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# BISON for Metallic Fuels Modeling

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The fuel performance code BISON has recently been extended to simulate U-Zr and U-Pu-Zr metallic fuel rods irradiated in the US sodium cooled fast reactor EBR-II. By introducing fuel and clad specific material models, the backbone provided by the MOOSE/BISON software architecture has allowed rapid development of metallic fuel capabilities. Zirconium based fuels present unique challenges due to the different phases that exist at irradiation temperatures. Each phase possess differing thermo-mechanical properties, necessitating explicit tracking of the relative concentration of phases throughout the fuel rod in order to capture the integral behavior. In addition, the transition temperatures between phases change over the course of irradiation due to zirconium diffusion in the fuel, necessitating coupling of the thermo-mechanical simulation to the Fickian and Soret diffusion of Zr.

Along with a robust U-Zr and U-Pu-Zr zirconium redistribution model, newly formulated thermodynamic properties such as thermal conductivity, and phase-dependent mechanical properties such as swelling, allow BISON to capture the behavior of zirconium based metallic fuel at a variety of operating temperatures and irradiation histories. These models have been integrated into BISON, verified using standard practices, and validated against full 2D-RZ simulations of fuel irradiated in EBR-II. The incorporation of phase-dependent models allows BISON to be extended to test other novel fuel designs, some of which show promising characteristics depending on fabrication feasibility.

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