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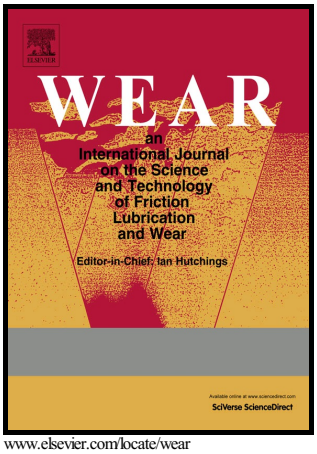

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Friction of rough surfaces on ice: experiments and modeling

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Abstract

Over a century of scientific research on the sliding friction of ice has not been enough to develop an exhaustive explanation for the tribological behavior of frozen water. It has been recognized that ice shows different friction regimes, but a detailed description of all the different phenomena and processes occurring at the interface, including the effect of surface roughness of both the ice and the antagonist material is still missing.
In this work the effect of surface morphology on the friction of steel/ice interfaces is studied. Different degrees of random roughness on steel surfaces are introduced and the friction coefficient is measured over a wide range of temperature and sliding velocity. Correlation between the surface roughness and the lubrication regime and friction coefficient is discussed. A theoretical model is developed in order to explain this correlation, and to control the tribological behavior of the system by a proper selection of surface roughness parameters.

Keywords

Friction, Ice, Roughness, Liquid-Like-Layer, Ice friction model

1. Introduction

The study of friction between metals and ice is as struggling as important in a wide range of fields, from ice sports to motorized traffic [1-3]. That being said, the debate behind the origin of the low friction coefficient that characterizes ice surfaces is still open even after decades of experimental and theoretical research on both saline and freshwater ice [4-10].

The friction coefficient of a solid surface sliding on ice is related to the existence of a thin layer of water between the slider and the ice itself. There are three main mechanisms that govern the formation of this layer [10]: *surface melting*, *pressure melting* and *frictional melting*. The *surface melting* is a spontaneous generation of a thin layer of melted ice (with thickness in the order of magnitude of few nanometers) without contact with other bodies and without any applied pressure, when the temperature approaches the melting value. The origin of this phenomenon observed in a number of solid surfaces is still under debate, although the most prevailing theories indicate the minimization of free surface energy as