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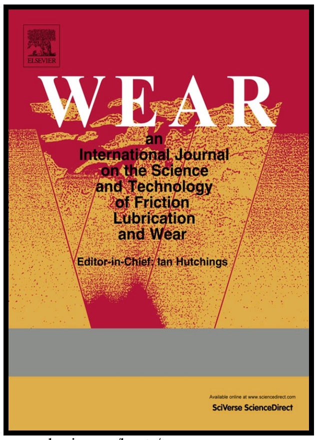

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Wear Behavior of Annealed Atomic Layer Deposited Alumina

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Abstract

Atomic layer deposited (ALD) alumina is a promising candidate for use as a wear-resistant and protective coating in MEMS and other applications. While the tribological properties of ALD alumina may be affected by numerous factors related to processing, environment, and operating conditions, its wear behavior is neither quantified nor well understood. In this study, ALD alumina is annealed at different temperatures, then subjected to sliding wear testing in a humid air environment. Tribological properties appear to be heavily influenced by annealing temperature. Surprisingly, the wear rate decreased by about two orders of magnitude after annealing at 1000 ^oC for 1 hour. This improvement in wear resistance was shown to be influenced by the formation of crystalline phases as annealing temperature increased.

Keywords: alumina; atomic layer deposition; ALD; sliding wear; annealing

Introduction

The design and fabrication of micro/nano-electromechanical systems (MEMS/NEMS) have seen tremendous developments in the last few decades, but the negative effect of wear and friction on their performance has spurred a need for wear-resistant and protective coatings[1]. While most commercially successful MEMS devices have nonmoving parts or very little contact between their parts, more advanced devices can include, for instance, intermeshing gears and micro-bearings, which make wear mitigation a necessity to extend useful life and ensure proper functioning[2–4]. Depositing protective or wear-resistant coatings on the surfaces of NEMS/MEMS is thus crucial, but growing films with uniformity and conformality on the complex geometries and confined surfaces of these devices can be challenging. Hence, atomic layer deposition (ALD) has emerged as a promising technique for this type of application due to its ability to achieve angstrom-level thickness control, excellent uniformity, and unrivaled