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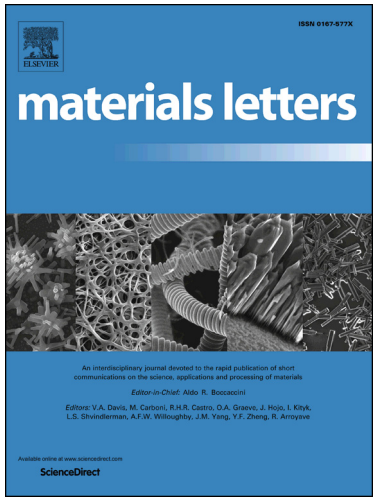

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Xiaohui Lu, Dongsheng Qian, Wei Li, Xuejun Jin

PII: S0167-577X(18)31386-7
DOI: https://doi.org/10.1016/j.matlet.2018.09.017
Reference: MLBLUE 24885

To appear in: *Materials Letters*

Received Date: 25 April 2018
Revised Date: 1 September 2018
Accepted Date: 3 September 2018

Please cite this article as: X. Lu, D. Qian, W. Li, X. Jin, Enhanced toughness of bearing steel by combining prior cold deformation with martensite pre-quenching and bainite transformation, *Materials Letters* (2018), doi: https://doi.org/10.1016/j.matlet.2018.09.017

Enhanced toughness of bearing steel by combining prior cold deformation with martensite pre-quenching and bainite transformation

Xiaohui Lu [a,b], Dongsheng Qian [c,*], Wei Li [b], Xuejun Jin [b,**]

a School of Automotive Engineering, Wuhan University of Technology, Wuhan, Hubei 430070, PR China
b School of Materials Science and Engineering, Shanghai Jiao Tong University, Shanghai 200240, PR China
c School of Materials Science and Engineering, Wuhan University of Technology, Wuhan, Hubei 430070, PR China

Abstract:

This work reasonably utilizes the decreasing of martensite start (Ms) temperature caused by prior cold deformation, combining martensite pre-quenching and bainite transformation to develop ultrafine martensite-bainite duplex microstructures for improves toughness of GCr15 bearing steel. Comparison with the conventional quenched and tempered (QT) specimen, the remarkable improvement of impact toughness (～87 J) and fracture toughness (～39 MPa·$m^{1/2}$) were achieved in 30% prior cold deformed specimen, while with a slight decrease in the hardness. The enhanced toughness was attributed to the nanometric martensite-bainite duplex microstructures and the formation of film-like retained austenite.

Keywords: Prior cold deformation; Martensite-Bainite; Toughness; GCr15 Bearing steel

1. Introduction

GCr15 bearing steel is the most commonly used material for ball and roller bearing applications [1, 2]. The microstructures, which obtained by conventional quenched and tempered (QT) treatment were consisted of tempered martensite, retained austenite and spherical carbides, were cannot afford extreme loading conditions, for example, shock loads. Thus, the enhanced toughness was demanded for further improve the reliability and fatigue performance of bearings [3, 4].

It is well known that the martensite-bainite duplex microstructures have better combination of strength-toughness than those with single martensite or bainite microstructure [5, 6]. Generally, GCr15 bearing steel was subjected to cold deformation before heat treatment with the aim of ring-forming for bearings, such as cold ring rolling or cold forging. Chakraborty *et al.* [7] reported that by combining prior cold deformation with austempering could further improve the impact toughness of GCr15 bearing steel due to the austenite grain refinement by the recrystallization of prior cold-deformed ferrite. However, Li *et al.* [8] demonstrated that just adopt martensite pre-quenching (below Ms temperature) and subsequent bainite