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Modelling of the effect of a Mo-addition on the kinetics of precipitation reactions in high-strength micro-alloyed structural steels during heat treatment and hot-dip galvanizing

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High-strength structural steels offer several attractive advantages over mild steel, such as a higher strength-to-weight ratio and a reduced carbon footprint. Molybdenum plays an important role in achieving this goal, as it markedly improves the hardenability of steel. Heat treatment during production aims to find a balance between the desired strength and toughness for a given steel composition. While lower tempering temperatures generally lead to a higher strength, they are often connected with a reduced low-temperature toughness. High tempering temperatures, on the other hand, generally lead to an improvement of the low-temperature toughness at the cost of a lower strength.
Thermodynamic modelling of phase equilibria is a useful tool for the design of the heat treatment of microalloyed structural steels. Its possibilities can be augmented by modelling of the kinetics of precipitation reactions that take the actual temperature-time history into account, as this has a strong impact on the size and volume fraction of precipitates. Within the present investigation, the precipitation kinetics during heat treatment and hot-dip galvanizing of an S620 high-strength structural steel with and without molybdenum addition were modelled. This made it possible to investigate the effect of variations in heat treatment parameters and the steel composition. This was coupled with laboratory heat treatment trials and characterization of the mechanical properties. In the present case, it was found that a variation in tempering temperature has a stronger effect on carbonitride and cementite precipitates than a variation of the temperature during hot-dip galvanizing.

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