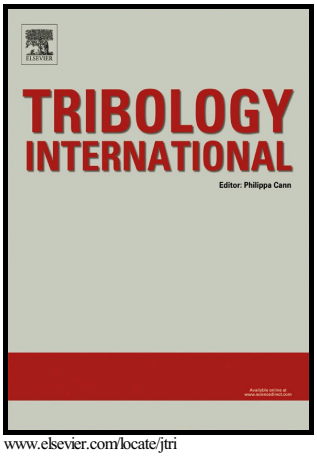

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Mechanical Characterization and Single Asperity Scratch Behaviour of Dry Zinc and Manganese Phosphate Coatings

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Abstract

The goal of this study is to characterise the mechanical properties of zinc and manganese phosphate coatings before and after running in. The characterisation is done with nano-indentation to determine the individual crystal hardness and single asperity scratch tests to investigate the deformation behaviour at the single asperity level. The nano-indentation and scratch tests reveal brittle deformation behaviour for the as received coatings. Under uni-directional sliding both layers reduce to a powder which is subsequently compacted to a so called glaze layer. The smooth and brittle glaze layer has a higher hardness compared to the as received coating and its properties can be satisfactorily described by models normally used for a hard coating on a soft substrate.

Keywords: mechanical characterisation, phosphate conversion coatings, scratch test, nano-indentation
2016 MSC: 00-01, 99-00

1. Introduction

Phosphate conversion coatings are often used to facilitate the running-in phase of machine elements [1]. In the oil and gas industry these coatings are, amongst others, used as corrosion protection [2–5] of casing connections during storage. An added benefit of the coatings is the improved galling resistance in the assembly phase [6].

The casing connections contain a metal-to-metal seal to ensure pressure integrity of the created conduit after installation. The sealing performance of metal-to-metal seals has been shown to be determined by the surface texture and changes thereof [7–10]. Phosphate coatings, therefore, play an important role in the seal ability of the casing connections.

Typically zinc and manganese coatings consist of respectively hopeite [11] and hureaulite [12] crystals. The crystal hardness is reported by [13] to be 3.2 and 5 on the Mohs scale. Others

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