DEVELOPMENT AND VALIDATION STATUS OF THE IFMIF HIGH FLUX TEST MODULE

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The International Fusion Materials Irradiation Facility IFMIF is projected as dedicated research facility to investigate the properties of structural and functional materials under fusion power plant irradiation conditions. A suitable flux of neutrons with an appropriate energy distribution is created by the nuclear reactions of accelerated deuterium ions (40MeV, 2x125mA) on a lithium target. Directly behind this neutron source, in the high flux region, structural materials (especially RAFM steels) are to be irradiated. The irradiation (to be followed by post irradiation examination) is planned at several irradiation temperatures (i.e. 250-550°C for RAFM steels) to accumulated structural damage of up to 150 displacements per atom (dpa). The device to facilitate the irradiation and the temperature control of the specimens, is the IFMIF High Flux Test Module (HFTM).

The envisaged structural damage rate in the range of 20-50 dpa per full power year can be achieved theoretically in a volume of approx. 0.5 litres behind the neutron source. Because of the beam divergence, the neutron flux intensity drops rapidly with distance. The HFTM design objective is therefore to achieve a high integration density of material specimens, while avoiding parasitic volumes occupied by structure and control devices. Due to the high sensitivity of material properties to irradiation temperature, especially in the range 300-400°C, a reliable adherence to the prescribed specimen temperature level with a low spread and uncertainty must concurrently be achieved by the design.

A new modular design has been developed for the HFTM, which can accommodate 24 irradiation rigs with about 80 miniature specimen inside each. The irradiation capsules have beed modified for reliable filling of the NaK-78 liquid metal into the specimen stack, which is needed for a homogenous temperature field. The HFTM container has been improved in respect to the assembly steps, which have to be performed under hot cell environments. To test the reliability of the HFTM, and to prove the temperature control strategy, a helium cooling loop, capable to deliver the massflux of 120g/s for the cooling of a 1:1 HFTM mockup, has been built and taken into service. A mockup for an irradiation compartment, has been designed and fabricated, and is now ready to test a 1:1 irradiation rig, which will be instrumented by dedicated miniaturized measurement techniques, to assess the deflections of the insulation gaps between the specimen capsule and the cooling helium (responsible for the temperature field inside the capsule) online and in situ. The new design of the HFTM has been incorporated in CFD and FEM models. Results of according calculations are available to be compared with the results to emerge from the experiments. An experimentally validated design and engineering tools are considered vital, to ensure a safe and reliable operation of the HFTM under irradiation conditions in IFMIF.