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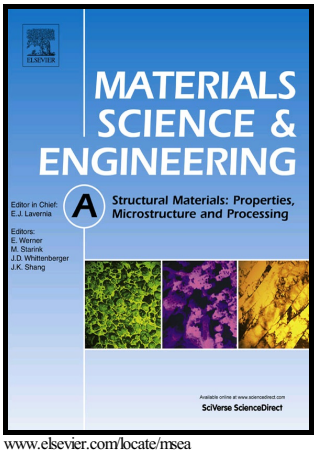

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Effect of heavy warm rolling on microstructures and mechanical properties of AISI 4140 steel

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Abstract

In this study, ultrafine structured AISI 4140 steels with ultrahigh strength, sufficient ductility and low yield ratio were obtained through warm rolling and subsequent quenching without tempering. The effect of warm rolling reduction ratio ranging from 60% to 90% on microstructures and mechanical properties of steels was investigated. It was clarified that the microstructures of steels were remarkably refined after heavy warm rolling. Ultrafine grained ferrite was formed because of dynamic ferrite transformation and dynamic recrystallization. Great enhancements in YS, UTS and microhardness after warm rolling were attributed to grain refinement and subsequent formation of martensite. The increasing ferrite and decreasing martensite contents contributed to the decrement of strength and increment of ductility in steels when the warm rolling reduction ratio increased. The WR (60%) steel exhibited the highest strength with YS and UTS of 1570 MPa and 2370 MPa respectively. And the WR (85%) steel exhibited an optimal balance of strength and ductility with YS, UTS and elongation of 1080 MPa, 2022 MPa and 7.9% respectively.

Keywords: ultrahigh strength; ultrafine grains; warm rolling; microstructure;

1. Introduction

Ultrafine grained steels with grain size around 1μm are attractive to many scientists due to their excellent mechanical properties[1-5]. In recent years, two main methods have been developed to produce ultrafine grained steels including severe plastic deformation (SPD)[6-8] and advanced thermomechanical processing[9-12]. By comparing with SPD processes, advanced thermomechanical processing methods