SESSION 5: IRON AND STEEL, HARBOR HALL

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The austenitic peak stress model of low-alloy steel at elevated temperature based on the valence electron theory

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ABSTRACT

First, the average coefficient of thermal expansion of the low-alloy steel was calculated using the JmatPro software; then, the lattice constants of both no carbon-containing and carbon-containing austenite unit cells are computed at high temperature with the weighted average method. The Austenitic valence electron parameters and their statistical values are calculated based on above lattice constants using the empirical electron theory. The austenitic unit cells in this paper include no carbon containing, carbon containing, silicon containing, manganese containing, and molybdenum containing. Then, their binding energies were calculated. Finally, using the sum of both the binding energy based on the valence electron statistic parameters and the mole fractions of the above elements in low alloy steel, the semi-empirical model of austenitic peak stress at high-temperature was established, by combining with Medina's austenitic measurement data. By the fitted regression relationship of binding energy with the iron, carbon, silicon, manganese, and molybdenum elements in the low-alloy steel, the austenite peak stresses simplified empirical model was obtained. The results show that the austenitic peak stress model presented in this paper was provided with good precision, indicating that the establishment method of peak stress model of austenite at high temperature based on statistical parameters' binding energy is valid. Since considering the impact of more additional chemical elements in the low-alloy steel, the empirical model provides an effective way for low-alloy steel deformation resistance calculation.

KEYWORDS: valence electron theory, binding energy, austenite at high-temperature, peak stress