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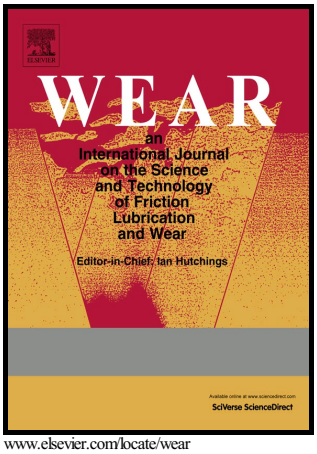

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Wear performance of hierarchically structured alumina reinforced by hybrid graphene encapsulated alumina nanofibers

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Abstract

Nowadays, the lightweight composites with superior mechanical and tribological properties to be used for several applications in automotive and aerospace industries attract much research interest. Graphene added into ceramic-based composites is believed to positively contribute into sliding wear resistance of materials. To study an effect of graphenated fillers, dry sliding wear behaviour of spark plasma sintered alumina and its hierarchically structured composites reinforced by hybrid graphene encapsulated alumina nanofibres were tested against alumina at a reciprocating mode under mild (0.98 N) and severe (4.90 N) loading conditions for 72 hours and 1 hour, respectively. The tests were conducted at an average velocity of 0.006 $m \cdot s^{-1}$ in air for the composites with different content (0 - 15 wt.%) of the fillers corresponding to 0 - 1.5 wt.% of graphene. Benchmarked against the pure alumina, the composites added with 1 - 5 wt. % of hybrid nanofibres exhibited at least threefold higher wear resistance under mild conditions along with insignificant change in coefficient of friction; whilst under severe conditions, the wear resistance was found to increase up to 90 % along with a decrease in the coefficient of friction only for the composite added by 1 wt.% of fibres. Wear reduction for the composites with a low content of hybrid nanofibres might be attributed to increase in hardness together with increase in indentation fracture toughness. The relative index of brittleness is shown to serve as a wear performance indicator only under mild environment.

Keywords: alumina, nanofibres, graphene, sliding wear, coefficient of friction

1. Introduction

Structural ceramic materials are an actively developed field of research for advanced engineering applications due to their excellent properties such as high temperature stability, chemical inertness, high strength, and good wear performance. Alumina (Al_2O_3) is one of the most attractive ceramics owing to