Contribution ID: **498** Type: **Poster**

Small Specimen Test Technology Development Towards Design of Fusion DEMO Reactors and Future Direction Plan

Thursday, 20 October 2016 08:30 (4 hours)

Small specimen test technology or technique (SSTT) towards design of fusion DEMO reactors was investigated and evaluated in the related studies of the International Fusion Materials Irradiation Facility / Engineering Validation and Engineering Design Activities (IFMIF/ EVEDA) project under Broader Approach (BA) Agreement between EURATOM and Japanese Government. The main results were described as follows:
(1) The master curve which is an evaluation method for the ductile-brittle transition temperature behavior of the materials was found in the difference between F82H steel and Eurofer97 steel, and the optimization curve for F82H steel with sizes from 0.16CT (small size) to 1CT (standard size) was evaluated as an equation: K(JC-1T(med))= 30+70exp{0.05(T–To)} in this study, where T is the test temperature, To is the reference fracture toughness transition temperature, using a random inhomogeneous model.
(2) In the studies of the effects of size and shape on fatigue properties of F82H steel, a good correlation at room temperature was obtained between the small specimen with a diameter of 1 mm in the center of round bar and the standard size with 10 mm. No size effect on the fatigue life was recognized in the test section with diameters ranging from 1 mm to 10 mm. In a hour glass specimen, the crack initiation life was shortened with a smaller diameter because of the influence of stress concentration, which result in a fatigue life shorter than that of standard specimens in the low strain condition without plastic strain.
(3) The crack growth rate (CGR) of F82H steel using a wedge-opening load (WOL) type specimen with 1/4T (small size) and 3/4T (almost standard) in the water was examined, and the value was a slightly lower than that of 304 stainless steel.

SSTT standardization of RAFM steels and the other materials, which will be tested in the irradiation facilities, has to be established for design of fusion DEMO reactors, and it is desirable to establish firstly the test standard and the methodology for the non-irradiation materials of the fusion structural materials. Then, we also have to consider and establish the standardization for the irradiated materials containing transmutation atoms generated by the irradiation, such as helium.

Paper Number

MPT/P5-25

Country or International Organization

Japan

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Session Classification: Poster 5

Track Classification: MPT - Materials Physics and Technology