IFERC Newsletter

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Status of DEMO R&D Activity

Highlights on development of structural materials

Task 2 of DEMO R&D consists of four sub-tasks, sub-task 2-1: Development of irradiation database and material property handbook (MPH) of blanket structural materials, sub-task 2-2: Development of irradiation database and MPH for divertor baseline materials, sub-task 2-3: Materials modelling toward the validation of a DEMO fusion neutron irradiation database and the material property handbook, and sub-task 2-4: Development of fusion structural design rules.

In task 2-1, the EUROFER MPH has been reviewed and updated in EU. The MPH is currently limited to the 1st and 2nd batches of EUROFER97. Thermo-physical and mechanical properties of F82H have been updated in JA. High-dose neutron irradiation data on F82H (IEA, BA12) and Ni-doped F82H were also updated. The Bayesian approach to materials data assessment has been applied to selected datasets for both EUROFER97 and F82H.

In task 2-2, activities towards the development of the "baseline" CuCrZr and tungsten (W) MPH have been pursued in EU. New mechanical properties; data on CuCrZr plates and tubes in SAcwA condition and after additional aging treatments have been added. The reported data on different grades of W were evaluated to close the gaps in the W MPH. The irradiated thermo-physical properties of W and CuCrZr were identified, along with references to the erosion-corrosion behaviour of non-irradiated CuCrZr. The effects of damage dose and temperature dependent mechanical properties of W were analysed. The test matrices for W and CuCrZr, both in irradiated and non-irradiated conditions, have been consolidated. For toughness evaluation of W, the pre-crack initiation was successfully performed by JA.

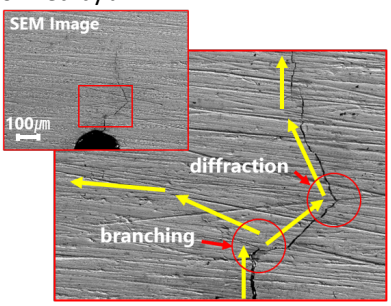

Fig-1: Pre-crack introduction of W

In task 2-3, EU focused on 1) development and application of FEM for irradiated structures on a reactor component scale, 2) predictive simulation study, 3) direct experimental observation of residual lattice strain in W exposed to neutron irradiation to high doses, 4) new method for the characterization of defect structures using AI, 5) detailed examination of effects of post-irradiation-annealing fusion steels initially exposed to high dose neutron irradiation. JA focused on 1) PKA energy dependence of the size distribution of surviving defects, 2) related paper survey and data collection about cascade collapse, 3) improvement of the current rate theory model for the temperature dependence of point defect binding free energies to defect clusters, 4) microstructure evolution up to 60 dpa, 5) investigation of the desorption temperature of He/H atoms from cavities by in-situ TEM with TDS, 6) size and composition dependence of the bubble formation energy and the point defect binding energy using DFT, 7) coalescence mechanism between He bubbles by the SEAKMC (Self-Evolving Atomistic Kinetic Monte Carlo) method, 8) He effect on the sink strength of grain boundaries, 9) relaxation volume of SIA clusters and vacancy clusters, 10) step height measurements of the irradiated surface.

In task 2-4, in EU, several additions to DEMO Design Criteria (DDC)-In-vessel Components (IC) are considered to be 1) foreseen design challenges relating to welds and interfaces, 2) scope and salient aspects pertaining to a DEMO-specific safety report, 3) preliminary guidance on aspects underpinning the formulation of the load cases, 4) foreseen challenges for DEMO from a regulatory viewpoint, 5) selected differences between DEMO and ITER. Work has also progressed on the validation of design rules, etc. In JA an update of the Design rules started for 1) preliminary probabilistic structural analysis method for the combined effects of various loads constructed last year, 2) modified universal slope method to multi-axial fatigue-creep tests and 3) brittle and ductile fracture methods by the local approach. For completion of the capability assessment of the various non-destructive techniques, selected techniques such as high-energy X-ray spectroscopy method are also under development.

(DEMO R&D Task-2 TROs)