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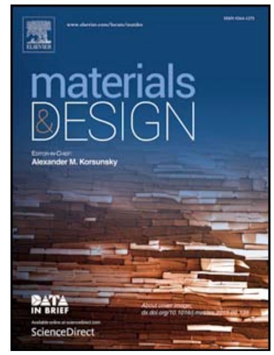

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Towards efficient microstructural design and hardness prediction of bearing steels — an integrated experimental and numerical study

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Abstract

The present work develops a numerical approach combining thermodynamic and kinetic simulations to investigate the austenitisation process on spheroidised bearing steel. The approach incorporates the dissolution of spheroidised cementite present prior to austenitisation and the influence of austenitisation temperature. It allows predictions including the chemical driving force of austenite formation, the evolution of phase constituents and their chemical compositions during austenitisation, as well as an assessment on the austenite stability upon quenching. The calculated results further allow to predict the hardness of the produced martensitic steels. The model predictions are validated against experimental data in two commercial bearing steels with six austenitisation processes. Good agreement between the experimental results and numerical predictions is obtained on the steel microstructure, austenite stability and material hardness. In addition, comparison of the two steels show that 100Cr6 requires to be austenitised at temperatures 10 °C higher than 100CrMnSi6-4, to achieve the same driving force for austenite formation, and 20 °C higher to achieve identical austenite stability upon quenching. The method can be adopted beyond bearing steels to design austenitisation processing schedules.

Keywords:
Microstructure design, Steel with spheroidal cementite, Austenitisation, Transformation kinetics, Austenite, hardness

1. Introduction

Upgrading steel properties relies directly on designing the microstructure of the material, which can be tailored via carefully designed heat treatments. For bearing steels which are subject to billions of stress cycles at contact pressures up to 3 GPa [1], obtaining superior hardness (> 653 HV [2]) is essential for secured fatigue life of bearing components.

Bearing steels are commonly made of 1C-1.5Cr wt.% steels with up to 10 types of alloying element additions [2, 3, 4]. After steel making and forming, the hypereutectoid steels are

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