TORSION TEST TECHNIQUE FOR INTERFACIAL SHEAR EVALUATION OF F82H RAFM HIP-JOINTS

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A hot isostatic press (HIP) process is a key technology to fabricate a first wall with cooling channels of the blanket system utilizing a reduced-activation ferritic/martensitic (RAFM) steel such as F82H [1]. To establish the HIPed first wall component, the followings need to be developed: 1) HIP joining technology, 2) HIP joints database including mechanical properties and microstructural information, 3) small specimen test techniques viable to evaluate the actual thin-wall cooling channels, and 4) destructive/non-destructive inspection techniques. A Charpy impact test method is essentially valuable but insufficient considering the inspection of the real blanket module because of the limitation of the applicable specimen size. A primary objective of this study is to characterize interfacial properties of HIPed F82H joints by torsion to identify the feasibility of this test method as alternative options for inspection of the HIPed F82H joints.

A base material was a F82H-IEA steel. F82H blocks are canned and de-gassed and surface-finished to obtain various levels of HIP joints (HIP-1, -3 and -4) with 10, 80 and 100% reduced upper shelf energies, respectively, against the F82H base metal (HIP-BM). The de-gassed tubes were subsequently cold-crimped and welded. The F82H blocks were then consolidated by HIP at 140 MPa at 1100 °C for 2 hours. After the HIPing, thermal treatments of 960 °C for 0.5 h and 750 °C for 0.5 h were performed. Interfacial properties of the HIPed joints were evaluated by the torsion test method at room-temperature with a guideline of ASTM F734. Microstructural observations were performed by the scanning and transmission electron microscopes.

From Figure 1, it is apparent that the absorption energies of the HIP joints varied by the processing conditions, although the maximum shear strength was not much different. According to the fracture surfaces, it is indicated that the reduction of the absorption energy obtained in the torsion tests for HIP-1 was due primarily to the oxide formed on the interface of the HIP joint and this was consistent with the results of Charpy impact tests. In conclusion, the torsion test method with a miniature specimen enables to precisely evaluate the shear properties of the HIPed joint interface and becomes one of promising powerful techniques for inspection of the HIP joints.

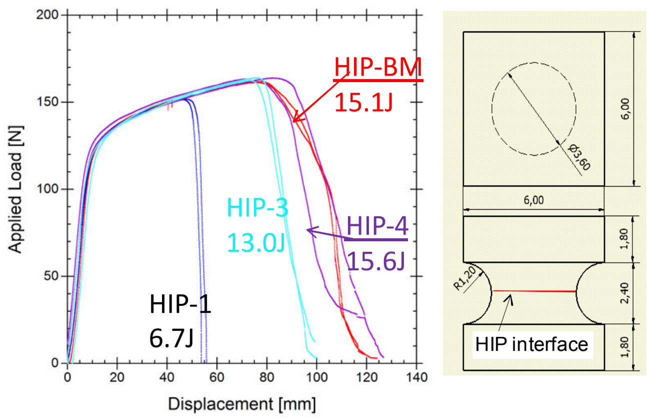

Figure 1: Typical load vs. crosshead displacement curves of torsion tests for F82H HIPed joints

[1] T. Hirose et al., J. Mucl. Mater., 329-333 (2004) 324-327.