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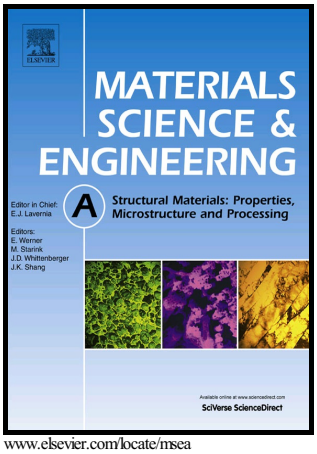

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Microstructural and mechanical properties of low-carbon ultra-fine bainitic steel produced by multi-step austempering process

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Abstract

The multi-step isothermal austempering heat treatment to achieve an ultra-fine bainitic microstructure and maximum volume fraction of bainite was conducted on a steel containing 0.26 wt.% carbon. The microstructural and crystallographic characteristics, as well as the mechanical properties and fracture behavior were studied. The results showed that the subsequent austempering heat treatment at a lower temperature, immediately after partial bainite formation at a higher temperature, would replace the coarse austenite/martensite areas with much refined bainite consisting nanoscale plates of bainitic ferrite and filmy austenite which ultimately leads to the refinement of the bainitic microstructure. This microstructural modification, in addition to the increased yield strength, causes a significant increase in the impact fracture toughness of the multi-step austempered steels. The EBSD analysis also showed that the subsequent austempering heat treatment at a lower temperature results in a finer structure of Bain groups and increase in the fraction of high angle grain boundaries leading to higher resistance against crack propagation and subsequently higher impact energy absorption.

Keywords

Bainite; Multi-step austempering; Mechanical properties; EBSD; SEM; XRD

1. Introduction

Nanostructured Low-temperature Bainitic Steels (NLBS) have been the subject of extensive research due to their excellent mechanical properties. High strength and improved ductility have made them an excellent alternative material for producing many high-performance products. Their exceptional combination of high strength and ductility is directly related to the unique microstructural characteristics which can be obtained by isothermal