C3-O-035901

UNIFORM ION DOPING OF NUCLEAR MATERIALS FOR SUBSEQUENT TEM STUDIES

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During an operation of nuclear reactors there is doping of fuel materials and construction materials in the active core by nuclear reaction products. These products are mainly atoms of noble gases (e. g. Kr, Xe, He). The atoms are insoluble in most materials. They strive for segregation on structure defects. Such behavior leads to irreversible degradation of mechanical properties of the materials. The degradation is observed in the form of high-temperature embrittlement, creep, fatigue changes, swelling [1-4]. The radiation swelling is the main factor limiting time of exploitation for construction nodes and active core details in nuclear reactors [1]. Structure researches of materials doped by noble gases atoms are carried out with usage of transmission electron microscopy (TEM). Such studies are widely used for estimation of materials radiation resistance.

As an alternative of difficult and expensive experiments using research nuclear reactors, it is possible to apply ion implantation [5]. However, the main problem of ion implantation is a complexity of getting required concentration of the doping impurity in a sample volume. Nowadays in Flerov Laboratory of Nuclear Reactions of Joint Institute for Nuclear Research a principle of uniform ion doping is developed. The principle is applied to material samples before further structure researches by TEM. As the base of the method is an idea of uniform scanning of ion zone stopping across the depth in target substance. For realization of the method, a construction of the target node was developed and made. In this construction a rotating target is irradiated. The rotation velocity changes across giving functional dependence versus rotation angle. Based on the theoretical calculation a software for control of target rotation and measure devices was created.

Nowadays the uniform ion doping experiments are carried out at EG-5 accelerator (Frank Laboratory of Neutron Physics, JINR) using helium beams (He^+) with the energy of 2.5 – 4 MeV for irradiation of metal samples.

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