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Tolerant and catastrophic adhesion evaluation by ASTM G-98 galling resistance test of stainless steels with and without surface treatments

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Galling threshold of stainless steels such as 316L, AISI630, AISI660 and Nitronic60, in the presence or not of thermomechanical treatments has been measured with ASTM G-98. In addition of basic material transfer criteria at the initial phase, "tolerant galling", and "catastrophic galling" are introduced to distinguish different evolution ways to final phase of adhesion. Microstructure and geometrical analysis using Scanning Electron Microscope (SEM), Electron Back Scattering Diffraction (EBSD) and 3D profilometry show correlations between galling level and near surface microstructure evolution.

Keywords : Stainless steel, adhesion, galling threshold, tolerant and catastrophic adhesion

1. Introduction

To have reliable data on adhesion resistance of metal pairs, pin-on-plate ASTM G-98 galling test is commonly used by industries due to the abundance of data in the literature and simplicity of the determination of resulting galling threshold. But the galling threshold defined by material transfer is not sufficient to determine galling severity, *i.e.* distinguish cases where movement can be continued for many cycles to case where two pieces are cold welded. It is therefore interesting to look for other criteria to complete the galling threshold and understand mechanisms of various forms of galling.

2. Methods

Galling test were carried out with pin on plate test bench according to the ASTM G-98 standard (pin of D 12.7 mm on plate under maximal pressure of 350MPa). Austenitic stainless steels such as 316L and Nitronic60,precipitation hardened AISI660 and precipitation hardened martensitic stainless steel AISI630 with and without thermomechanical treatment were tested under different pressure. Friction torque and acoustic emission were measured during the test. Close surface microstructure of specimen after test were observed by means of Scanning Electronic Microscope, Electron Back Scattering Diffraction (EBSD) and 3D profilometry in order to study wear mechanisms of different friction pairs.

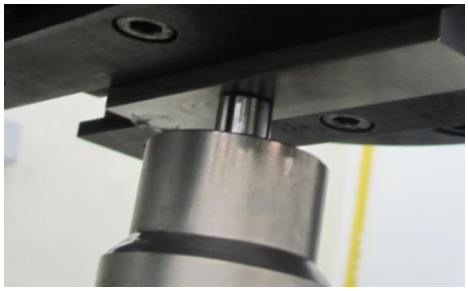

Figure 1: Pin on plate galling test bench .

3. Results

The resulting pins indicate that galling resistance can first be defined by pressure threshold where first material transfer is observed. However, detail analysis show some friction pair have " tolerant galling behavior" with less quantity of material transfer, less friction energy and less acoustic emission activities, like 316L/Nitronic, compared with "catastrophic galling" such as 316L/AISI630 with a scratch-like wear and high amount of localized material transfer.

EBSD analysis show that the degradation of the microstructure is significantly lower for "tolerant galling" like Nitronic60 as compared to "catastrophic galling" such as 316L or AISI630.

Application of S^3P surface treatment like Kolsterising ® could turn catastrophic galling into tolerant galling under certain circumstances, e.g. treated AISI630.

4. Discussions

ASTM G-98 galling test method could be improved to explore potentiality of many stainless steels for bearing sealing applications . In addition of pressure threshold by surface transfer observation, other test parameters like friction energy, acoustic emission activities and intragranular misorientation of microstructure.

5. References

[1] Lesage et al., "Galling categories investigations in stainless steel" WEAR, in press.