Wear resistance of a novel high silicon carbide-free bainitic steel - WTC 2022, Lyon

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In this work, wear performances of a novel high silicon carbide-free bainitic steel and the effect of microstructural modifications on its tribological behavior were evaluated. Ball-on-disc wear tests were carried out on samples austenitized at 900 °C for 5 min and austempered at 250, 300 and 350 °C in salt baths. Specimens austempered at the lowest temperature exhibited the best tribological performances, thanks to their finest microstructure, high hardening capability of retained austenite and transformation induced plasticity (TRIP) effect. All specimens also showed a reduction of the total amount of the retained austenite in the range of 10-31 % and a significant hardness increase.

Keywords: Carbide-free bainite steel, retained austenite, wear, TRIP

1. Introduction

Carbide-free bainitic steels represent one of the most interesting candidates for several industrial applications thanks to their exceptional combination of strength, toughness and ductility. Their microstructure consists of bainitic ferrite and carbon enriched austenite. Silicon is then added to both suppress carbide precipitation and avoid depletion of mechanical properties. Several studies report the great performances of these steels also when high wear resistance is required. It has been found [1,2] that, thanks to the ultrafine microstructure and higher hardness, carbide-free bainitic steels show better friction and fatigue resistance than quenched and tempered steels.

2. Methods

The investigated material is a 0.38C-2.6Mn-3.2-0.1Al carbide-free bainitic steel. Specimens for wear tests consisted of discs 45 mm in diameter and 5 mm in thickness, austenitized at 900 °C for 5 min and austempered at 250, 300, 350 °C, in salt baths, until completion of bainitic transformation. Specimens in the annealed condition were used as a standard. A 100Cr6 steel ball 6 mm in diameter was used as counter-body material. Wear tests parameters are listed in Table 1. The microstructure characterization was carried out by scanning electron microscopy (SEM), X-ray diffractometry, Vickers microhardness before and after wear tests. The friction coefficient was provided directly by the equipment, whereas the wear rate of the carbide-free bainitic steel was evaluated by measuring the cross-section area of the wear track with a non-contact 3D profilometer. The obtained results are the average value of three tests.

Table 1: Wear tests parameters

Load [N]	20
Sliding distance [m]	2000
Track diameter [mm]	36
Rotational speed [m/s]	0.3

2.1. Results

An overview of the results obtained in this work is shown in Figure 1.

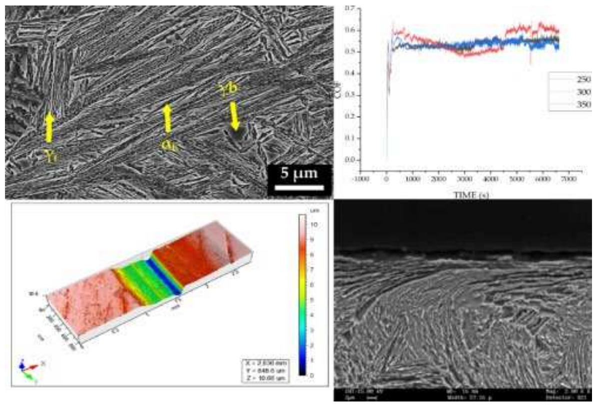

Figure 1: Microstructure before and after wear tests, friction coefficient variations with sliding distance, 3D isometric view of the wear track.

3. Discussion

Comparing the samples in all heat treatment conditions, those austempered at 250 °C showed the finest microstructure and the best tribological performances thanks to the highest hardening capability of the retained austenite and strain-induced martensitic transformation. In addition, the retained austenite content was a crucial factor in determining the wear resistance of the samples austempered at the lowest temperature. Mild-oxidational wear was identified as the main wear mechanism. During the sliding motion, fragmentation of the tribofilm caused abrasion of the wear tracks.

4. References

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