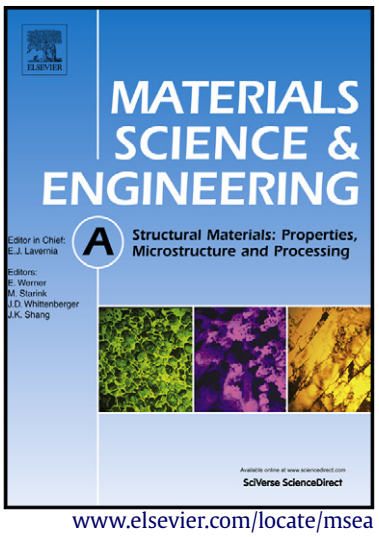

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Effect of microstructure on hydrogen diffusion and notch tensile strength of large steel forging

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Abstract: Microstructure, hydrogen diffusion coefficient and notch tensile strength (NTS) in two different parts (1/2 radius and 3/4 radius) of a large steel forging have been investigated by means of microscopy, thermal desorption spectrometry (TDS), and slow strain rate tensile tests (SSRT), respectively. The microstructure in the 1/2R part is granular pearlite while that in the 3/4R part is composed of granular pearlite and bainite with many fine $M_{23}C_6$ carbides. Results of TDS analysis indicate that hydrogen content in the 3/4R part is much higher than in the 1/2R part, corresponding to a hydrogen diffusion coefficient about one order lower. SSRT results showed that although NTS decreased with the increase of hydrogen content in both parts, the 3/4R part showed a higher NTS at the same H content. The higher H content, lower H diffusion coefficient and higher NTS in the 3/4R part can be attributed to the fine $M_{23}C_6$ carbides which can act as hydrogen trapping sites.

Key words: large forging; hydrogen embrittlement; hydrogen diffusion coefficient; SSRT; TDS

1. Introduction

Large steel forgings are widely used for engineering components which require high strength and good toughness as well as large size. While hydrogen in large forgings may influence their properties, leading to failures such as hydrogen induced delayed cracking, hydrogen in large steel forgings has been paid much attention to[1]. However, it is not easy to understand H in large steel forgings since it is not evenly distributed and sometime too low to be accurately measured. Recently, thermal desorption spectrometry (TDS) method has been used as an effective means to study the hydrogen behavior in steel since the accuracy of TDS measurement of hydrogen is as accurate as 0.01 ppm [2]. Quantitative relationship between hydrogen content and the notch tensile strength has been obtained for high strength steels through by TDS and slow strain rate tensile tests (SSRT) [3-7]. Since large steel forgings may have inhomogeneous microstructure in different parts across section, the effect of microstructure on H content, H diffusion, and notch tensile strength has not been fully clarified [8-9]. In this paper, it is aimed to investigate H content, H diffusion behavior, and H effect on NTS in two different parts (1/2 radius and 3/4 radius) of a large steel forging by means of TDS and SSRT.

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