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Alloy Development for Irradiation Performance

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U.S. Department of Energy
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Prior research on the tensile behavior of the quenched and tempered steel HT-9 has shown that the steel exhibits marked susceptibility to hydrogen embrittlement and hydrogen induced intergranular fracture. The severity of the embrittlement can he significantly reduce? and the intergranular fracture mode entirely eliminated by swaging and retempering the steel. These improvements are attributed to a reorientation of the prior austenite grain boundaries with respect to the tensile axis and to reduced carbide and impurity coverages of grain boundary interfaces. The swaging results suggest that the hydrogen compatibility of HT-9 could be increased by reducing the grain size. To assess the role of grain size, two different austenitizing treatments were employed. The first employed reductions in austenitizing tempemture to refine the prior austenite grain size. To asses8 the roles of microstructural features other than grain sine, a two step austenitizing treatment was used. In these treatments specimens were quenched from a fixed initial austenitizing temperature which determines the austenite grain size to a second, lower, austenitizing temperature. The second austenitizing temperature will redistribute the carbides and grain boundary segregants. As the same temperatures Were used in varying the austemitizing temperature and the second austenitizinq temperature in the step treatments, comparison of the two treatments should provide some insight as to the rote of grain size in the hydrogen embrittlement of this steal. The major effects of lowering the austenitizing temperature from 1050°C are to increase the hydrogen charged tensile ductility and to reduce the yield strength. Decreasing the austenitizing temperature from 1050° to 900°C increases the hydrogen charged tensile ductility from 13% to 47% and decreases the yield strength from 110 ksi to 72 ksi. Decreasing the second austenitizing temperature in the step treatment does not lower the yield strength as much as lowering the austenitizing temperature. Therefore, at the same austenitizing and second austenitizinq temperatures, the carbide morphologies are not the same and comparison of the two heat treatments cannot he used to define the role of grain size.

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In the 2 1/4 Cr-I Mo, 9 Cr-I MoVNb, and 12 Cr-1 MoVW steels currently of interest as structural materials for fusion reactors, the molybdenum will form long-lived isotopes that will make such alloys difficult to dispose of after reactor operation. As an alloying element, tungsten is often similar to molybdenum. To determine if tungsten can replace molybdenum in the ferritic steels of interest, eight 18-kg heats of chromium-tungsten steels have been prepared and are being investigated.

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