§2. Characterization of Low Activation Ferritic Steel (JLF-1) Weld Joint by Simulated Heat Treatments

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Fe-Cr-W ferritic steels are candidate low activation materials for fusion reactor structural components. Japanese universities have been promoting a test program of a low activation Fe-9Cr-2WVTa alloy named JLF-1. For an application of candidate materials to fusion reactors, engineering technologies related to component fabrication are becoming major issues. Characterization and optimization of welding procedures have been considered to be particularly important in the fabrication of complex components such as a fusion blanket support structure. Under this motivation, some of the authors investigated the correlation or relationship between microstructures and hardness at various positions of a tungsten inert gas welding (TIG) weld joint of JLF-1. In that study, the characteristics of base metal (BM), heat affected zone (HAZ) and weld metal (WM) were examined.

In this study, X-ray diffractometry and hardness measurements were carried out on JLF-1 after TIG welding or simulated heat treatment. The heat treatment was carried out with different temperatures for simulating thermal histories of various locations on the welded joint. The objective of this study is to characterize and analyze the TIG joints of JLF-1 according to the heating history of each position.

The change of X-ray diffraction patterns and hardness are compared and discussed for a TIG weld joint and heat treated samples of JLF-1. The X-ray difractometry showed that the structural change (lattice spacing, internal strain, residual stress) occurs at a heat treatment temperature of 830 ℃. This result suggests that a phase transformation occurs and thus the A3 temperature should be around 820-830 ℃. The hardening, on the other hand, commences at 840 ℃ suggesting that the transformation does not necessarily cause the hardening.

The internal strain and the residual stress do not change through the HAZ, in spite of a large variation in hardness with the distance from the center of weld metal. Probably, a single heat treatment cannot simulate correctly the HAZ of the welded joint, because repeated heating with the different maximum temperatures and different cooling rates have been applied to the HAZ.

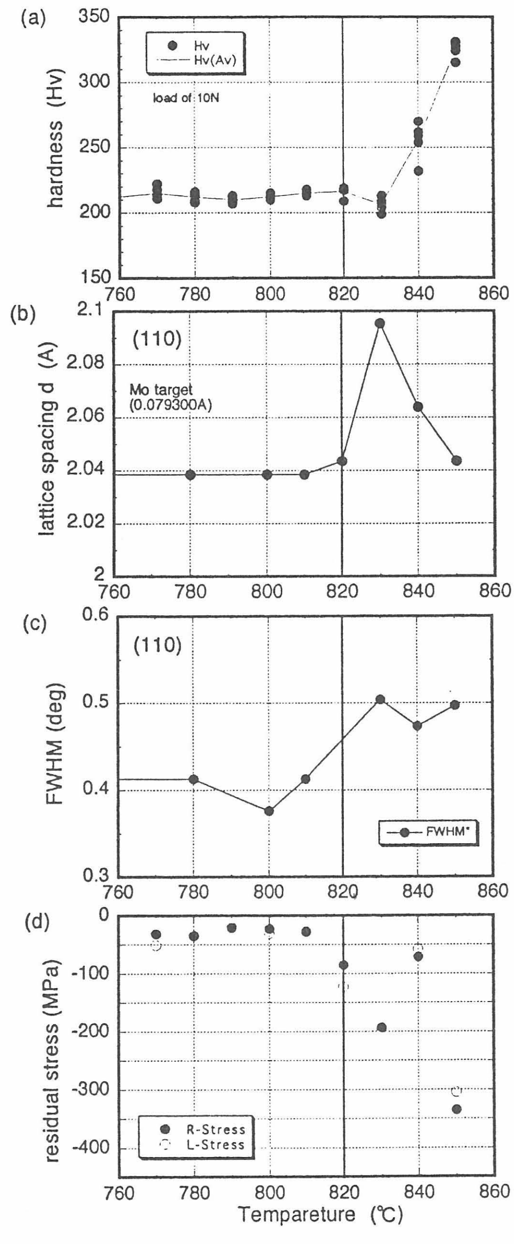

Fig. 1 Change of the hardness (a), the lattice spacing (b), the FWHM (c) and the residual stress (d) at various heat treatment temperatures.