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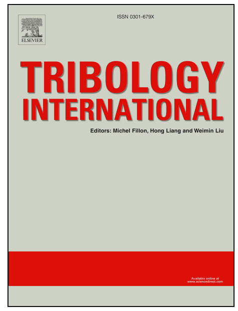

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Comparison of fretting behaviour of electrodeposited Zn-Ni and Cd coatings

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Abstract

Zn-Ni is a primary replacement candidate for cadmium in the aerospace industry. However, tribological behaviours of these coatings are not well understood, despite the importance in their applications. This study compares the fretting behaviour of Zn-Ni and cadmium coatings, a hard and a soft coating. As the mechanical properties are different, coatings were compared under similar contact stresses and normal loads. Under similar contact stresses, Zn-Ni wore severely due to gross slip in the contact at high displacement amplitude. For cadmium, wear occurred through ejection of the coating from the contact, which became more severe when the displacement amplitude increased. Under similar normal loads, Zn-Ni remained in the stick regime and there was minor wear in the contact.

Keywords: Fretting; Wear Mechanisms; Stick-slip; Coatings

1. Introduction

Zn-Ni was developed in the 1980's to replace cadmium as a corrosion protective coating in the automotive industry due to the carcinogenic and toxic nature of cadmium [1-7]. There is an increasing interest for Zn-Ni coatings in the aerospace industry due to more stringent requirements for cadmium. In the aerospace industry, cadmium is mainly used for the corrosion protection of steel, such as for fasteners and landing gear components. Fretting, due to small oscillatory motions, such as vibration is an issue in these applications.

Fretting occurs when there are small oscillatory motions that have amplitudes smaller than the contact radius. In practice, the displacement amplitude does not equal to the actual displacement since the motion can be partially accommodated by elastic deformation of the test equipment or the bulk of the sample [8]. Fretting is separated into three different regimes (stick or partial slip regime, mixed slip regime, and gross slip regime) depending on the combination of the contact conditions (stick, partial slip, and gross slip) [9-11]. Changing the displacement amplitude changes the contact conditions [9-11]. In terms of contact conditions, sticking occurs when there is no actual displacement in the contact and is characterized by very limited surface damage [9, 11]. Partial slip occurs when there is a region in the contact where the surfaces are stuck together, usually in the center of the contact, and a region in the contact where sliding occurs, usually in the annular region [9, 10]. Gross slip occurs when the entire contact is slipping and is characterized by severe surface damage through wear [9-11]. In terms of fretting regime, in the stick or partial slip regime, stick or partial slip contact conditions prevail throughout the test. In the gross slip regime, gross slip occurs in the contact throughout the test. Mixed slip regime occurs when a combination of the stick/partial slip and gross slip contact conditions occur over the contact's life [9, 10]. Another method of distinguishing these regimes is through dynamic force versus displacement analysis, such as fretting loops or hysteresis loops [9-11]. Generally, a closed loop indicates stick behaviour, a partially open or elliptical loop indicates partial slip and