IFERC Newsletter

IFERC-N-2023-7, 19 June 2023
International Fusion Energy Research Centre, Rokkasho, Aomori 039-3212, Japan

Status of DEMO R&D Activity

Highlights on development of structural materials

Task 2 is composed of five main activities: (sub-task 2-1) Development of irradiation database and MPH (Material Property Handbook) of blanket structural materials, (sub-task 2-2) Development of irradiation database and MPH for divertor baseline materials, (Common issues in sub-tasks 2-1 and 2-2) SSTT (Small Specimen Test Techniques) development and neutron irradiation, (sub-task 2-3) Materials modelling towards the validation of a DEMO fusion neutron irradiation database and MPH, and (sub-task 2-4) Development of DEMO specific structural design rules.

In sub-task 2-1, revisions have been made to the EUROFER MPH in the EU, including updated data and consideration of DEMO design team needs. New curves for elongation properties, Charpy impact properties, fracture toughness, and LCF (Low Cycle Fatigue) have been provided (Fig-1), and tests are ongoing to refine the negligible creep domain. Thermo-physical properties of F82H have been updated in JA. High-dose neutron irradiation data on F82H and Ni-doped F82H have also been updated.

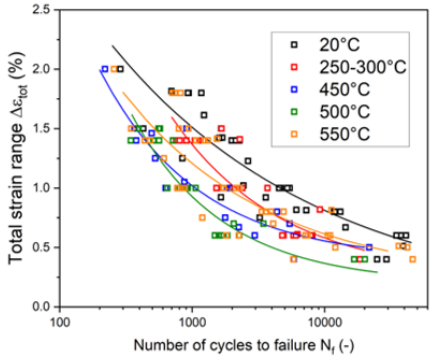

Fig-1: LCF data in the unirradiated state grouped according to testing temperature.

In sub-task 2-2, efforts have been made towards developing baseline W (tungsten) and Cu-alloy materials for MPH. Four types of tungsten materials with different rolling processes were examined by both EU and Japan for their thermo- physical and thermos-mechanical properties, such as microstructures, hardness, tensile properties etc. Dispersion of tensile strength was an issue for one of the tungsten materials but showed some improvement with another. Fracture toughness was also examined by both parties, with the EU focusing on K_Q (fracture toughness) values and DBTT (Ductile-to-Brittle Transition Temperature) evaluation, and JA introducing a fatigue pre-crack for precise validation. Recrystallization properties were also characterized by the EU.

Regarding common issues in sub-tasks 2-1 and 2-2, a fundamental assessment of miniature specimens was conducted for various test modes such as tensile, fracture toughness, and creep (Fig-2). The study outlined a general procedure for determining true stress vs. true strain for tensile testing and demonstrated the capability of the multi-axial creep test method using a cruciform specimen.

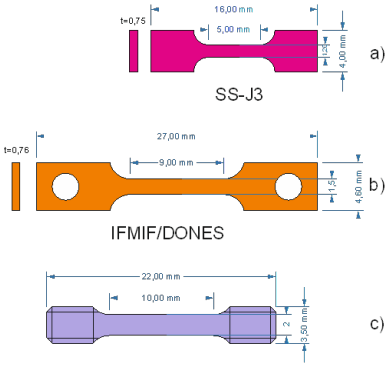

Fig-2: Tensile specimen geometries proposed; a) SS-J3 geometry; b) IFMIF/DONES geometry and c) SCK CEN cylindrical specimen.

As for sub-task 2-3, EU has shown progress in wide areas. For example, a new method for the characterization of defect structure has been developed. JA conducted research activities on the assessment of irradiation damage and the correlation of irradiation effects between different environments. For example, the synergistic effect of He and H was evaluated in mono vacancy-He-H bubbles.

In sub-task 2-4, in EU, R&D has progressed in validating design rules for the DEMO fusion power plant, including creep-fatigue rules and fracture behavior of irradiation embrittled materials. JA updated brittle and ductile fracture methods.

(DEMO R&D Task-2 TROs)