

IFERC Newsletter

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Status of DEMO R&D Activity

Highlights on development of structural materials

Task 2 (T2) on R&D on development of structural material for fusion DEMO in-vessel components is composed of five main activities: 1) Development of irradiation database and Material Property Handbook (MPH) of blanket structural materials (subtask 2-1), 2) Development of irradiation database and MPH for divertor baseline materials (subtask 2-2), 3) Small Specimen Test Techniques (SSTT) development and neutron irradiation (common issues in subtasks 2-1 & 2-2), 4) Materials modelling towards the validation of a DEMO fusion neutron irradiation database and MPH (subtask 2-3), and 5) Development of DEMO specific structural design rules (subtask 2-4).

In subtask 2-1, the updated 4th edition of the EUROFER MPH draft was released in EU, where tensile and impact properties were reviewed in the DEMO database, missing data were complemented, duplications and erroneous entries were identified (data redundancy must be avoided in order not to influence the statistical analysis), and material properties' curves have been consolidated. In JA, updating MPH of F82H was continued specifically addressing the demonstration of reproducibility: ~5dpa irradiation on F82H variants, e.g., BA07 and BA12 as well as IEA and Mod3 (previously reported), and new data: ~50dpa high-dose irradiation on welds as shown in Fig.-1. Also, statistical analysis, e.g., Bayesian approach, was continued to evaluate reference strength.

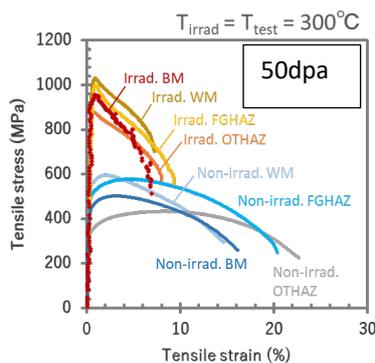


Fig.-1: BM: Base Metal, WM: Weld Metal, FGHAZ: Fine-Grained Heat-Affected Zone, OTHAZ: Over-Tempered HAZ. Like BM, WM and HAZ undergo hardening and loss of ductility by irradiation.

In subtask 2-2, the 2nd update of W and CuCrZr MPHs is in preparation and to be released in the end of 2023. MPH of baseline W materials was updated, specifically addressing 1) the evaluation of the validity of the fracture toughness data for baseline W, which were pre-cracked using the developmental technique, by referring the ASTM standard criteria, and 2) high-temperature tensile testing for baseline W (IGW, IMPW, etc.). A first set of neutron irradiation data of CuCrZr-IG was included in MPH; tensile properties and electrical resistivity by HFIR irradiation to 5 dpa at 100, 230, 250, 300°C (Fig.-2). Fracture surface observation is also ongoing.

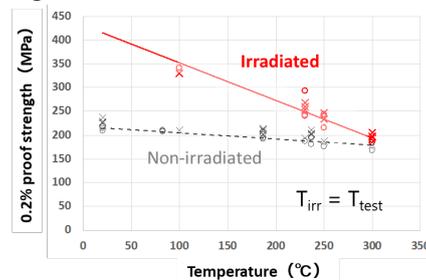


Fig.-2: Neutron irradiation (~5 dpa) effect on tensile properties of CuCrZr-IG

Regarding the common issues in subtasks 2-1 and 2-2, a pilot run on the standardization of SSTT for tensile tests, which is an interlaboratory study, started in S2 2023, and the SSTT methods for fatigue and fracture toughness were developed. In particular, the experimental test bench was upgraded and the testing procedures were defined.

As for subtask 2-3, EU has shown progress in AI-based predictive simulations of high-temperature properties of W. The stable nucleus size of voids in F82H was computationally estimated under various irradiation conditions in JA.

In subtask 2-4, in EU, the 2nd update of DDC-IC (draft edition) is in preparation and to be released in the end of 2023. R&D on guideline development of DEMO structural design rules was continued by JA, specifically addressing exploration of the capability of experimental and analytical methodologies to evaluate the impact of electromagnetic force on F82H.

(DEMO R&D Task-2 TROs)