Resolution Capabilities for Measurement of Fuel Swelling Using X-ray Tomography

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The miniature fuel (MiniFuel) irradiation experimental design at Oak Ridge National Laboratory (ORNL) enables irradiation testing of small fuel specimens, with the first set being available for post-irradiation examination this year. Because of its non-destructive nature, x-ray computed tomography (XCT) has been established as a viable method for determining the post-irradiation volume of the specimens and the corresponding swelling due to irradiation. The swelling due to irradiation can be determined by measuring the fuel volume both pre- and post-irradiation. For this work, XCT and custom image analysis software have been used together to determine the volume of samples representative of the MiniFuel kernel geometries. For the representative geometries, tungsten was used as a surrogate for metallic uranium and zirconia was used as a surrogate for uranium ceramics. This presentation discusses the MiniFuel design, the XCT approach for determining fuel volumes, the image analysis approach to automate the volume-determining process and to determine fuel volume uncertainties, and the resolution capability of using XCT to determine the volume of representative MiniFuel geometries. Additionally, optimal parameters for specimen geometries are presented based on experimental results. By using XCT with the image analysis software, post-irradiation volume and fuel swelling in MiniFuel specimens can be determined in a non-destructive manner, allowing for quantitative measurements under varying irradiation conditions.

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