IMPACT PROPERTIES OF GA'S 832864 HEAT OF V-4Cr-4Ti ALLOY AFTER EXPOSURE IN THE JFT-2M TOKAMAK - H. Tsai (Argonne National Laboratory), W. R. Johnson, P. W. Trester (General Atomics), S. Sengoku (Japan Atomic Energy Research Institute)

SUMMARY

Four Charpy impact specimens were received from General Atomics (GA) after they were exposed in the tokamak environment of the JFT-2M. These specimens were prepared from the GA's 832864 heat of V-4Cr-4Ti material. The exposed specimens were impact tested at ANL using established procedures. The results showed no appreciable degradation of impact properties of the material from the JFT-2M exposure.

OBJECTIVE

The objective of this task was to determine the impact properties of the 832864 heat specimens after the exposure in the JFT-2M tokamak.

BACKGROUND

A long-term test has been conducted in the JFT-2M tokamak fusion device to determine the effects of environmental exposure on the mechanical and chemical behavior of a V-4Cr-4Ti alloy. Test specimens of the alloy were exposed in the outward divertor chamber of JFT-2M in a region away from direct contact with the plasma, and were held in a fixture which contained a heater to preheat the specimens to 300C prior to plasma discharges. During their nine-month residence in JFT-2M, the specimens experienced exposure to air, low-pressure hydrogen and deuterium ($\approx 10^{-2}$ Pa), titanium (during vessel interior conditioning via sputtering of titanium by Ar ions with magnetron-type RF discharges), and interaction with neutral high energy particles, including metallic species, during 2,210 plasma shots and disruptions. The latter included approximately 200 lower-single-null divertor shots for which high energy particle fluxes to the test specimens were significant, and a number of non-divertor disruptions and upper-single-null divertor shots for which high energy particle fluxes to the test specimens were very low.

Similar specimens from a different heat of V-4Cr-4Ti alloy (Heat 832665) have been exposed to the DIII-D tokamak environment. Results to date from those tests[1] indicate the absorption of interstitials is limited to the very near surface, and that neither the strength nor the Charpy impact properties of the alloy are significantly changed.

EXPERIMENTAL PROCEDURE

Test Specimens

The test specimens for this study were prepared from the 832864 heat[2] of V-4Cr-4Ti alloy. The composition of the material is shown in Table 1.

Table 1. Chemical composition of the 832864 heat

Heat Number	Ingot Size (kg)	Nom. Composition (wt.%)	Interstitial Content (wppm)			
			O	N	C	Si
832864	1200	V-3.8Cr-3.8Ti	370	120	30	270

The Charpy impact specimens were 1/3-size, 3.3 mm (t) x 3.3 mm (w) x 25.4 mm (l), with a 30°,

*Work supported by U.S. Department of Energy, Office of Fusion Energy Research, under Contract W31-109-Eng-38.

0.61-mm-deep, 0.08-mm-root radius machined notch. The notch orientation (i.e., crack propagation direction) was perpendicular to the final rolling direction and into the thickness of the plate. This Charpy specimen design is a de facto standard and has been used extensively in previous fusion materials tests.

Test Procedure

The Charpy impact tests were conducted in air with a Dynatup drop-weight tester following established procedures. Specimen temperature during the impact test was measured with a thermocouple spot-welded to the end of the specimen. For the above-ambient-temperature tests, a hot-air blower was used to provide the heating. For the below-room-temperature tests, liquid nitrogen was used to chill the specimens.

RESULTS AND DISCUSSION

The results of the Charpy tests are summarized in Table 2 and Fig. 1. From Fig. 1, which also shows the baseline data for the 832864[3] heat and other relevant data of the sibling 832665 heat, it appears that the impact properties of the JFT-2M-exposed 832864 specimens are essentially unchanged from the nonexposed baseline. The exposed material still possesses excellent impact properties at temperatures as low as –150°C.

SEM fractographic examination of the tested specimens confirmed these positive findings. Even at a low temperature of –150°C, the fracture was ductile tear. Only at –195°C, did the specimen show brittle cleavage fracture. These results are shown in Fig. 2.

Table 2. Charpy impact properties of the 832864 specimens after the JFT-2M exposure

Spec.	Test temperature	Absorbed
G1	23	9.7
G2	-195	3.5
G3	-150	11.8
G4	200	9.9

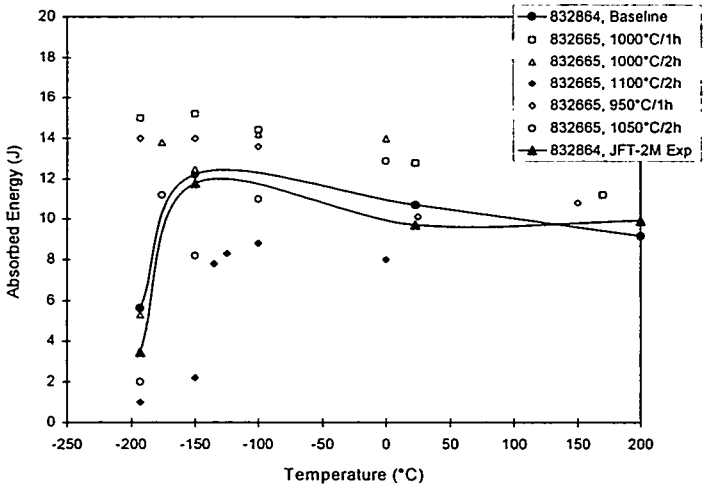
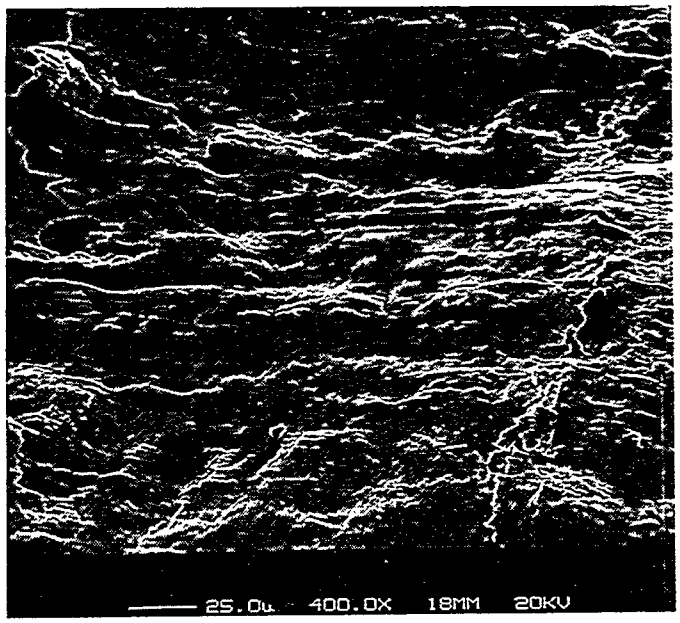
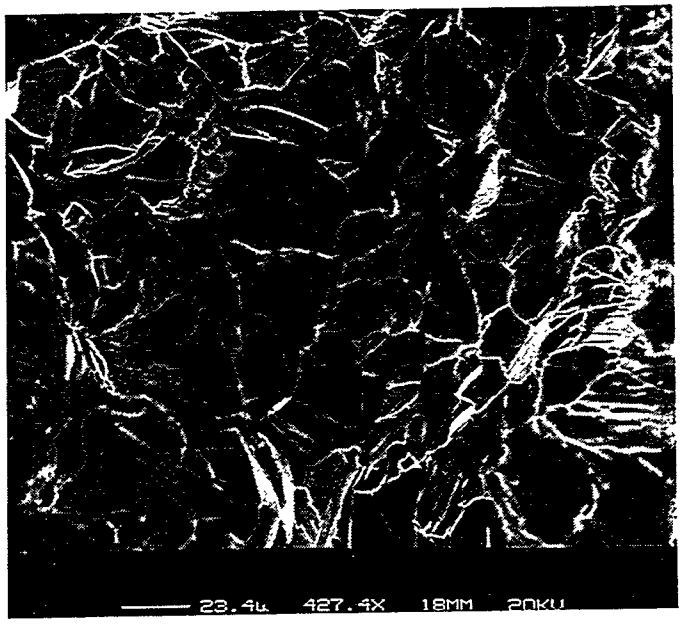


Fig. 1. Charpy impact properties of Heat 832864 specimens after the JFT-2M exposure



-150°C



-195°C

Fig. 2. SEM fractography of the JFT-2M-exposed Charpy specimens showing ductile tear at -150°C and brittle cleavage at –195°C.

REFERENCES

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