of material, particle-surface dwell time, and the environment (air, distilled water, PWR water).

Biography: Prof. Michael Short leads the MIT Mesoscale Nuclear Materials Group (MIT-MNM), which focuses on studying material degradation and development for energy applications, with a focus on nuclear materials. The group uses an integrated combination of nanoscale and macroscale experiments, multiphysics, multiscale simulations, and advanced characterization techniques to discover mesosscale mechanisms of sudden material property change and response, for example, in the formation of dissimilar oxide adhesive bonds, or void swelling in ferritic/martensitic steels. Current projects in the MIT-MNM group include:

- Simulations and experiments to understand and prevent the formation of fouling deposits in energy systems
- Laser surface acoustic wave-based non-destructive, in-situ evaluation of radiation damage
- Development of a 3D heterogeneous material nanoprinter



CRUD formed on TiO_2