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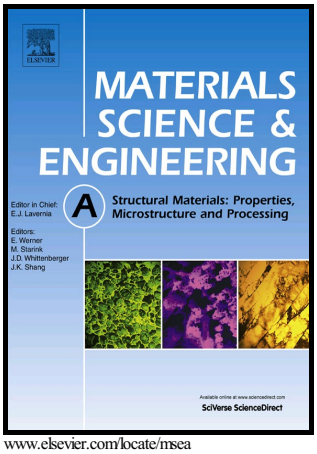

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Effect of bainitic transformation during BQ&P process on the mechanical properties in an ultrahigh strength Mn-Si-Cr-C steel

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Abstract

A medium carbon Mn-Si-Cr alloyed steel was treated by a novel bainite-based quenching and partitioning (BQ&P) process: after full austenization, the steel was firstly austempered at 300°C, 320°C, 340°C, 360°C and 380°C for 30min, and then quenched to 120°C, followed by partitioning at 360°C for 45min. The multiphase microstructures containing carbide-free bainite (CFB, bainitic ferrite lath plus filmy retained austenite), martensite and retained austenite were characterized by optical microscope, scanning electron microscopy, transmission electron microscopy, X-ray diffraction and dilatometer analysis. An optimum combination of strength and ductility was achieved in the BQ&P steel when the bainitic austempering temperature is 360°C (ultimate tensile strength: 1495MPa; uniform elongation and total elongation: 26.2% and 31.8%; the reduction of area: 47.9%). Besides the transformation-induced plasticity effect of the retained austenite and the composite effect of the multiphase after BQ&P treatment, the formation of carbide free bainite also plays a significant role on the enhanced mechanical properties. The carbide-free bainite could improve the damage resistance of the multiphase due to the additional strain-hardening capacity within the local plasticity deformation zone near the tip of micro-cracks. In this case, the fraction and distribution of CFB should be controlled properly and the macrosegregation should be avoided.

Keywords:

quenching and partitioning; bainite; retained austenite; ductility; micro-crack

1. Introduction

Due to the increasing demands for energy saving and cost reduction requirements, extensive effort has been placed on the development of a new generation of inexpensive advanced high-strength steels (AHSS) with excellent ductility [1]. Attaining an optimum balance of hard and