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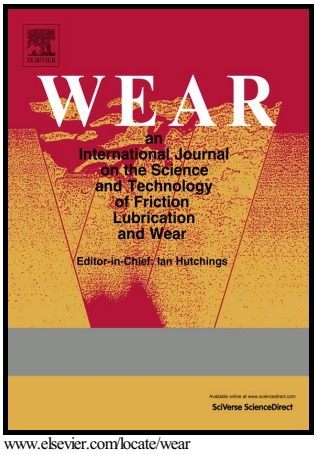

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Dry friction and wear of self-lubricating carbon-nanotube-containing surfaces

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Abstract

The unfavorable environmental conditions of certain tribological systems, such as operation at high temperatures or under vacuum, set the need to replace liquid with solid lubricants. Multi-Wall-Carbon Nanotubes (MWCNTs) have been emphasized as a very effective solid lubricant. The particles have been used to create self-lubricating materials by acting as reinforcement phase in composites or as solid-lubricant coating that works in conjunction with textured surfaces to prevent the removal of particles from the contact. However, both approaches are restricted to some extent. In the case of composites, the solid lubricant concentration is limited so as not to influence the mechanical stability of the final component. For coated surface structures, the textured surfaces can degrade during the experiment. The present study focuses on the combination of these approaches in order to create enhanced self-lubricating surfaces with MWCNTs as the solid lubricant. A custom-made ring-on-block tribometer is used to study the behavior of laser textured MWCNT-coated and MWCNT-reinforced nickel matrix composites under the conditions of unidirectional sliding in conformal contact. It is shown that the combination of both approaches allows for a maximum 4-fold reduction in friction and a 115-fold reduction in wear rate compared to the reference. Additionally, the lubrication mechanism of the MWCNTs is investigated in more detail and a structural degradation model of the mechanically stressed MWCNTs is proposed. Our results highlight the integrated solution as a suitable approach for self-lubricating surfaces subjected to unidirectional sliding.

Keywords

Self-lubricating; Carbon nanotubes, Solid lubrication, Metal matrix composites; Laser texturing; Coating

1 Introduction

In almost every technical system, motion is realized through various types of bearings. Their tribological optimization with respect to the material [1], the surface design [2,3] and the lubrication type [4] is an important task. The effective lubrication of a bearing is often achieved using a liquid lubricant. However, the use of solid instead of liquid lubricants can be advantageous in cases of unfavorable environmental conditions such as high