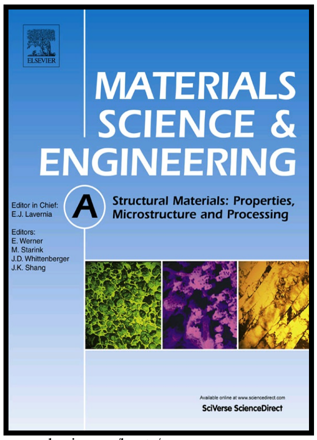

www.elsevier.com/locate/msea

Impact toughness of a 10% Cr steel with high boron and low nitrogen contents

R. Mishnev, N. Dudova, V. Dudko, R. Kaibyshev

PII: S0921-5093(18)30770-6
DOI: https://doi.org/10.1016/j.msea.2018.05.103
Reference: MSA36541

To appear in: *Materials Science & Engineering A*

Received date: 6 April 2018
Revised date: 23 May 2018
Accepted date: 26 May 2018

Cite this article as: R. Mishnev, N. Dudova, V. Dudko and R. Kaibyshev, Impact toughness of a 10% Cr steel with high boron and low nitrogen contents, *Materials Science & Engineering A,* https://doi.org/10.1016/j.msea.2018.05.103

Impact toughness of a 10% Cr steel with high boron and low nitrogen contents

R. Mishnev[a], N. Dudova[*], V. Dudko, R. Kaibyshev

Belgorod State University, Pobeda 85, Belgorod, 308015, Russia

*Corresponding author. *E-mail address*: dudova@bsu.edu.ru (N. Dudova)

Abstract

The effect of temperature on the impact toughness and fracture behavior of a 10% Cr-2% W-0.7% Mo-3% Co-0.05% Nb-0.2% V-0.008% B-0.003% N (all in wt%) steel was studied. The ductile-brittle transition (DBT) occurs at 10°C. At the DBT temperature (DBTT), the onset of unstable crack propagation occurs at the maximum load. The embrittlement is attributed to the onset of unstable crack propagation at stresses below the general yielding. A decrease in nitrogen content and an increase in boron content lead to the formation of chains of closely spaced $M_{23}C_6$ carbides at lath boundaries. The formation of numerous voids at carbide-matrix boundaries results in the appearance of crack with critical dimension after stable crack propagation over a very short distance. As a result, the energy of the stable crack propagation is low and the embrittlement takes place at relatively high temperature.

Keywords: Fracture; Brittle-to-ductile transition; Charpy impact test; Martensitic steel; Fractography.

1. Introduction

Heat-resistant high-chromium martensitic steels are widely used in various critical components of fossil power plants due to their superior creep resistance and high-temperature strength [1,2]. High fracture toughness is an important property to assure the reliability of steam turbine parts produced from these steels [1]. The 9% Cr steels with ~0.1 wt% C and ~0.05 wt% N exhibit a high toughness ≥ 200 J/cm^2 at room temperature [3-10]. The ductile-brittle transition temperatures (DBTTs), which are estimated on the basis of 68 J criterion or the V-notch impact