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Influence of the ball material on microabrasion-corrosion

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This work aims to evaluate the influence of the ball material on microabrasion-corrosion of AISI 304 stainless steel. Three different balls were used being: one ceramic (Si_3N_4) and two thermoplastic polymers, polypropylene (PP) and polyacetal (POM). Tests with Si_3N_4 balls resulted in a lower wear rate and friction coefficient when compared to PP and POM polymeric balls. By evaluating the minimum passivation current density, it was evidenced that the removal of the passive layer and the formation of a $FeSO_4$ film were less effective in the tests using ceramic counter-bodies.

Keywords: microabrasion-corrosion, abrasive wear, friction, potentiodynamic polarization.

1. Introduction

Under abrasion-corrosion, plastic deformation on the surfaces in contact influences the mechanical failure due to wear and leads to the exposure of the metal, making it highly reactive and, therefore, accelerating corrosion [1]. In this context, it can be thought that the characteristics of the body and counter-body pair may influence the development of the wear crater and the passive layer in microabrasion-corrosion tests [2]. The present work aims to contribute to understanding the influence of the counter-body (ball) material on simultaneous abrasion and corrosion investigated via microabrasion-corrosion tests.

2. Methods

The tests were performed in a fixed-ball microabrasion-corrosion test rig attached to a BioLogic® SP150 potentiostat. Three different balls were used: one ceramic (Si_3N_4) and two thermoplastic polymers (PP and POM). Sanded (# 600 sandpaper) AISI 304 ((Sa = 0.254 μm) stainless steel specimens were used. Abrasive SiO_2 particles were used at a 10% concentration in an electrolytic solution of 1N H_2SO_4 in distilled water and a flow rate of 1.7 ml/min. The applied normal load varied between 0.85 and 1.02 N. Potentiodynamic polarization curves were established with a potential increase rate of 0.85 mV/s and a duration of 30 min for each test battery. Three test batteries were made for each ball, and each test was done on the same abrasive drag track, resulting in 90 min accumulated test time in the same abrasive drag track. The wear coefficients (k) were calculated by measuring the generated crater, and changes in the friction coefficient were monitored throughout the test. For the analysis of the worn surfaces, scanning electron microscopy (SEM) and X-ray energy dispersion spectroscopy (EDS) were employed.

3. Results and Discussion

The tests made with Si_3N_4 ceramic counter-bodies showed a lower wear rate (Figure 1-a) and friction coefficient (Figure 1-b) compared to polymeric PP and POM counter-bodies. It was evidenced, through the analysis of the minimum passivation current density, Fig. 2, that the removal of the passive layer and the $FeSO_4$ film is less effective in the tests with ceramic counter-bodies, being more effective the protection and lubrication effect of the $FeSO_4$ film that collaborates to reduce the friction coefficient.

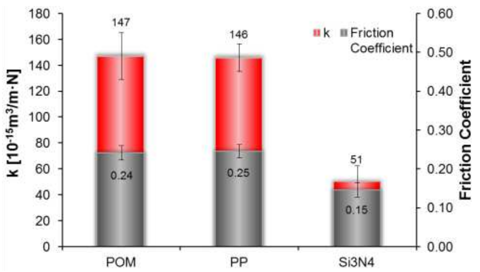

Figure 1: Influence of counter-body material in: (a) average wear rate (k), and (b) friction coefficient.

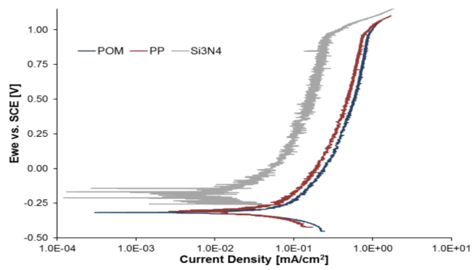

Figure 2: Typical polarization curves for abrasion-corrosion tests for AISI 304 stainless steel using different counter-bodies (PP, POM, and Si_3N_4).

4. References

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