

**MATERIALS ENGINEERING
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**“Three-dimensional Analysis of Constituent Redistribution and Swelling in a Neutron
Irradiated U-10 wt.% Zr fuel using FIB-SEM Serial Sectioning”**

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Purdue MSE M.S. Final Exam

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ABSTRACT

Transition to a sustainable power grid entails the use of all net-zero carbon emission technology that is currently available. Liquid metal fast nuclear reactors (LMFRs) are technologies capable of competitively provide power while attaining sustainability and reliability. Uranium-zirconium metallic alloys have been proposed as LMFRs fuels based on the performance of the fuel in experimental scale reactors, achieving up to 20 at.% burn-up. The irradiation performance of U-Zr fuels is affected by the following phenomena: constituent redistribution, swelling, fuel-cladding mechanical interaction (FCMI), and fuel-cladding chemical interaction (FCCI). Further understanding of these phenomena, and development of predictive models requires data collection of variables such as composition, morphology of the redistribution regions, porosity distribution, porosity morphology, fission gas release, and the relation between local composition and porosity evolution. To achieve this, focused ion beam-scanning electron microscopy (FIB-SEM) serial sectioning was applied to specimens from the different compositional regions developed during constituent redistribution of a U-10 wt.% Zr fuel neutron irradiated to 5.7 at.% burn up. High-resolution backscattered electron (BSE) micrographs, and energy dispersive spectroscopy (EDS) spectra were obtained for several sections of each specimen. Each section was analyzed to identify the microstructural and compositional evolution in the specimen volume. Three-dimensional porosity and phase volume distribution was obtained using image processing and three-dimensional object classification. The study revealed local segregation of phases within each of the regions, porosity distribution dependency on temperature and local composition, preferential porosity nucleation sites, porosity evolution trends, interconnectivity, possible sinks/nucleation sites for porosity and precipitates, as well as possible mechanisms for fission gas release.

Date: Wednesday, April 19, 2023

Time: 1:00 P.M.

Place: ARMS 1021 or via Webex- <https://purdue.webex.com/meet/mokuniew>



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