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In-reactor Creep-fatigue Deformation Behaviour of CuCrZr alloy

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CuCrZr alloy used in the first wall and director components of ITER will be exposed to a relatively high flux of 14 MeV neutrons and will experience thermo-mechanical cyclic loading. This kind of cyclic loading would induce not only fatigue damage but also make the material creep during the operation. Not much is known at present about the impact of this complicated mode of deformation on the mechanical performance of this alloy particularly in the environment of intense neutron flux. In order to make a realistic evaluation of the response of this material under these conditions, an experimental programme was initiated with the objective of carrying out creep-fatigue experiments directly in the environment of neutrons.

Recently we have carried out a number of such creep-fatigue tests on CuCrZr alloy in the BR-2 reactor at Mol (Belgium). For comparison, out-of-reactor creep-fatigue tests have also been carried out on the unirradiated CuCrZr alloy. In the present paper we shall first describe the details of the test facilities and experimental procedure used in the present creep-fatigue tests. Results on the mechanical response during these tests will be reported in the form of hysteresis loops for different cycles. In addition, the evolution of stress in the specimens during such cyclic loading will be reported as a function of numbers of cycles. Results will be reported for tests carried out with strain amplitudes of 0.25, 0.35 and 0.5 %. During the test a holdtime of 10 or 100s was implemented both in the tension and compression sides of the cyclic loading. Microstructural changes during out-of-reactor and in-reactor tests were investigated using transmission electron microscopy. The fracture surfaces were examined in a scanning electron microscope. Results clearly suggest that the neutron irradiation has practically no effect on the lifetime (number of cycles to failure) of the specimen creepfatigue tested in the neutron environment.