§15. Annealing Effects on Mechanical Properties and Microstructure for Oxide Dispersion Strengthened (ODS) Steel as Fusion Blanket Structural Materials

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Introduction

Oxide dispersion strengthened (ODS) steels are the promising fusion blanket structural materials for use up to about 650- 700℃ because of the excellent creep strength relative to Reduced Activation Ferritic/martensitic steels (RAFMs).[1,2] It is very important to understand the fundamental stability behavior during different heat treatments for the ODS steels.

Experimental

The material used is the 9Cr-ODS steel with a chemical compositions of Fe-9.08wt%Cr-1.97%W-0.14C%-0.29%Y-0.23Ti%. The steel was normalized at 1050℃ for 1 hour and then tempered at 980℃ for 1 hour.

The annealing experiments were carried out from 700 to 1150℃ for 1 hour with a step of 50℃ to understand the thermal stability fundamentally. After annealing, hardness was measured with a loading of 300 g for 30 s. Microstructure was also observed by scanning electron microscope (SEM).

Results

The hardness results are shown in Fig.1. Heat treatment below 900℃ for 1 h did not change the hardness, indicating the stability of microstructure. On the contrary, the hardness was increased significantly at temperature over 900℃, suggesting the phase transformation.

Figure 2 shows the microstructure at normalization and tempering (N&T) condition and after annealing observed by SEM. As shown in Fig. 2(a), the 9Cr-ODS steel exhibits a tempered martensitic structure decorated with the carbides and fine dispersed nano-particles. The size of grains and particles were almost no change after annealing from 700 to 900℃. On the contrary, phase changed from martensite to austenite above ~950℃. This is agreed to the results of hardness measurement.

Conclusion:

The 9Cr-ODS was annealed from 700 to 1150℃ for 1 hour. After annealing, the hardness and microstructure did not change when temperature below ~900 ℃, suggesting stability. While above ~900℃, the hardness increased and phase changed from martensite to austenite.

1) Ukai, S. et al.: ISIJ International **43** (2003) 2038.
2) Li, Y.F, et al.: Fusion Eng. Des. **86** (2011) 2495.

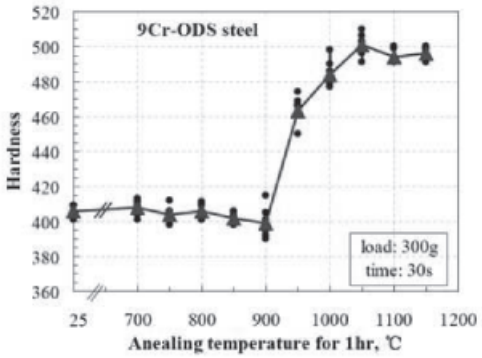
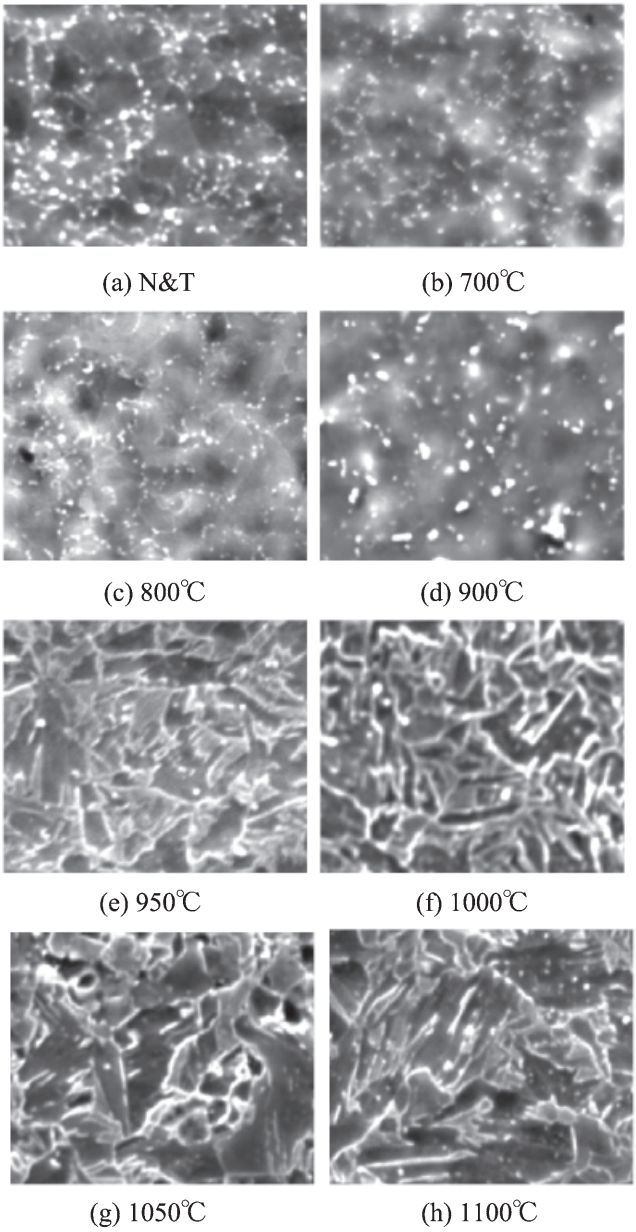


Fig.1 Dependence of hardness on annealing temperature for 9Cr-ODS



(a) N&T (b) 700℃

(c) 800℃ (d) 900℃

(e) 950℃ (f) 1000℃

(g) 1050℃ (h) 1100℃

Fig.2 Microstructures by SEM at normalization and tempering (N&T) and annealing conditions from 700 to 1100℃.