High-temperature tribological behavior of sintered B-containing 316L steel

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This work studies the tribological behavior of the 316L austenitic stainless steels alloyed with 0.6 wt% and 0.8 wt% boron produced by conventional powder metallurgy (P/M). The friction and wear behavior of the sintered materials was investigated using dry reciprocating sliding wear tests at room temperature and at 350 °C. The increase in test temperature decreased the friction coefficient regardless boron content. Sample with a lower boron content exhibited an improved wear resistance at high-temperature sliding conditions. The occurrence of adhesive and oxidative wear is related to the enhanced tribological behavior of the materials at high temperature.

Keywords (from 3 to 5 max): sintered stainless steel, boron, wear, friction, high-temperature sliding test.

1. Introduction

Austenitic stainless steels (ASS) are widely used in several industries due to their high corrosion and oxidation resistance. However, these materials exhibit high levels of wear and friction in tribological applications. Boron addition has been proved that enhances the tribological properties at room temperature of ASS produced by P/M. The improved tribological behavior correlates with the formation of hard eutectic borides and with the increased densification and hardness of these materials [1]. Some ASS applications demand high-temperatures wear resistance, which is an open room for additional research. This study evaluates the friction and wear properties of boron-containing ASS, under high-temperature reciprocating sliding conditions.

2. Methods

Sintered 0.6 wt% and 0.8 wt% boron-containing 316L austenitic stainless steels were prepared by conventional P/M. Powder mixtures were sintered for 30 min at 1340 °C in vacuum. The tribological behavior of the sintered materials was investigated using reciprocating sliding tests under dry conditions. The wear tests were carried out using a ball-on-plate configuration with a normal load of 8 N applied over an alumina ball (counterbody). A06-RT and A08-RT, containing 0.6 and 0.8 wt.% B, respectively, were tested at room temperature while A06-HT and A08-HT samples were tested at 350 °C. The average friction coefficient (μ) was calculated from the normal and tangential loads signals obtained at an acquisition rate of 70 Hz. The specific wear rate (*k*) and the roughness *Ra* and *Rq* of the wear tracks were determined by 3D optical microscopy. The wear mechanisms were evaluated with the aid of field emission scanning electron microscopy (FESEM) and energy dispersive X-ray spectroscopy (EDS).

2.1. Results

Table 1 presents μ, *k*, *Ra,* and *Rq* values of the worn samples. Figure 1 shows a FESEM image and the elemental chemical composition (EDS) of a specif region of the worn surface.

Table 1: Tribological responses of sintered materials and roughness parameters of wear tracks.

Sample	μ	*k* (10^{-4} mm³/Nm)	*Ra* (μm)	*Rq* (μm)
A06-RT	0.80 ± 0.06	1.49 ± 0.00	8.25	9.69
A06-HT	0.66 ± 0.02	0.97 ± 0.05	3.82	4.92
A08-RT	0.76 ± 0.07	0.57 ± 0.11	3.19	3.98
A08-HT	0.64 ± 0.01	0.58 ± 0.08	3.21	3.97

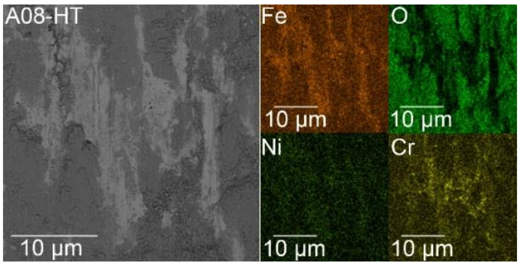

Figure 1: FESEM and EDS of worn surface. A08-HT

3. Discussion

The friction coefficient did not change with B addition but decreased when reciprocating sliding tests were conducted at 350°C. The lower μ obtained in high-temperature tests can be related to the oxide nature observed on the worn surfaces [2]. In contracts, the specific wear rate (*k*) decreased with the increase in boron content. The lower plasticity index and the higher dynamic hardness can explain the enhanced wear resistance of the samples with the highest amount of B [1]. Sample with 0.6 wt% B showed a decrease in *k* probably because the glaze iron oxide hindered further wear [2]. Adhesive transfer and mild oxidation wear mechanisms were observed for the tested materials. Higher *Ra* and *Rq* roughness indicate more severe material removal by wear.

4. References

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