Hydrogen absorption behavior in Quenching and Partitioning treated low-carbon martensitic stainless steel

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1. Introduction

Martensitic stainless steels are used as machine structural applications because of their higher strength, superior wear-resistance and corrosion-resistance. Authors have recently attempted to apply the Quenching and Partitioning (Q&P) treatment to a conventional martensitic stainless steel in order to improve its mechanical property. As a result of Q&P treatment for martensitic stainless steel, a large amount of retained austenite was obtained, and the strength-ductility balance was markedly improved by the transformation induced plasticity (TRIP) effect owing to the retained austenite [*]. However, the effect of hydrogen on the mechanical properties of this steel has never been investigated. The aim of the present study is to investigate the hydrogen absorption behavior and existing state in Q&P treated martensitic stainless steel and the effect of retained austenite on them was discussed.

2. Experimental procedure

A low-carbon 12Cr martensitic stainless steel was used in this study. The material was held at 1273K for 1.8ks and then quenched to 513K which is between Ms and Mf temperature. Subsequently, the specimens were reheated and held at 723K for 0.6ks, followed by water-cooling to room temperature. Microstructures were examined by SEM/EBSD and TEM. Hydrogen was introduced into the specimens by electrochemical charging in a 3%NaCl aqueous solution containing 3g/L of NH_4SCN at a current density of 10A/m^2. The hydrogen desorption was measured by a thermal desorption analysis (TDA) from room temperature to 773K.

3. Results and discussion

Fig.1 shows the orientation imaging maps of the Q&P treated specimens (Q&P steel). It is found that fine retained austenite grains are homogeneously dispersed in the martensitic structure mainly at lath boundaries. The width of them is roughly 1.5μm or less. The volume fraction of retained austenite was estimated to be 14vol.% by saturation-magnetization measurement. **Fig.2** shows hydrogen desorption rate curves of Q&P steel. For comparison, the data of conventional quenched and tempered specimens (QT steel) is also included in the same figure. It is revealed that the hydrogen desorption peak temperature (T_C) are less than 473K in both steels, suggesting they are due to the release of hydrogen from reversible trap sites. However, Q&P steel has a significantly higher peak temperature compared with QT steel. In addition, the amount of hydrogen contents is about six times larger in the Q&P steel (36.6mass ppm) than in the QT steel (5.59mass ppm). This result suggests that retained austenite significantly increases the amount of hydrogen storage into the 12Cr martensitic stainless steel.

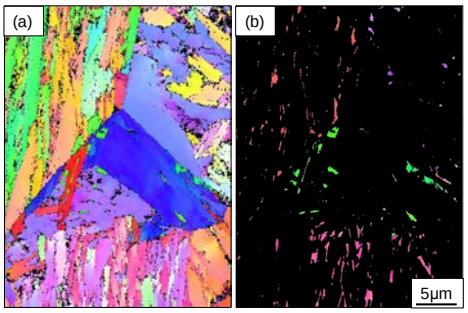

Fig. 1 Orientation imaging maps of 12Cr martensite steel with 723K-0.6ks partitioning treatment. Martensite and retained austenite are simultaneously shown in (a), while only retained austenite is shown in (b).

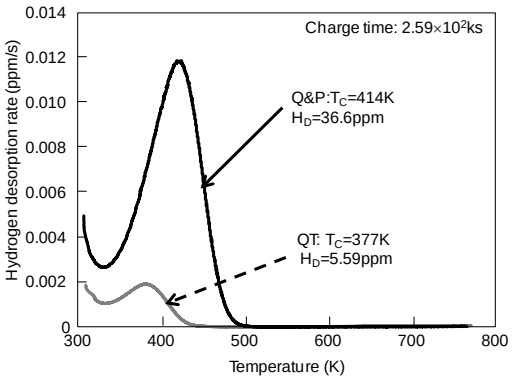

Fig. 2 Hydrogen desorption rate curves of hydrogen-charged Q&P and QT treated 12Cr steels.

[*]T. Tsuchiyama, J. Tobata, T. Tao, N. Nakada, S. Takaki, Mater. Sci. Eng. A, 532 (2012), 585.