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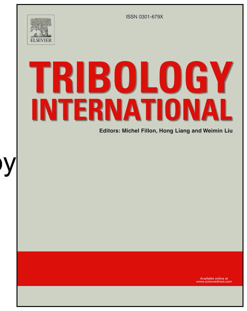

A tribo-oxidation abrasive wear model to quantify the wear rate of a cobalt-based alloy subjected to fretting in low-to-medium temperature conditions

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A tribo-oxidation abrasive wear model to quantify the wear rate of a cobalt-based alloy subjected to fretting in low-to-medium temperature conditions

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Abstract

Wear mechanisms of cobalt-based alloys are commonly known to be dependent on temperature: above a glaze layer transition temperature, wear rates are very low and a compacted oxidized compliant debris layer is spontaneously created in the contact. The present study focuses on the high wear rate mechanism occurring below this transition temperature of a HS25/alumina contact subjected to gross-slip fretting. The investigation shows that the wear volume is proportional to the product of the Archard's work multiplied by the oxide thickness generated between each fretting sliding pass. A simple tribo-oxidation wear model was developed and a very good correlation was observed with experiments as long as the compaction of debris layer leading to a glaze layer structure was not activated.

Keywords

fretting; oxidative wear; abrasive wear; wear transition

1. Introduction

Cobalt-based alloys (Stellite, Haynes) are commonly used in industry for their good mechanical properties and resistance to corrosion [1]. The Haynes alloy contains a Cr-Ni-W-C solid solution embedded in a cobalt matrix where chromium provides strength and corrosion resistance by creating carbides and a thick protective layer of chromium oxides Cr_2O_3 [2]. The presence of tungsten promotes additional hardening due to solid solution and the formation of carbides which enhance corrosion resistance by its "non-oxidation condition" [2]. Finally, the addition of nickel ensures that the alloy has a good ductility. Microstructure and phase transformations also have an important role on resistance to sliding wear. First, the presence of hard phases in the cobalt matrix promotes high-temperature resistance[2,3]. Second, Co-based alloys exhibit a phase transformation from FCC to HCP down to a depth of several micrometers below the surface [4], which is promoted by