§10. Evaluation of Mechanical Properties and Aging of High-chromium and Yttrium-added Vanadium Alloys

Satou, M., Sato, T., Hasegawa, A. (Tohoku Univ.), Nagasaka, T.

It has been demonstrated that controlling of interstitial impurity levels by means of modification of melting process or addition on scavenging elements like yttrium was improved the material performance through evaluation of baseline properties and irradiation behaviors for V-4Cr-4Ti alloy(as known as NIFS-heats). Further improvement in strength of the alloy at high temperature is one of the issues for applications of fusion reactor blanket. Solid-solution.-hardening by chromium addition controlling interstitial impurity level low and thermo-mechanical treatment including thermal aging are adopted to improve the high-temperature strength. In this study, mechanical properties of high-Cr vanadium alloys with yttrium addition were examined to understand and to deepen knowledge of improvement of the material performance.

It has been show that small additions of yttrium improve mechanical properties after neutron irradiation by means of its scavenging effects. To reduce interstitial impurity level, however, may decrease the strength of the alloys. At temperature ranging from 650 to 700^{o}C, tensile strength of the vanadium alloys showed relatively large temperature dependence, so that it may be better to reduce temperature dependence from engineering points of view. Previous results of mechanical tests include workability and impact test of a series of vanadium alloys with different amounts of chromium addition indicated that the maximum concentration of chromium of the vanadium alloys was about 7 %, when interstitial concentration of the alloy was reasonably reduced. Thermal aging and solid-solution strengthening were studied for V-7Cr-4Ti type alloys with various mechano-thermal treatments.

Tensile tests, micro-hardness tests, resistivity measurements were carried out for V-7Cr-4Ti-Y type alloys and V-4Cr-15Ti-Y type alloys which were annealed for 2 hours or 10 hours at 600^{o}C after cold rolling. Figure 1 shows Vickers hardness changes before and after heat treatment for 10 hours. The hardness of the V-7Cr-4Ti-Y type alloy increases after the heat treatment but that of the V-4Cr-15Ti-Y type alloy decreases. Electrical resistivity measured at room temperature by four-probe method decreases for all of the alloys about 5 to 8 nΩm. The decrease of the resistivity supposed to be corresponding to decreasing interstitial impurities like oxygen in solution due to formation of precipitation. For comparison, the results for V-4Cr-4Ti-Y type alloy after aging followed by re-crystallized heat treatment are shown in the fig.1. Smaller changes of resistivity are observed for the alloy with small addition of yttrium.

The results of the V-Cr-Ti-Y type alloys with small addition of yttrium indicated that to maintain the microstructures or mechanical properties of the alloys after thermal aging, addition of yttrium may be effective so far. Further mechanistic study will be continued to reveal creep properties of the alloys together with a series of microstructure examination.

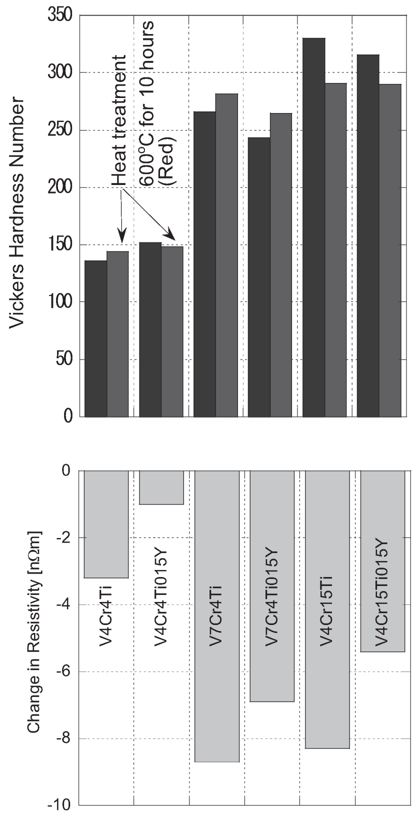

Fig. 1 Vickers hardness and electrical resistivity of V-Cr-Ti-Y type alloys after thermal aging at 600^{o}C for 10 hours.