§6. Mechanical Properties of Oxide Dispersion Strengthened (ODS) Steel as Fusion Blanket Structural Materials

Li, Y.F., Nagasaka, T., Muroga, T.

Reduced activation ferritic/martensitic steels (RAFMs) are considered as the primary candidates of fusion blanket structural materials.[1)] Oxide dispersion strengthened (ODS) steels are the advanced materials with a potential to be used at elevated temperature due to the addition of thermally stable oxide particle dispersion into the RAFM matrix.[2)]

The mechanical properties of 9Cr-ODS were investigated and compared with those of the current RAFMs of CLAM and JLF-1, Chinese and Japanese candidates, respectively. Their chemical compositions and heat treatment conditions are given in Tables 1 and 2, respectively.

The tensile properties are shown in Fig.1. The 9Cr-ODS steel exhibited a superior tensile strength. The ultimate tensile strength (UTS) and yield strength (YS) are almost double those of CLAM and JLF-1. The strength level of the 9Cr-ODS at 923-973 K was still comparable with those of CLAM and JLF-1 at 823 K, the typical maximum operation temperature for RAFMs. On the contrary, the total elongation (TE) of the 9Cr-ODS was only slightly smaller than those of CLAM and JLF-1.

Figure 2 shows the creep curves tested at 823 K. At 823 K with 300 MPa applied stress, the both RAFMs ruptured very quickly after less than 1 hour. While the 9Cr-ODS did not rupture and only yielded a very small deformation after more than 300 hours. With the increase in stress to 400 MPa, the 9Cr-ODS steel was still keeping well after 1200 hours' running. This means that, at 823 K, the minimum creep rate of 9Cr-ODS was ~10^5 smaller and rupture time was ~10^3 longer than those of RAFMs.

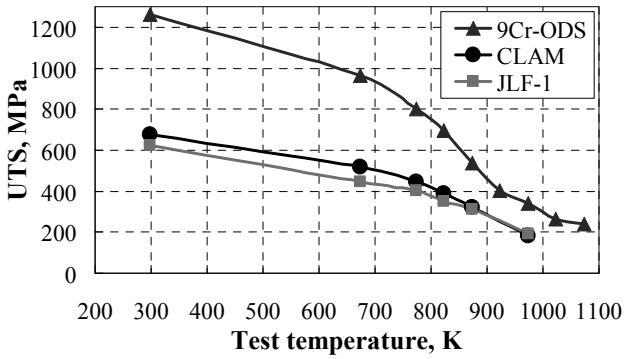
The present tensile and creep data suggested that, the maximum service temperature of the 9Cr-ODS can be improved successfully from 823 K to 923-973K by the application of fine oxide particles into RAFMs.

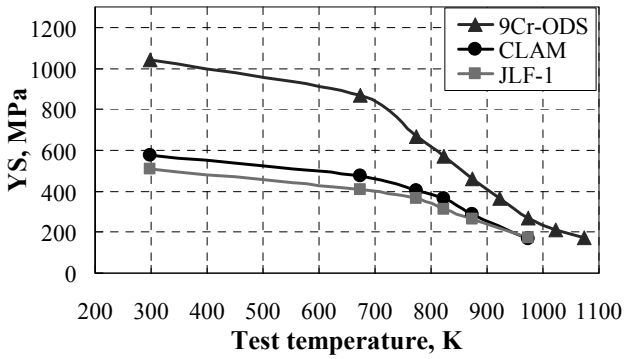
Table 1 Chemical compositions (in weight %).

	9Cr-ODS	CLAM	JLF-1
Cr	9.08	8.94	9.00
W	1.97	1.45	1.98
C	0.14	0.13	0.09
Ta	-	0.15	0.083
Y	0.29	-	-
Ti	0.23	-	-
Fe	bal.	bal.	bal.

Table 2 Heat treatment conditions (AC: air cooling).

	Normalizing	Tempering
9Cr-ODS	1323 K/60 min /AC	1073 K/60 min /AC
CLAM	1253 K/30 min/AC	1033 K/90 min/AC
JLF-1	1323 K/60 min/AC	1053 K/60 min/AC





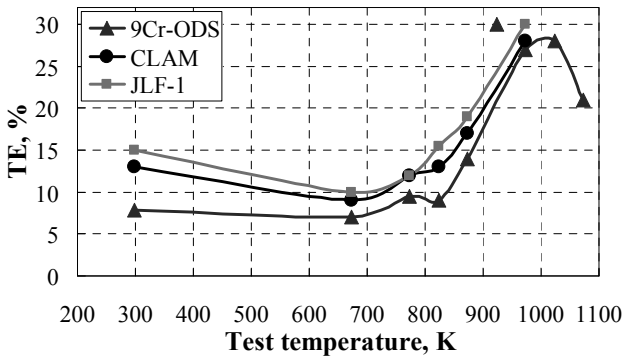


Fig.1 Dependence of tensile properties on test temperature for 9Cr-ODS, CLAM and JLF-1

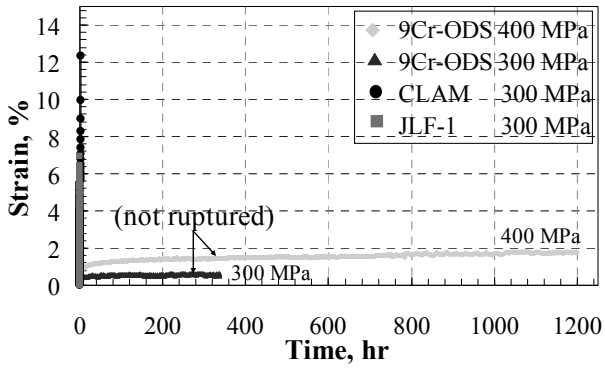


Fig.2 Strain-time creep curves for 9Cr-ODS, CLAM and JLF-1 tested at 823 K.

1) Muroga, T. et al.: Fusion Eng. Des. **61-62** (2002) 13.
2) Ukai, S. et al.: ISIJ International **43** (2003) 2038.