Predicting the M_s temperature of steels with a thermodynamic based model including the effect of the prior austenite grain size

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A thermodynamic based model for predicting the martensite-start temperature (M_s) of steels has been developed that accounts for variations in the austenite grain size (D^γ). This is achieved by introducing two additional energy terms in the physical expression of the critical driving force proposed by Ghosh and Olson. Since grain refinement leads to stronger austenite, a higher driving force and thus a lower M_s is required to initiate the shear transformation. This first mechanism is described by a Hall Petch strengthening term. Secondly, the aspect ratio of martensitic units, i.e. laths, increases when D^γ becomes lower than a critical diameter D_C. This implies more stored energy and therefore a higher driving force is required which also contributes to a decrease of M_s. Model calculations show a good agreement with experimental dependencies between M_s and D^γ. Although the developed M_s model has a strong thermodynamic basis, predictions can be made without having access to thermodynamic calculation software and databases. Instead, for a certain critical driving force the corresponding M_s can be calculated using a simple composition dependent relationship that has been adequately validated with thermodynamic calculations. Model parameters have been optimized by fitting against experimental data of more than 100 alloys. Benchmarking of model predictions against calculations made with various empirical models from literature demonstrates a significant improvement in accuracy.