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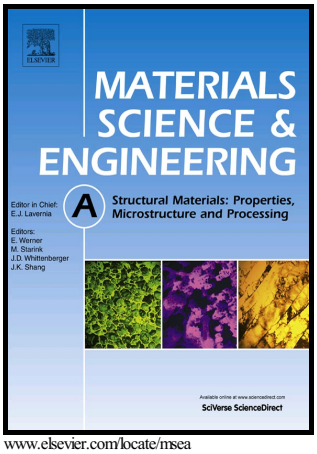

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An experiment-based model of combined hardening and non-hardening embrittlement in an interstitial free steel

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Abstract

The fracture appearance transition temperatures (FATTs) are evaluated for the samples of a Nb-stabilized and P-strengthened interstitial free (IF) steel. Based on the measurements, the combined effect of hardening and phosphorus grain boundary segregation on the embrittlement of the steel is investigated. Both hardening and P boundary segregation can raise the FATT of the steel, causing hardening embrittlement and non-hardening embrittlement, respectively. Meanwhile, the grain size influences both kinds of embrittlement, i.e., there is a synergistic effect between grain size and hardening or P boundary segregation on the FATT of the steel. With the aid of the Taylor expansion along with the experimental data, a combined hardening and non-hardening embrittlement equation is established, being expressed as $FATT = 2.1C_p + 3.48\sigma_s - 22.36d^{-1/2} + 0.64(C_p - 14)(d^{-1/2} - 3.06) + 0.896(\sigma_s - 14)(d^{-1/2} - 3.06) - 13.7$, where $FATT$ is the fracture appearance transition temperature in ^oC, C_p is the phosphorus boundary concentration in at.%, $_s$ is the yield strength in 10MPa, and d is the grain size in mm. A comparison of the calculated and measured FATTs is made, demonstrating that the calculated FATTs are well consistent with the measured ones.

Keywords: Embrittlement; Grain boundaries; Segregation; Metals and alloys