Interaction of precipitates and dislocations in low activation V-4Cr-4Ti alloy

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V-4Cr-4Ti is the leading candidate structural material in V-Li blanket of a fusion reactor for its low activation feature and good high temperature mechanical performance. Though some critical issues still remained to be solved, much effort was made to increase the strength of this alloy in recent years. There is strong precipitation hardening of the alloy when aging at 600°C though the hardening is thermally unstable above 500°C. To enhance the stability, strengthening by both precipitation and cold work (CW) hardening was studied. The studies showed the interactions between precipitates and dislocations, which stabilize microstructure and increase not only the high temperature tensile strength but the improvement of thermal creep property as well.

The hardening curves on aging temperature and time were established at 600-700°C. Based on the curves the activation energy was obtained, which showed the controlling process of the precipitate growth. The precipitation-hardening alloy was further cold rolled at room temperature with a 20% reduction in thickness. This increased the strength significantly even measured at elevated temperature. But the strain hardening capability lost much. Microstructural observation by TEM showed the stabilization of the precipitates due to the presence of dislocations. In another case, the alloy in SA state was cold rolled at first, aged at 600°C then. As expected, the aging does hardened the alloy additionally, but the hardening was not as significant as the one directly following the SA treatment. Therefore, the cold rolling could not only stabilize the precipitates, but also resist their formation.

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