§41. Effects of Excess Oxygen Level on Mechanical Properties and Microstructure for Two 9Cr-ODS Steels

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Introduction

One of the important reasons why the oxide dispersion strengthening (ODS) steels have attracted increasing interests to replace the reduced activation ferritic-martensitic (RAFM) steels for the applications in fusion blanket system, is their outstanding tensile and creep strength at high temperature regimes, profiting from the numerous nano-sized oxide particles embedded in the matrix [1]. The excess oxygen level may affect the formation of grain size, carbides precipitates, residual α-ferrite, and Y-Ti-O nano-particles [2]. Therefore, in this collaboration program, the detailed study on excess oxygen content effects were carried out. Two 9Cr-ODS steels were fabricated with different oxygen concentration. The mechanical properties were tested and the microstructure was analyzed.

Experimental

Two 9Cr-ODS steels were produced in NIFS, called as 9Cr-ODS-1, and 9Cr-ODS-2, respectively. The chemical composition (in wt%) were 9.08Cr, 1.97W, 0.14C, 0.29Y, 0.23Ti, 0.16O and balance Fe for 9Cr-ODS-1, and 9.02Cr, 1.91W, 0.13C, 0.28Y, 0.21Ti, 0.128O and balance Fe for 9Cr-ODS-2, respectively. The final heat treatments for both 9Cr-ODS steels included normalization at 1323 K for 1 h followed by air cooling, and tempering at 1023 K for 1 h followed by air cooling.

The Vicks hardness was measured at room temperature with a load of 1000 g. The microstructural characterization was examined by electron back-scattered diffraction (EBSD), which were conducted in IMR.

Results

Fig. 1 shows the comparison of hardness results for two 9Cr-ODS steels. The Vicks hardness was about 395 and 360 in 9Cr-ODS-1 and 9Cr-ODS-2, respectively, indicating that the 9Cr-ODS-1 was significantly stronger than that of 9Cr-ODS-2.

Fig. 2 Shows the different grain grain morphology by EBSD. The average grain size in 9Cr-ODS-1 was significantly smaller than that in 9Cr-ODS-2, which is one of reasons for its higher hardness and strength than that in 9Cr-ODS-2. The excess O level affects the formation of grain size by affecting the nano-scale particles.

Conclusion:

9Cr-ODS-1 was stronger than 9Cr-ODS-2. The finer grain size is one of the reasons for its higher strength and hardness. The oxygen level affect the grain morphology. Further investigations about the effects on other microstructure parameters such as precipitates and nano-particles are in progress.

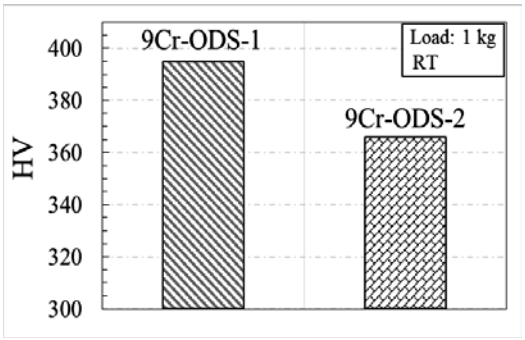

Fig.1 Comparison of Vickers hardness of 12Cr-ODS and 9Cr-ODS steels.

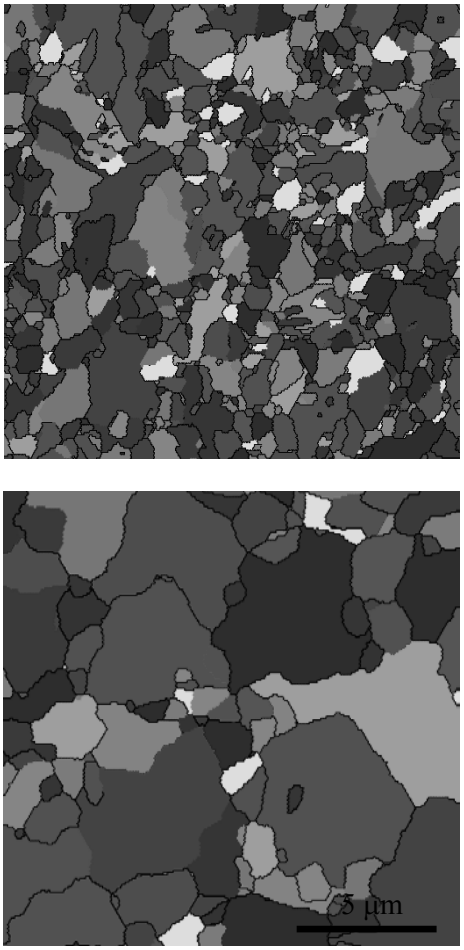

Fig.2 Microstructure by EBSD grain maps of 9Cr-ODS-1 (top) and 9Cr-ODS-2 (bottom) steels.

1) S. Ukai, et al.: ISIJ Int. *43* (2003) 2038.
2) S.Ohtsuka, et al., J. Nucl. Mater., 329-333 (2004) 372.