Analysis of retained austenite in 9 Cr-1 Mo-V steel weld metal*

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Abstract

The 9Cr-1Mo-V (P91) steel is a high strength alloy that normally transforms completely to martensite during air cooling. Measurements of specimen dilations during controlled thermal cycles were used to follow the martensite transformation in a P91 base metal and a weld deposit. For identical thermal cycles, the base metal transformed completely to martensite after normalizing, but austenite was retained in the weld deposit. The retained austenite transformed to martensite upon cooling from the tempering temperature, resulting in small amounts of untempered martensite in fully heat treated weld deposit. The transformation behavior was confirmed by high-temperature diffraction experiments conducted at the Advanced Photon Source. These experiments were used to monitor phase transformations in the P91 alloys during thermal cycles identical to those used to track dilation response. The differences in transformation behavior were attributed to microsegregation. An analysis of microsegregation by computational thermodynamics suggested that partitioning of C, Cr, Mn, and Ni increased the range between the martensite transformation start and finish temperatures in the weld deposit, increasing the likelihood of retained austenite in it. The retained austenite results in untempered martensite after final tempering. Creep testing indicated that the untempered martensite increases the strength of the weld deposit.

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