Fuel cladding chemical interaction with irradiated U-Zr-Ce fuel with Fe based cladding materials at high temperatures

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Metallic U alloy fuel and Fe based stainless steel cladding has been considered as fuel materials in sodium cooled fast reactor (SFR) over half century due to advantage of the usage of the U resource, high breeding potential, high thermal conductivity of U, and a good mechanical stability of stainless steel at high temperatures in fast neutron environment. One of critical degradation mechanism in metallic fuel is fuel cladding chemical interaction (FCCI). FCCI is a complex phenomenon resulting from the inter-diffusion between cladding and fuel constituents including fission products such as lanthanides. During the inter-diffusion, the major cladding element, Fe, tends to diffuse into the U-Zr matrix and it interacts with uranium and zirconium and forms stable compounds while U diffuses into Fe-Cr matrix and reacts with cladding constituents, causing reduction of cladding wall thickness. FCCI under normal reactor operation is not significant because of the low cladding temperature; however, FCCI can be active under the off-normal transient condition such as loss-of-flow. In this study, to investigate the FCCI reaction of metallic fuel under transient condition, FCCI tests were performed with the irradiated U-10Zr-5Ce fuel rod at hot-cell in Korea Atomic Energy Research Institute (KAERI). The burnup of the specimen is around 3 at. %. After the high temperature heating test, the microstructures of fuel and cladding are observed through scanning electron microscope (SEM), and element distribution was analyzed by using electron probe micro analyzer (EPMA). Also microstructure of the as-burned specimen was observed.