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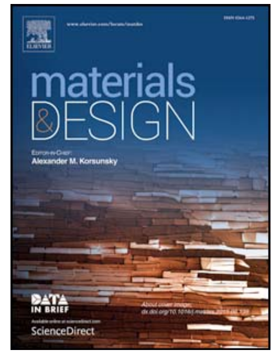

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Graphene Oxide and Graphene Nanosheet Reinforced Aluminium Matrix Composites: powder synthesis and prepared composite characteristics

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Keywords: aluminium matrix composites (AMCs), graphene nanosheets (GNSs), graphene oxide (GO), powder metallurgy (P/M), compaction, sintering.

Abstract. The preparation and properties of reduced graphene oxide (rGO) and graphene nanosheets (GNSs) reinforcement of aluminium matrix nanocomposites (AMCs) are reported. For the rGO-AMCs, commercial colloidal GO was coated onto aluminium powder particles and then reduced via thermal annealing. For the GNS-AMCs, graphene exfoliated from graphite through ultrasonication and centrifugation was coated onto aluminium particle surfaces via dispersion mixing, filtering and drying. Pure aluminium and aluminium composites with various reinforcement concentrations of rGO and GNS were cold compacted into disc-shaped specimens and sintered in inert atmosphere. The mechanical properties and microstructure were studied and characterised via Vickers hardness, X-ray diffraction, density measurement, and scanning electron microscopy. The reinforcements were uniformly distributed onto the aluminium particle surfaces before and after consolidation within the composites. The relevant factors for the powder metallurgy process (compaction pressure, density, and sintering conditions) were optimised. Increased levels of increased hardness were recorded, over baseline compacted and sintered pure aluminium samples, prepared under identical experimental conditions, of 32% and 43% respectively for the 0.3wt.% rGO-Al and 0.15wt.% GNSs-Al composites. The process developed and presented herein provides encouraging results for realising rGO-AMC and GNS–AMC nanocomposites via low cost cold powder compaction and sintering metallurgy techniques.

1. Introduction

Aluminium matrix composites (AMCs) have been widely studied since the 1920s. In the last few years AMCs have been utilized in both high-tech structural and functional applications including aerospace, defense, automotive, thermal management, sports and recreation, electronic packaging, and armour [1]. These composites are utilised as substitutes for monolithic materials including aluminium, ferrous, titanium alloys and polymer based composites. Alumina and silicon carbide reinforcements are commonly utilised in AMCs. The tensile strength of alumna and SiC being on the order of 300 MPa is much below that of graphene at 130 GPa. A small percentage of GNS or even rGO could therefore increase the overall composite physical properties greatly. The electrical conductivity of graphene is similarly an order of magnitude greater than that of aluminium. With such increased strength and conductivity, power transmission lines would therefore be a good end application for AMCs developed based on these reinforcements. Several papers have recently been published on carbonaceous-reinforced aluminium composites e.g., single or multi-walled carbon nanotubes SWNTs/MWCNTs [2-11]. To achieve the integration of CNTs into AMCs, the following methods have been used: mechanical dispersing, e.g., ball milling process [3], friction stir process [8-10], solvent dispersion e.g., ethanol with surfactant/ultrasonic support [12], or hybrid methods of the above [13]. It has been reported that the large aspect ratio of CNTs (wt.%>2) was difficult to

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