TRIBOLOGICAL STUDY OF THE BEHAVIOR OF THE BORIDE LAYERS OBTAINED ON BIOMEDICAL GRADE 316L STEEL

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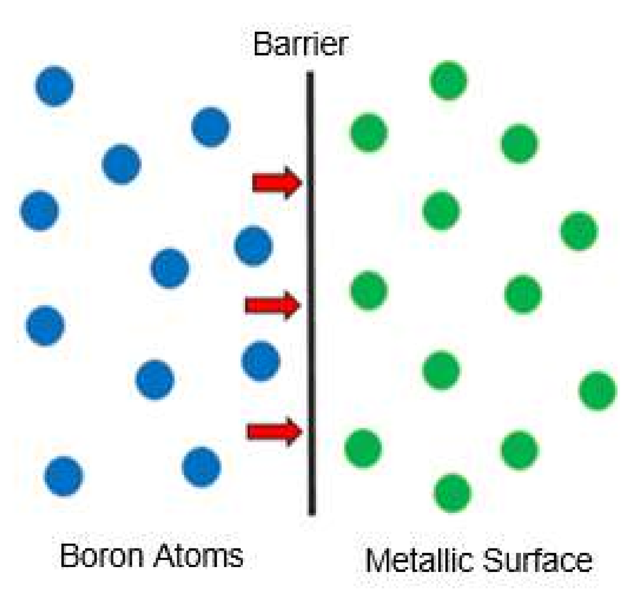
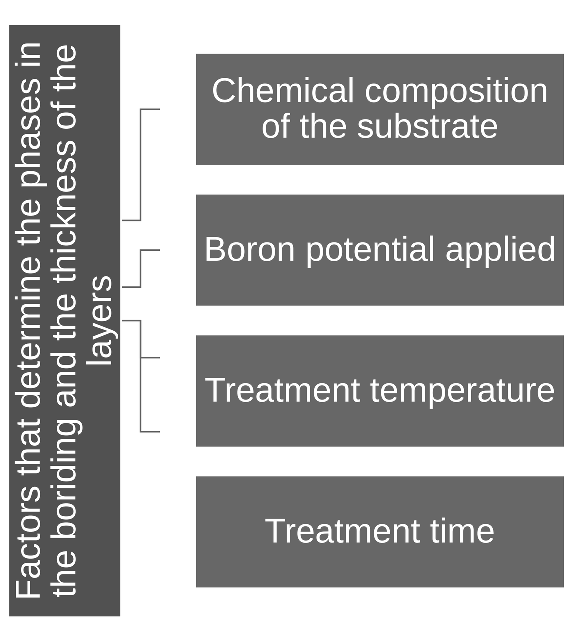
Abstract

This study evaluates the tribological behavior of boride layers deposited on samples of biomedical grade 316L stainless steel to determine their coefficient of friction and resistance to wear. The samples were exposed to the boriding treatment for 2, 4 and 6 hours at a temperature of 950 ° C. A tungsten carbide (WC) ball was used for tribological tests against 316L steel; loads of 1, 5 and 10 N were applied to the samples. The results showed that the coefficient of friction of the borided specimens decreased considerably, in most cases, with respect to the 316L steel without boring, as well as a relationship between the treatment time and the friction coefficient. The results also revealed a lower appearance of wear mechanisms in the borided specimens, as well as a decrease in the width of the test track in these.

INTRODUCTION

Boriding is a thermochemical atomic diffusion treatment that generates a coating with a surface layer on metals, where boron diffuses and combines with the substrate, boron being very soluble in metals with small atomic numbers. This treatment has the characteristic of improving the mechanical properties of the materials, in terms of their resistance to wear and corrosion, significantly increasing the surface hardness.





METHODOLOGY

Table 1 "Experimental conditions"

Sample number	Characteristic
1	316L steel untreated
2	316L steel borided for 2 hours at 950 ° C
3	316L steel borided for 4 hours at 950 ° C
4	316L steel borided for 6 hours at 950 ° C

Fig. 1 Thermochemical Treatment

Conditions for "Pin-On-Disc" test

- *Temperature: 16-17 °C*
- *Relative Humidity: 71%*
- *Radius of application: 5,6 and 7 cm*
- *Applied loads: 1.5 and 10 N*
- *Linear speed of the disc: 0.13 m / s*
- *Distance traveled: 100 m*

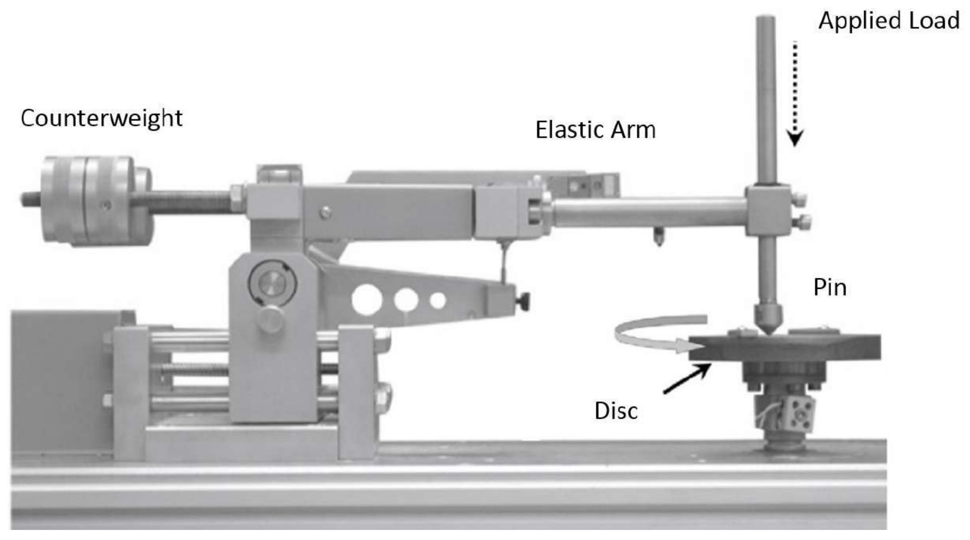


Fig. 2 "Pin-On-Disc" test equipment (McKeen, L. W., 2016)

RESULTS AND DISCUSSION

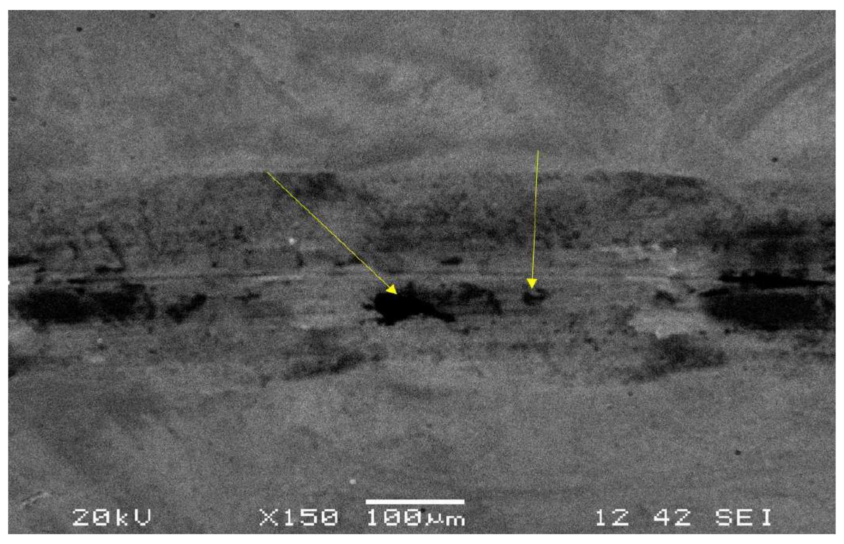


Fig. 3 SEM image for the 5N test for sample 1

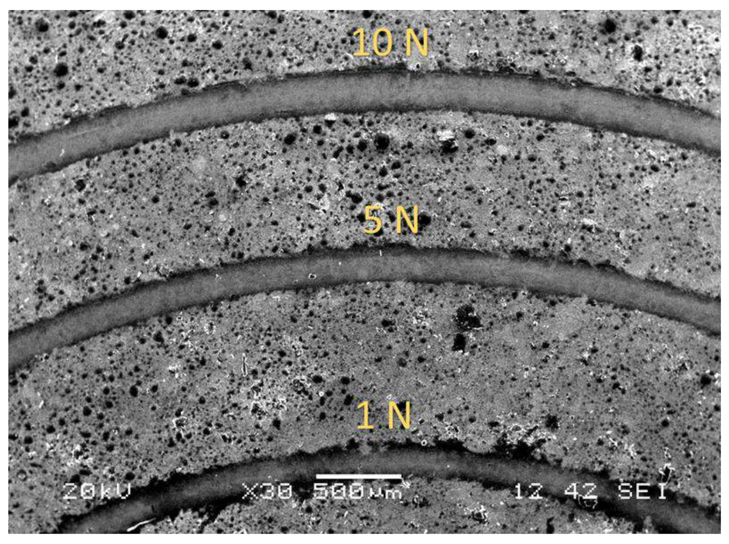


Fig. 5 SEM image of the Pin-On-Disc tests for 1N, 5N and 10N of sample 2

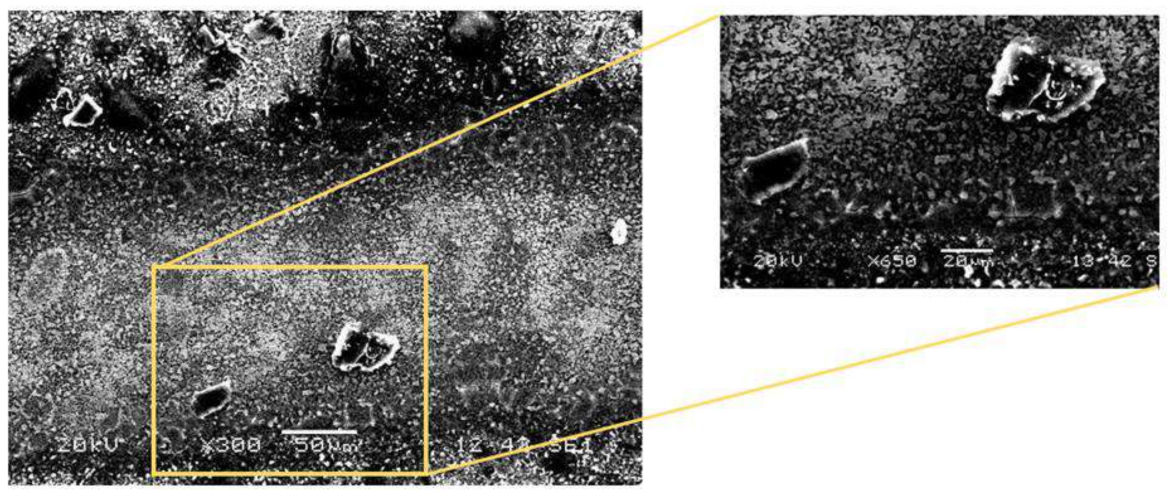


Fig. 7 SEM image of sample # 2 for a 10N load

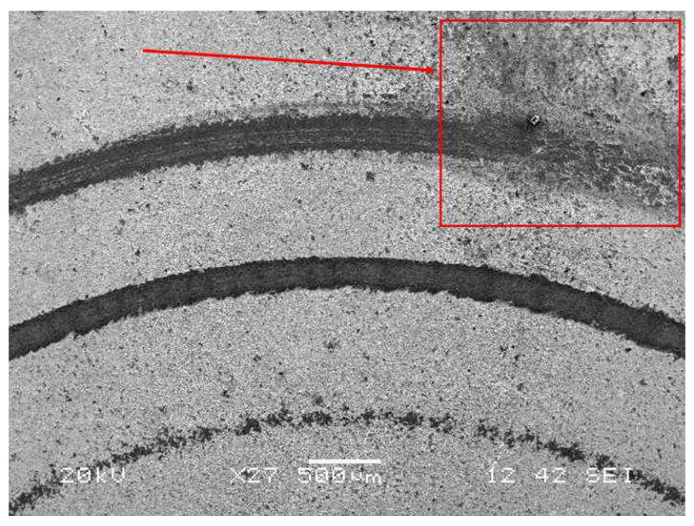


Fig. 9 SEM images of sample # 4 (the red box shows the wear of the surface)

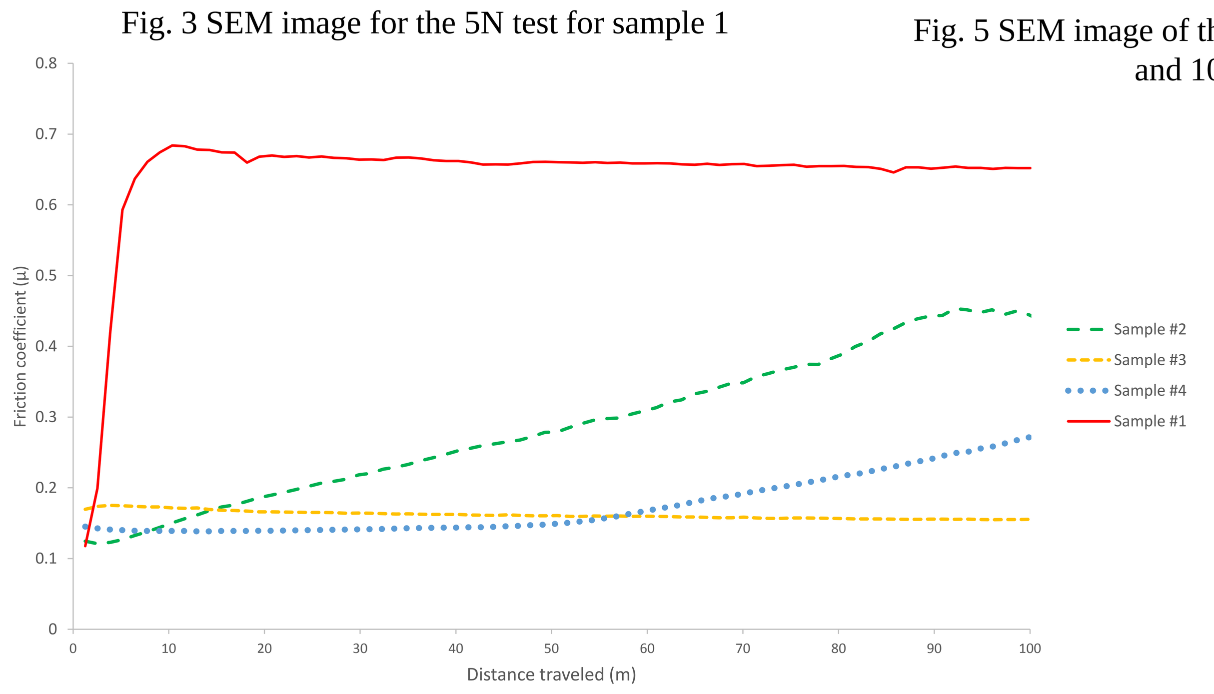


Fig. 4. Coefficient of friction vs Distance traveled of the 4 samples for the 1N load

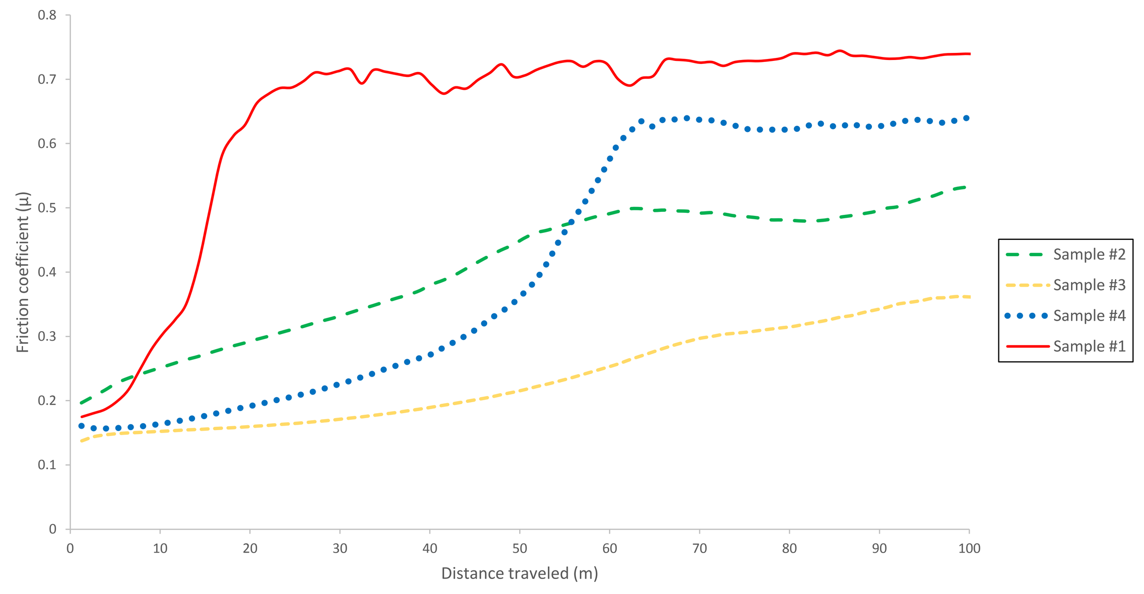


Fig. 6. Coefficient of friction vs Distance traveled of the 4 samples for the 5N load

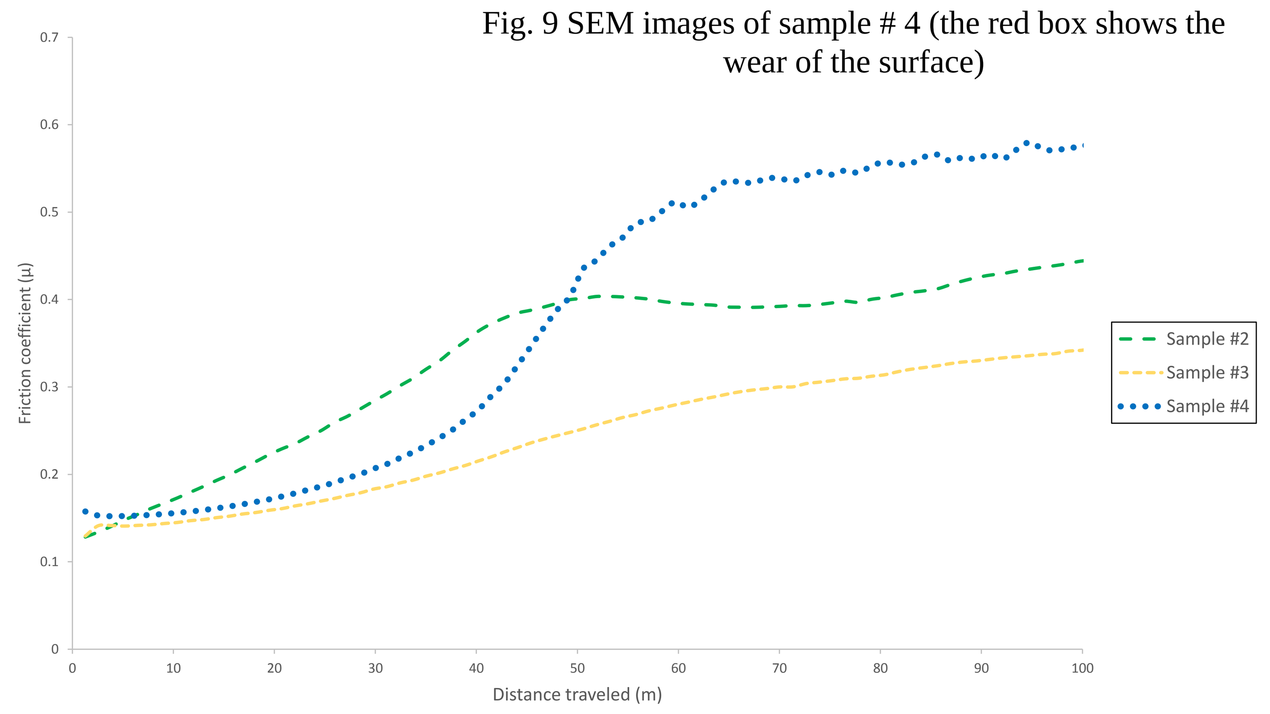


Fig. 8. Coefficient of friction vs Distance traveled of the 4 samples for the 10N load

ACKNOWLEDGMENT

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CONCLUSIONS

The boriding treatment is effective in reducing the coefficient of friction of the surfaces of 316L steel, since it is possible to reduce the coefficients of friction from approximately 0.65 to values below 0.3 in some cases. The treatment time turned out to be a significant factor for the reduction of the friction coefficient for the cases of 2 hours and 4 hours, however for the time of 6 hours the friction coefficient seems to begin to increase its value, suggesting that before such a high time reduces the functionality of the embroidered layer. The wear mechanisms in the borided specimens are not expressed in the same way as in the non-borided specimen, however a certain level of wear is still present.