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Thermodynamic Simulation of Precipitation Hardening Stainless Steel

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INTRODUCTION

The forging industry, dedicated to the processing and casting of steels, makes use of sophisticated thermodynamic tools for analysis and design to improve its alloys. It is well known that material properties and behavior are strongly dependent on chemical composition. However, it is expensive and time consuming to carry out experiments for each new alloy. Therefore, this paper shows the development of a heat-treated stainless steel precipitation hardening grade using ThermoCalc, it was found that even slightly different chemical compositions can have an impact on transformation temperatures, amount, and type of precipitates.

Grade 16Cr.4.0Ni-0.30Nb-4.0Cu is a martensitic precipitation hardening stainless steel. The mechanism of Precipitation Hardening consist in secondary phases within the grain and the interface boundaries, to achieve it is necessary to obtain a uniform distribution of the precipitates and optimal spacing [1]. The microstructure consists of a final martensitic matrix, Cr precipitates, NbC, $M_{23}C_6$, retained/reverted austenite and low percentage of delta ferrite [2]. It is important to control the amount of these to not negatively affect mechanical properties.

The evolution of microstructure depends on chemical composition, forging process and heat treatment cycles. Figure 1 shows its evolution during heat treatment [3].

