3-6 Developing a Method for Suppressing Irradiation Hardening of F82H by Heat Treatment Utilizing the Difference in the Hardening of Weld Joints

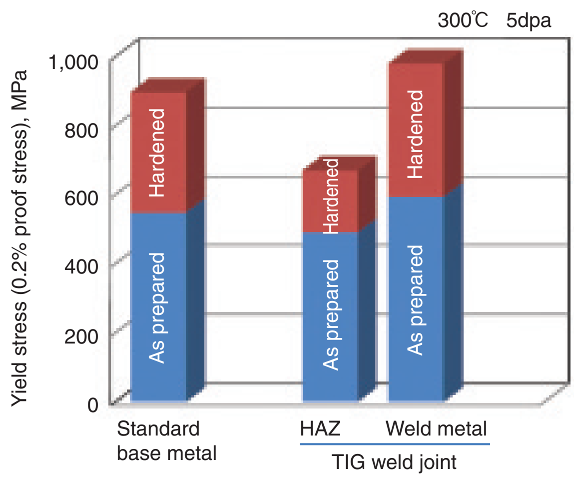


Fig.3-15
Yield stress of the base metal and TIG weld joints of F82H, i..e. heat affected zone (HAZ) and weld metal, before and after irradiation. Irradiation hardening of HAZ is smaller than that of base metal and weld metal.

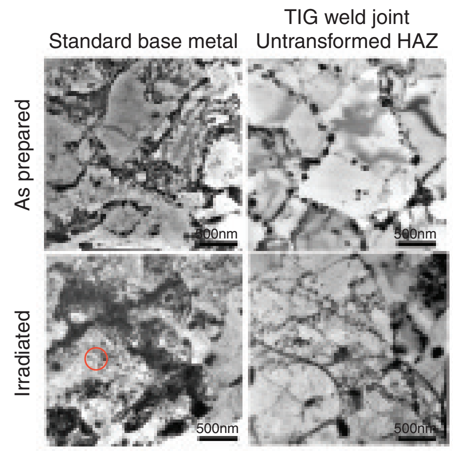
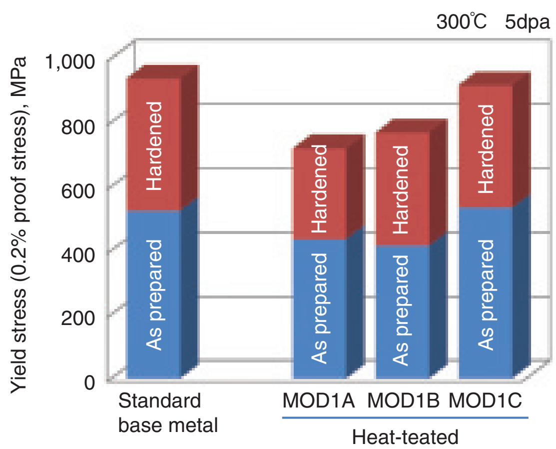


Fig.3-16 TEM microstructure of base metal and untransformed TIG-HAZ region before and after irradiation.
Dislocation loops dominate in irradiated base metals (indicated by ◯) is not observed in untransformed TIG-HAZ region.



Heat treatment conditions

F82H standard base metal
1,040℃×30min, 750℃×1hour

F82H MOD1A
(Untransformed HAZ region equivalent)
800℃×30min, 700℃×10hours

F82H MOD1B
(Transformed HAZ region equivalent ver.1)
860℃×30min, 700℃×10hours

F82H MOD1C
(Transformed HAZ region equivalent ver.2)
920℃×30min, 700℃×10hours

Fig.3-17 Yield stress of standard and heat-treated F82H, simulating the thermal history of TIG-HAZ region
The F82H heat treated under conditions simulating the thermal history of untransformed HAZ region (Mod-1 A) exhibits less hardening upon irradiation than the others.

Reduced activation ferritc/martensitic steels (RAFMs) are the leading candidates for the fusion blanket structural material. F82H (Fe-8Cr-2W- V,Ta) is the one of the RAFMs which has been developed by JAEA. The key issue now is how to suppress the irradiation hardening and embrittlement induced by neutron irradiation at temperature below 350℃.

In the course of research into irradiation hardening, it was found that the irradiation hardening at the heat affected zone (HAZ) of a TIG weld joint is much smaller than that of the standard base metal and the TIG weld metal (Fig.3-15). TEM observation of these regions revealed that dislocation loops, which are recognized as the key feature causing irradiation hardening, are not observed in the untransformed HAZ region (Fig.3-16). Based on these results, F82H was heat treated in a manner simulating the thermal history of HAZ region, and then neutron irradiated. A tensile test revealed that the heat treating which simulates the thermal history of untransformed HAZ region yielded the smallest hardening (Fig.3-17).

This research was conducted as the part of the collaborative program for testing structural materials in mixed-spectrum reactors of JAEA and US Department of Energy.

Reference

Wakai, E. et al., Effect of Initial Heat Treatment on DBTT of F82H Steel Irradiated by Neutrons, Fusion Science & Technology, vol.47, no.4, 2005, p.856-860.