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Methods for Fabrication of Composites: A Review

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Abstract

With advancement of engineering in the field of aerospace, marine, transportation etc the materials of higher strength and stiffness required. Composite materials are one of the best options to fulfill these requirements because of their superior mechanical properties. A composite material is a combination of two or more materials that results in improved properties than those of the individual components used alone. The different methods are specialized for fabrication of a variety of composite materials. This paper let know us about the various methods for fabrication of composites such as powder metallurgy, stir casting method, casting, and microwave assisted fabrication. Along with controlling process parameters of these methods and knowledgeable us regarding the properties of fabricated composite material.

Keywords: *Composite Materials, Al, Mould and Matrix Composite*.

1. Introduction

A composite material is a combination of two or more materials that results in improved properties than those of the individual components used alone. In difference to metallic alloys, each material retains its separate chemical, physical, and mechanical properties. The composite materials have major advantage of their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part. Composite materials are used in aerospace, transportation, construction, marine goods, sporting goods, and more recently in infrastructure as these have better mechanical properties than other materials and can stand against higher loads and temperature.

The composite materials can be fabricated by the use of different metallurgies such as casting, powder metallurgy, stir casting etc. These metallurgies have different operating parameters and can be applied for fabrication of various composites. The literature review of articles provides us the information regarding the operating parameters of these metallurgies and the improved properties of these fabricated composite materials.

2. Literature Review

B. Ziębowicz, D. Szewieczek, L.A. Dobrzański [1] fabricated nanocrystalline composite having forced ferromagnetic and mechanical properties. First of all nanocrystalline powder of $Fe_{73.5}Cu_1Nb_3Si_{13.5}B_9$ was obtained by milling its metallic glass strip and at metastabled at 443K. For fabrication of composites 2.5, 5.0 and 7.5% of polyethylene mass portions are mixed with $Fe_{73.5}Cu_1Nb_3Si_{13.5}B_9$ alloy powder by mill shaker for 0.01, 0.25, 0.50 hour. The mixture further moulded at 350 MPa and dies of composites. Testing was performed for all fabricated composites and analysed that 5% polyethylene mass portion with $Fe_{73.5}Cu_1Nb_3Si_{13.5}B_9$ alloy powder milled for 0.25 hour gives best magnetic and mechanical properties.

A. Santhana Krishna Kumar, S. Kalidhasan, Vidya Rajesh, N. Rajesh [2] prepared chitosan-surfactant modified sodium montmorillonite (NaMMT) clay composite by microwave assisted preparation for detoxify heavy metal chromium. Initially chitosan solution prepared by dissolving 3 gm of chitosan solution in 10 mL of 1% v/v acetic acid and 5.0pH obtained by NaOH solution. On another hand 6 gm surfactant modified NaMMT clay was diffused in 10 mL of methanol. After that chitosan solution gradually added to clay suspension; for homogeneity this magnetically stirred for 5 min; than mixture was irradiated for 30 min with 1 min interval under microwave conditions. During 1 minute interval little quantity of methanol added every minute as a paste. At last prepared composite material treated to hot air at 120^oC for 6 hours for dryness.

KATICA MILOŠ, IVICA JURIĆ, PERO ŠKORPUT [3] formed Al/Al_2O_3 composite by compression followed by extrusion. Highly purified aluminium powder of 40 µm particle size (Ecka AS-011S) and Al_2O_3 powder (Zwsk and Zesk (Treibacher Chemische Werke)) of particle size 22-50 µm are mixed together for 25 min in different compositions. These mixtures are compressed into bars of 40 mm diameter under 600 MPa pressure. The compressed bars wrapped in aluminium foil to reduce oxidation of Al and friction during extrusion. These wrapped bars than heat treated for 1 hour at 500^oC in extrusion pre-chamber and followed by extrusion into 10 mm diameter under 800-1200 kN at speed of 10 mm/s. After fabrication of composites of various compositions mechanical properties are measured and observed that finer particles have better mechanical properties.

R. Eires, J. P. Nunes, R. Fangueiro, S. Jalali, A. Camões [4] progress eco-friendly new hybrid composite boards and mortars for non structural elements of construction like dry walls & ceiling from granulated cork, cellulose pulp and hemp fibres. Initially it was tested that mixture of 75% metakaolin and 25% line gives the maximum compressive strength. They fabricated the following: a) Hempcrete block: made-up by curing at high the mixture of Hemp hurds (fibers), Waste paper in pulp and Metakaolin-Lime (75:25, as binder) at high temperature; lime is also added as additive. By compression test it was observed that hempcrete is very ductile and it can be used as non-structural applications such as absorbers for dumping in houses. b) Hempcrete plates: are prepared by compacting the hempcrete block which results in desperation of hemp fibre in all direction because of that it has the better mechanical properties. c) Granulated cork and paper pulp composite plates: are fabricated by primarily casting the paper pulp, granulated cork, hemp fibre for better strength and gypsum as binder. Further the cast compressed at 15 kN and thermally cured for 3 hours at 110^0C. This results into flexural strength of 400KPa, flat texture and suitable cohesion.

K.Deepika, C.Bhaskar Reddy, D.Ramana Reddy [5] developed non-asbestos bio-friction material for brake pads by powder metallurgy technique primarily from PKL: palm kernel shell (an agro-waste). The process parameters for powder metallurgy technique find out by Taguchi Method. The powders of PKS, brass chips, calcium carbonate, sulphur, carbon black and resin binder are blended together and compacted under pressure of dies. Finally the compact sintered by heat treatment process. After testing it was observed that fabricated brake pad has performed better then commercial brake pads for wear, disk temperature and stopping time.

R. RAVI RAJA MALARVANNAN, P. VIGNESH [6] compose Al-Si-SiC composite and analyzed it as piston by ANSYS simulation software. First of all aluminium (LM-6) melted at 650-750^0C in oil type furnace; Kavaral & degasser power added which float the impurities at top and these are removed. After that 224 µm meshed SiC powder was added to molt in furnace and molt stirred to blend SiC with Al for 3-4 min. Blending is followed by pouring the molt at 700^0C into the lubricated die and cooled by quenching process. At last cast was machined by lathe and tested for hardness, corrosion, wear and surface roughness; which results into increase in hardness and wear resistance.

Rajeshkumar Gangaram Bhandare, Parshuram M. Sonawane [7] fabricated the Aluminium Matrix Composite (AMC) by Stir Casing Method. For AMC; SiC, Alumina and Graphite reinforced with matrix of Aluminium (6061). Stir Casting consist of two-step mixing processes: a) Matrix material is completely melted over its liquid temperature and preheated reinforcement materials are added & mixed. b) This mixture is reheated to liquid state and mixed methodically. Stir Casting Apparatus consist of resistance heating furnace having conical shaped graphite of high melting point; which is located in muffle of high ceramic alumina and surrounded by heating element

Kanthol-Al. To reduce oxidation of aluminium, heat loss and gas transfer this entire close chambered with nitrogen gas and steel sheet. Stirrer shaft's one end is connected to 0.5 hp PMDC motor and 4 blades are welded to it at 45^0. Hopper is mounted for constant feeding of reinforcement particles. In starting of stir casting process; aluminium alloy melted by first setting heater temperature to 500^0C and after that upto 900^0C constantly. This high temperature and induced nitrogen gas decreases oxidation and improve wetability also 1% by weight of magnesium powder added to 700 gm of molten composite for improving wetting. Further the blending machine mixed all throughout for 1 day. Reinforcements are heated at 500^0C for half hour and stirred with molten matrix by stirrer rpm increasing from 0 to 300 rpm. The matrix heated to 630^0C below its melting point for a uniform semisolid stage and reinforcements at flow rate of 0.5 gm/sec are poured by conical hopper. Further the semisolid state slurry stirred for 5 minutes and reheated to 900^0C for fully liquefying the slurry. At last the molten slurry is poured into preheated mould at 500^0C. It was observed that stir casting method is less expensive for manufacturing AMC.

3. Conclusions

Different composite materials of different properties can be fabricated by various methods based upon the required characteristics. Major conclusion for fabrication methods are as follows:

- For powder metallurgy, smaller the particle size of powders results into the superior mechanical properties of fabricated composite.
- Required magnetic and mechanical properties both together can be achieved by controlling the mixing and mould parameters.
- Stir casting is cheapest method for fabrication of AMC.

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