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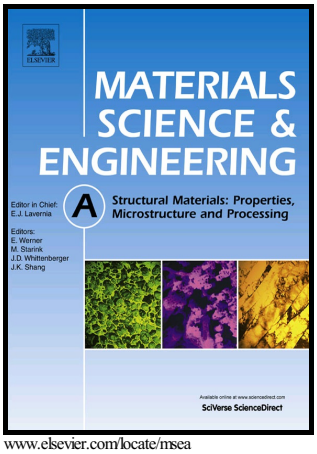

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PII: S0921-5093(18)30800-1
DOI: https://doi.org/10.1016/j.msea.2018.06.016
Reference: MSA36571

To appear in: *Materials Science & Engineering A*

Received date: 2 March 2018
Revised date: 2 June 2018
Accepted date: 4 June 2018

Cite this article as: C.J. Tang, C.J. Shang, S.L. Liu, H.L. Guan, R.D.K. Misra and Y.B. Chen, Effect of volume fraction of bainite on strain hardening behavior and deformation mechanism of F/B multi-phase steel, *Materials Science & Engineering A,* https://doi.org/10.1016/j.msea.2018.06.016

Effect of volume fraction of bainite on strain hardening behavior and deformation mechanism of F/B multi-phase steel

C.J. Tang [a,*], C.J. Shang[b,*], S.L. Liu[c], H.L. Guan[d], R.D.K. Misra[e], Y.B. Chen[a]

[a]Beijing National Innovation Institute of Lightweight Ltd., Beijing 100083, China
[b]Collaborative Innovation Center of Steel Technology, University of Science and Technology Beijing, Beijing 100083, China
[c]State Key Lab of Metal Matrix Composites, School of Materials Science and Engineering, Shanghai Jiao Tong University, Shanghai 200240, China
[d]Tangshan Zwell Technology Co.,Ltd., Zunhua 064200, China
[e]Laboratory for Excellence in Advanced Steel Research, Materials Science and Engineering Program, Department of Metallurgical, Materials and Biomedical Engineering, University of Texas at El Paso, 500W. University Avenue, El Paso, TX 79968, USA

Abstract

Five ferrite/bainite (F/B) multi-phase experimental steels with different volume fraction of bainite were processed by thermo-mechanical controlled processing (TMCP). The strain hardening behavior and deformation mechanism of F/B multi-phase steel were studied by modified C-J analysis, Hollomon analysis and numerical simulation method. The study indicates that the deformation mechanism in stage I and stage II are directly related to elastic-plastic deformation of ferrite and uniform strain (deformation) of ferrite and bainite, respectively. As the volume fraction of bainite increases, the deformation mechanism of ferrite and bainite changes from incoordinate deformation to coordinate deformation, which will cause the strain difference between ferrite and bainite being lessened gradually, as well as might be the reason for the transition from three-stage to two-stage in modified C-J analysis. The deformation mechanism was verified experimentally. Moreover, the effect of volume fraction of bainite on yield stress/tensile stress ratio (yield ratio), strain hardening exponent and uniform elongation were explained by the division and strain hardening capability of the stages in modified C-J analysis.

Keywords: F/B multi-phase steel, strain hardening behavior, volume fraction of bainite, modified C-J analysis, yield ratio, strain hardening exponent

***Corresponding author:** Tel: +86 15801547450, Fax: +86 10 62912638.

E-mail address: tangcunjiang@163.com(C.J. Tang); cjshang@163.com(C.J Shang)

1. Introduction

Pipeline transportation is considered as the most cost-effective, safe and eco-friendly approach to transport oil and natural gas [1].With ever-increasing demand for oil and natural gas, the oil and gas pipelines have been laid in hostile environments such as polar areas, ocean and geologically unstable regions. However, pipelines passing through tundra, seabed, seismic area, land subsidence and slide areas are most likely to experience high degree of plastic deformation, which can cause failure accidents through distortion, buckling and fracture [2, 3]. High deformability pipeline steel is a type of structural material suitable for areas with harsh geological conditions, which can minimize possible damage caused by ground movement. The pipeline steel should possess adequate strength and toughness as well as deformation and strain