

## **A New Fission Gas Release Model for Predicting Gas Release during Steady State and Slow Power Ramps and for Initializing Fast Transients**

Ken Geelhood  
Carl Beyer  
Pacific Northwest National Laboratory  
902 Battelle Boulevard, P.O. Box 999, Richland, WA 99352  
Phone: (509)372-4556  
Fax: (509)372-6421  
[kenneth.geelhood@pnl.gov](mailto:kenneth.geelhood@pnl.gov)

### **Abstract**

A new fission gas release (FGR) model has been developed for use in the FRAPCON-3 steady-state fuel performance code. This model is a two-phase diffusion model that simulates diffusion from the grains to the grain boundary. Upon saturation of the grain boundaries a certain fraction of the gas on the grain boundaries is released to the rod void volume. In addition, resolution of the gas on the grain back into the grain boundary is modeled. This model calculates the grain growth that occurs in the pellet center as well as the grain restructuring and increased porosity that occurs on the pellet rim at high burnup.

The model has been calibrated against electron probe microanalysis (EPMA) and X-ray fluorescence data of xenon. These data are used to show how much gas resides in the grain matrix and how much gas resides in the grain boundary. This is of particular importance for modeling gas release during rapid transients such as reactivity initiated accidents. During the short period of high temperature ( $\ll 1$ ) sec over which an RIA takes place, it has been observed that 10-30% gas release occurs. It is known that this period of time is too short for diffusion of any additional gas from the grain to the grain boundary. However, the grain boundaries are known to fracture due to the rapid temperature increase, releasing much of their stored gas.

Using the predictions of this model, a transient fission gas release model to be developed for the FRAPTRAN transient fuel performance code can be initialized and used to predict fission gas release and gaseous swelling during rapid transients such as RIA.

This model has also been calibrated against the FRAPCON steady-state and power ramp assessment cases to ensure that this model predicts these release data as well as the previous model that did not accurately predict the gas partition between the grain matrix and the grain boundaries.

This new model predicts xenon concentration in the grain matrix to within  $\pm 0.1$  wt% Xe. The model predicts the fission gas release from steady-state cases and power-ramp cases as well as the previous fission gas release model in FRAPCON. A version of FRAPCON containing this model is expected to be released to the users group near the end of 2007.