Recent examinations of microstructural evolution of metallic fuels for sodium-cooled fast reactors after a reactor transient.

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The irradiation performance and benefits of metallic fuel are well demonstrated. However, studies are still necessary to optimize and extend operational and safety limits for sodium fast reactors (SFR) employing metallic fuel, through the reduction of uncertainties in transient fuel behaviors, fuel failure thresholds, and source term. This work describes the recent experimental efforts performed under the Department of Energy (DOE) Advanced Fuel Campaign (AFC) in fuel safety research for metallic fast reactor fuel. These experiments aim at describing and understanding the effect of microstructure evolution under irradiation on fission product behavior, to serve to reduce uncertainties in source term determination for SFRs. We investigated microstructural changes, fission product chemistry, and transport in metallic fuel samples which underwent a reactor transient.

In this presentation, we will describe the characterization effort on a metallic fuel pin that underwent a 30% overpower ramp in EBR-II. Two sections were investigated: one from the top of the fuel pin (longitudinal cut) and a cross section (transversal cut) from a middle axial position. We will present these samples' microstructural changes, fission products behavior and main phases redistribution, analyzed by various post irradiation examinations techniques (optical, scanning electron microscope, electron probe microanalysis). In conclusion, attention will be placed on the analyses of Fuel Cladding Chemical Interaction (FCCI), may be relevant to fuel safety analyses. These samples have been chosen for the high interest: the top of the fuel sample presents a particular phenomenon known as "foaming," which has not been well characterized but is relevant to transient behavior; the second sample (from the mid plan) will provide insight on fission product chemical form and matrix evolution during a moderate power ramp, to be compared with current results from irradiated steady samples and future sample that will undergo transients in TREAT. Thus, these studies will provide important data to understand future integral test behavior of fuel foam and fission product behavior during transients.