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Nanostructure evolution in structural materials under heavy ion irradiation

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Heavy ion beams are very effective instrument for the research of the radiation damage effects. Energetic ions can be used for the modification of the materials. Accelerated ions penetrate into the material from nanometers up to centimeters, depending on the ion energy and chemical composition of the material. The ion implantation results in the changes both in the material structure and its chemical composition in the irradiated region. Ion beams can be used also to understand the effects of neutron irradiation on reactor components, and interest in application of heavy ions for the imitation experiments has grown in recent years. In this report modification of nano-structured dispersion strengthened steel (structural material for advanced nuclear power plants) under heavy ion irradiation is presented. Previous studies of the effect of irradiation on the ODS Eurofer steel have showed an exchange of chemical elements between the oxide inclusions and clusters through the material matrix under irradiation. Neutron irradiation at 300℃ causes a significant change in the cluster chemical composition: vanadium goes from clusters into the matrix, and yttrium and oxygen partially leave the oxide particles and enrich clusters. In the report APT and TEM study of different ODS steels produced by mechanical alloying: ODS Eurofer, ODS13.5Cr and ODS13.5Cr0.3Ti is presented. These materials were irradiated with Fe (5.6 MeV) or Ti (4.8 MeV) ions up to 10^15 ion/cm^2 at RT and 300 ℃. In all cases, volumes for investigation were extracted from about 1 μm depth from the surface. It was found by TEM that the number density of oxide particles in all of the irradiated samples grew up and their average size went down. APT revealed essential growth of the nanoclusters number density. To sum up, irradiation of the samples may change the details of the steel nanostructure (number densities of clusters and oxides, their size distributions, as well as clusters chemical composition).

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