AUTOMATED CHARACTERIZATION OF URANIUM-MOLYBDENUM FUEL MICROSTRUCTURES

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Abstract:
Understanding the performance of nuclear fuel materials under various irradiation conditions is critical to the qualification of new nuclear fuels. Automated image processing routines have the potential to aid in the fuel performance evaluation process by eliminating judgment calls that may vary from person-to-person or sample-to-sample. This study presents several image analysis routines designed for fission gas bubble identification in pre- and post-irradiation uranium molybdenum (U-Mo) monolithic-type plate fuels. Plate irradiations took place at Idaho National Laboratory’s Advanced Test Reactor. Focused Ion Beam (FIB) prepared samples were milled from the fuel and imaged with a scanning electron microscope. An unfortunate side effect of FIB milling is the curtaining effect caused by the area around the gas voids milling faster than the bulk material. Frequency domain filtration, enlisted as a pre-processing technique, can eliminate artifacts from the image without compromising the features of interest. This process is coupled with a bilateral filter, an edge-preserving noise removal technique aimed at preparing the image for optimal segmentation. The bilateral averaging filter operates pixel-by-pixel, with considering both the intensity and the spatial proximity of the pixels to the local window, allowing for the retention of even the smallest gas voids. Adaptive thresholding proved to be the most consistent gray-level feature segmentation technique. The Sauvola adaptive threshold technique segments the image based on histogram weighting factors in stable contrast regions and local statistics in variable contrast regions. Binary morphology operations clean up the image following segmentation. Once all processing is complete, the algorithm outputs the total fission gas void count, the mean void size, and the overall image porosity. The final results demonstrate an ability to extract fission gas void morphological data faster, more consistently, and at least as accurately as manual segmentation methods.

TOWARDS A METHOD TO ANALYZE DEDICATED FAILURE FLOW ARRESTOR FUNCTIONS

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Abstract:
Risk analysis in engineering design is of paramount importance when developing complex systems or upgrading existing systems. In many complex systems, new generations of systems are expected to have decreased risk and increased reliability when compared with previous designs. Within the American civilian nuclear power industry, the Nuclear Regulatory Commission (NRC) has progressively increased requirements for reliability and driven down the chance of radiological release beyond the plant site boundary. However, many ongoing complex system design efforts analyze risk after early major decisions have been made. One promising method of bringing risk considerations earlier into the conceptual stages of the complex system design process is functional failure modeling. Functional Failure Identification and Propagation (FFIP) and related methods began the push toward assessing risk using the functional modeling taxonomy. This presentation will be about the Designated Failure Flow Arrestor Function (DFFAF) methodology which incorporates dedicated Arrestor Functions (AF) whose purpose is to stop failure flows from propagating along uncoupled failure flow pathways, as defined by Uncoupled Failure Flow State Reasoner (UFFSR). By doing this, DFFAF provides a new tool to the functional failure modeling toolbox for complex system engineers. This paper introduces (DFFAF) and provides an illustrative simplified civilian (PWR) nuclear power plant case study.