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Modeling of Processes in Austenitic Steel Produced Under Irradiation in Fast Reactors and Possibilities of Model Practical Application

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Nowadays austenitic stainless steels are used as a cladding material for BN-600 and BN-800 reactors. Examinations carried out at the end of fuel element service life give the information about cladding state. On the basis of the examination it is necessary: 1 –to determine residual life and 2 –to find the way for its extension. Extrapolation methods are generally used for the first aspect. The results obtained for fuel elements of different fuel assemblies at attaining different damage doses and fuel burn-ups are used. As a rule the results are limited by linear extrapolation. The prediction accuracy is quite low for several reasons. The initial state of claddings from different lots (and casts) is not the same, therefore there is some error even when processes of properties changes linearly depend on irradiation parameters (for example, damage dose). Moreover, the dependence of some processes, radiation-induced swelling in particular, on dose and temperature is quite nonlinear. Therefore linear extrapolation is unacceptable.
Extrapolation used for the second aspect almost gives no results as the characteristics to be correlated are not defined.
At JSC “INM” a technical description of the processes occurring in metal materials under irradiation has been developed for a long time. Description of point defect formation (vacancies and interstitials) is the key concept. All further microstructural changes are determined by the formation intensity, migration and interaction with other microstructural elements (impurity atoms, dislocations, grain boundaries and other sinks). A machine for quantitative description of point defect migration and concentration has been developed and is used for austenitic stainless steels.
Based on the developed theoretical concepts different stages of structural changes, radiation-induced swelling in particular, as well as the effect of structural changes on physical and mechanical properties have been modeled. These models were used to predict changes in material structure and properties of the claddings operated in BN-600 reactor core.
The paper aims to show the developed at JSC “INM” models of changes in austenitic steel structure and properties under irradiation in fast reactors and to demonstrate their application for BN-600 reactor claddings.

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