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Full Length Article

Enhancement of Mechanical properties of Magnesium metal matrix composites

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ABSTRACT: The aim of this study is to fabricate magnesium reinforced metal matrix composites using graphene nanoplatelets (GNPs) via powder metallurgy processing in order to enhance room temperature mechanical properties. The microstructural evaluation and mechanical behaviors of composite powders and extruded bulk materials were examined by X-ray diffraction (XRD), differential scanning calorimeter (DSC), scanning electron microscopy (SEM) equipped with energy-dispersive spectrometer and mechanical tests. The uniform dispersion and large specific surface area per volume of GNPs embedded in magnesium matrix led to increment in micro hardness, tensile strength and fracture strains of the composites.

Keywords: Solution growth; powder X-ray diffraction; nonlinear optics.

1 Introduction

Graphene, a single layer of graphite, have attracted particular interests owing to its high electrical, thermal and mechanical properties. In the field of thermal interface materials (TIMs) graphene (thermally conductive nanomaterial) has been used as excellent filler. The strong graphene coupling to the metal matrix particles caused an increase in the thermal conductivity of resulting composite up to 2300%. Graphene nanoplatelets (few layer graphene) have also been considered as an ideal

Reinforcement to improve the electrical and mechanical performance of different polymers. An attempt was made to synthesize the Al-graphene nanocomposite through hot isostatic pressing and extrusion techniques. The experimental results revealed that Al-graphene nanocomposite showed decreased strength and hardness.

Magnesium have poor wettability with graphene nanoplatelets. Since graphene have good wettability with aluminium matrix. Therefore small amount of aluminum particles can be added into magnesium matrix along with graphene nanoplatelets to enhance the wettability. variable studies have indicated that mechanical properties of structural metal (aluminum) can be enhanced by addition of graphene sheets, it is still a great challenge to synthesize magnesium based metal matrix composites reinforced by graphene nanoplatelets due to poor wettability between magnesium matrix and graphene nanoplatelets. The GNPs and CNTs have similar molecular structure but GNPs have high potential to enhance the strength of Mg matrix as compared to CNTs. This is because of high specific area per unit volume of GNPs.

Mg+Al+GNP

2. Literature review:

1. The aim is to fabricate magnesium reinforced metal matrix composites using graphene nanoplatelets by using powder metallurgy process. The uniform dispersion and large specific surface area per volume of GNPs embedded in magnesium matrix lead to increase micro hardness, tensile strength of composites.

2. Its excellent mechanical properties lead is used in nanocomposites for enhance the strength. The effect of graphene nanoplatelets addition in the mechanical behaviour of pure magnesium under tension and hardness is noted.

3. The elastic properties and an intrinsic strength of monolayer graphene has been investigated.

4. A Rapid growth of engineering communities is in thermal properties of materials. Thermal And thermoelectric properties of carbon materials focusing on graphene, carbon nanotubes with degrees of disorder.

5. The thermal properties of graphene at room temperature are dominated by the acoustic phonons. Additional benefits of the graphene based composites are come at no additional are their expense low coefficient of thermal expansion and increased mechanical strength.

6. The synthesis and thermal properties of the electrically conductive thermal interface material are the hybrid graphene-metal particle filler.

7. Carbonaceous materials are attracted interest on engineering application due to fascinated electrical, thermal and mechanical properties. Pure Mg and Mg-composites are synthesized by semi-powder metallurgy combined with sintering process followed by hot extrusion.

8. Graphene reinforcement are appliedon the form of a graphene oxide (GO) water colloidal for safer and simpler processing. The result of Raman spectroscopy, the graphene reinforcement successfully mixed into an aluminium matrix by FSP (Friction stir processing).

9. The electronic structure of graphene is captured in Raman spectrum that clearly evolves with number of layers. The unambiguous, high-throughput, non-destructive identification of graphene layers are allowed. The layer is critically lacking in this emerging research area. Various forms of graphite, nanotubes, bucky balls, and other can be derivatives of graphene and not surprisingly, this basic materials has been investigated.

10. Carbon nanotubes reinforced magnesium nanocomposites are synthesised using powder metallurgy followed by hot extrusion. The thermo mechanical property results increase in the thermal stability with increasing amount of CNTs and Mg nanocomposites material.

11.There have been several investigation on the elastic stress and strain generated about inclusion, which has a coefficient of thermal expansion different from that of the matrix, as a result of heating or cooling. There have been a few investigations of the magnitude of the plastic strain and a plastic zone under the above conditions wherein the plastic deformation induced by the difference between thermal expansion coefficients was treated in continuum manner. An insitu transmission electron microscopy investigation was undertaken of dislocation generation at the inclusions due to the differential thermal contraction.

12. The strengthening behaviour for particle reinforced metal matrix composites are primarly attributed to the dislocation strengthening effect to account for this two effect in an unified way , a new hybrid approach is developed in this paper by incorporating geometrically necessary dislocation strengthening effect in to the incremental micro mechanical scheme

13. Magnesium is the lightest structural metal of CNTs are light weight reinforce with exceptional mechanical properties. Nano-composites configuration exhibit different tensile and compressive response function of CNT.Due to inherent nature of ball milling get different Al-CNT particles in term of size and surface energy.

14. Modern technology in the areas of aerospace and automotive industry has to development of metal matrix composites. MMCs are in light in weight, economically variable, amenable for production. Mg has some limitations such as low elastic module, rapid loss for strength with increase of temperature.

15.There are two main approaches to interpreting the mechanical properties of materials in the continuum approach. It is assumed the material properties can be described by global parameters. In the micro-mechanistic approach the understanding are built-up from a knowledge of the deformation processes at an atomic level.The effect of the particle parameters on mechanical properties and to assess the relative importance of the various strengthening models. MMCs based on pure aluminium are manufactured using a powder metallurgy route.

16. The Al-Cu particulate hybrids were incorporated into the Mg through powder metallurgy. Metallurgy and hot extrusion methods proved to be effective in synthesize the Mg based alloys. The mechanical properties of the synthesized alloys were superior when compared to the composites reinforcement.

17. Graphene nanoplatelets (GNPs) is the novel reinforcing fillers due to their fascinating mechanical properties. Their unique mechanical properties rapidly revolve as the sheets aggregate due to strong van der Waals forces and π-π attraction.Ttherefore limiting their applications in metal

matrix composites. In present work, the rapid aggregation of two-dimensional GNPs are inhibited by intercalating one-dimensional multi-walled carbon nanotubes.

18. The cohesive law of interfaces between a carbon nanotube (CNT) and polymer are not well bonded and are characterized by the van der Waals force. The tensile cohesive strength and the cohesive energy are given in terms of the area density of carbon nanotube, volume, density of polymer as well as the parameters in the van der Waals force. CNT in an infinite polymer, the shear cohesive stress vanishes, and the tensile cohesive stress depends only on the opening displacement. For a CNT in a finite polymer matrix, the tensile cohesive stress remains the same, but the shear cohesive stress depends on both opening and sliding displacements.

19. The graphene was achieved in a combination of electron beam lithography and the etching. The specimens are cleaned in situ by employing current induced heating, directly resulting on a significant improvement for electrical transport. Concomitant with high mobility enhancement, the widths of the characteristic direct peaks are reduced by a factor of 10 compared to traditional, non-suspended devices. This advance should allow for accessing the intrinsic transport properties of graphene.

20. The graphene-MLG nanocomposites were prepared by the ultrasonication of natural graphite in an aqueous solution of sodium cholate. The solution was left for 1 hour to settle follow by the removal of thick graphite flakes. The ultrasonicated solution are underwent sedimentation processing in a centrifuge.

3. Literature survey:

From the literatures the multiple ways to enhance and increase the mechanical properties of the magnesium metal matrix composites reinforced with graphene nanoplatelets. Now a days many research are under graphene due to their high thermal properties. The various mechanical test and diffraction tests has been taken for the results. The improvement of mechanical properties of magnesium reinforced with graphene nanoplatelets has application in automobiles, industries.

4. Experimental Procedure

4.1. Raw materials:

The average thickness and diameter of graphene nanoplatelets were 5-15nm and 10-25μm respectively. The Mg powder of 70μm particle size.

4.2. Preparation of nanocomposites:

The magnesium-GNPs composites were fabricated using liquid based mixing in ethanol. The Mg powder was mixed with required weight fractions of GNPs along with small amount of Al particles using mechanical agitator and fabricated using powder metallurgy with sintering process by hot extrusion

4.3. Material characterization:

The mechanical agitated composite powders were characterized by scanning electron microscopy, differential scanning calorimetry (DSC). Bulk samples were machined from extruded rods to evaluate the microstructural studies using and SEM equipment. X-ray diffraction (XRD) is used for composite powders and extruded materials. Automatic digital micro hardness tester was used to measure the Vickers Hardness of materials. And tensile test is taken for tensile strength.

5. Conclusion:

From the literature survey, the increased strength of composites may be efficient load transfer and mismatch in coefficient of thermal expansion and crystallographic texture difference between pure Mg and composites.the GNPs and CNTs have similar molecular structure. but GNPs have high potential to enhance the strength of Mg composites compared to CNTs. This because of high specific surface area per unit volume of GNPs

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