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ANALYSING THE MECHNICAL BEHAVIOUR OF CARBON NANOTUBES REINFORCED HYBRID METAL MATRIX COMPOSITES

P.U.Premsuryakanth, Dr T. Sunder Selwyn[1],
[1]Professor, Prince Dr K. Vasudevan College of Engineering and Technology, Chennai, India

***Abstract**—The super plastic formation is adopted in this research for formation of carbon nanotube reinforced materials with light material matrix composites. Diverse forming processes for the fabrication of various composite materials have been used in this work. The importance of superplastic shaping in the fabrication of complicated shapes in aluminium alloys is also discussed. The ideal circumstances for achieving optimal formability with shortest forming time have been discovered. This research is carried out by finding out the hybrid materials that are required to find out the synthesis process and the required methods also been carried out. The base material taken is aluminium and the reinforcing material are taken as copper, carbon nanotubes and magnesium. The synthesis process employed for synthesizing carbon nanotubes is chemical vapour deposition. The impact of mechanical and microstructural features is also discussed in this work.*

Keywords — *Carbon Nanotubes; chemical vapour deposition; super plastic formation; aluminium alloys*

I. INTRODUCTION

A metal matrix composite (MMC) is a composite material made up of at least two constituent pieces, one of which must be a metal and the other of which can be a different metal or another material like ceramic or organic compound. A hybrid composite is one that has at least three materials. A reinforcing substance is dispersed into a metal matrix to create MMCs.[1] To avoid a chemical reaction with the matrix, the reinforcing surface can be coated. Carbons, for example, are frequently employed in an aluminium matrix to create composites with low density and great strength. On the other hand, carbon interacts with aluminium to form Al4C3, a brittle and water-soluble molecule.[2]
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II. MATRIX AND REINFORCEMENT

The matrix is the monolithic material into which the reinforcement is embedded, and is completely continuous. This means that there is a path through the matrix to any point in the material, unlike two materials sandwiched together. In structural applications, the matrix is usually a lighter metal such as aluminum, magnesium, or titanium, and provides a compliant support for the reinforcement. In hightemperature applications, cobalt and cobalt–nickel alloy matrices are common. [3]

The reinforcement material is embedded into a matrix. The reinforcement does not always serve a purely structural task (reinforcing the compound), but is also used to change physical properties such as wear resistance, friction coefficient, 7 or thermal conductivity. The reinforcement can be either continuous, or discontinuous[4]. Discontinuous MMCs can be isotropic, and can be worked with standard metalworking techniques, such as extrusion, forging, or rolling. In addition, they may be machined using conventional techniques, but commonly would need the use of polycrystalline diamond tooling (PCD). Continuous reinforcement uses monofilament wires or fibers such as carbon fiber or silicon carbide. Because the fibers are embedded into the matrix in a certain direction, the result is an anisotropic structure in which the alignment of the material affects its strength. One of the first MMCs used boron filament as reinforcement. Discontinuous reinforcement uses "whiskers", short fibers, or particles. The most common reinforcing materials in this category are alumina and silicon carbide[5]. MMC manufacturing can be broken into three types—solid, liquid, and vapor

III SYNTHESIZING AND CHARACTERIZATION

It is a hybrid method using chemicals in vapour phase. Basic CVD process can be considered as a transport of reactant

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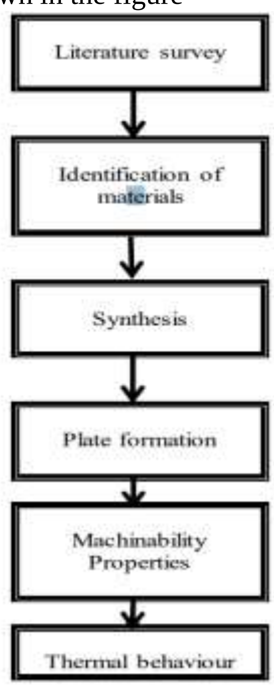
vapour or reactant gas towards the substrate kept at some high temperature where the reactant cracks into different products which diffuse on the surface, undergo some chemical reaction at appropriate site, nucleate and grow to form the desired material film. The by-products created on the substrate have to be transported back to the gaseous phase removing them from the substrate.[6] Vapours of desired material may be often pumped into reaction chamber using some carrier gas. In some cases the reactions may occur through aerosol formation in gas phase. There are various processes such as reduction of gas, chemical reaction between different source gases, oxidation or some disproportionate reaction by which CVD can proceed. However, it is preferable that the reaction occurs at the substrate rather than in the gas phase. Usually temperature ~ 300 to 1200 C is used at the substrate. There are two ways viz., hot wall and cold wall by which substrates are heated. In hot wall set up the deposition can take place even on reactor walls. This is avoided in cold wall design. Besides this, the reaction can take place in gas phase with hot wall design, which is suppressed in cold wall set up. Further, coupling of plasma with chemical reaction in cold wall set up is feasible. Usually gas pressures in the range of 0.1 torr to 1.0 torr are used. [7]Growth rate and film quality depend upon the gas 24 pressure and the substrate temperature. When the growth takes place at low temperature, it is limited by the kinetics of surface tension. CVD is widely used in industry because of relatively simple instrumentation, ease of processing, possibility of depositing different types of materials and economic viability. Under certain deposition conditions nanocrystalline films or single crystalline films are possible. There are many variants of CVD like metallo organic CVD (MOCVD), atomic layer epitaxy (ALE), vapor phase epitaxy (VPE), plasma enhanced CVD (PECVD) etc. They differ in source gas pressure, geometrical layout, temperature used etc.

IV METHODOLOGY

The methodology used in this research is as shown in the figure



IV MECHNICAL BEHAVIOUR

Analysis of mechanical properties The Fig. 3 shows that the specimen prepared for the different mechanical test based on their standard. The mechanical properties of the composite are analyzed by tensile test, shear test, flexural test, and bending test. With the same arrangement, three different specimens are made and its best values are presented in the table and the tests are conducted for the best specimen. The results of the three samples of the same specimen

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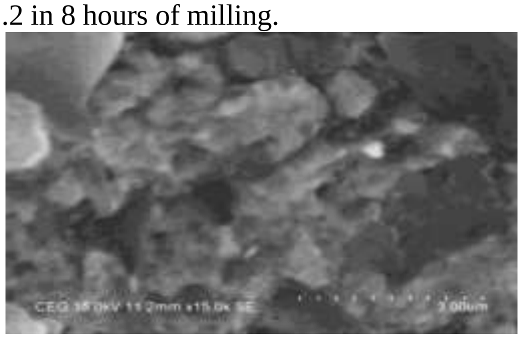
Table: Mechanical Properties

S.NO	TEST PARAMETERS	OBSERVED VALUES
1	Yield strength(Mpa)	61
2	Ultimate tensile strength(Mpa)	65
3	Elongation in 50 mm gl (%)	1.5

Figure 1 Component

V- SEM ANALYSIS

Figure 2 shows the morphologies of as received matrix aluminium powder and the reinforcements as a mixture of carbon nanotubes , copper and silicon carbide particles. The matrix material is relatively of a broad sized distribution with average size 500-600 nm and when they subjected to ball milling then for 4 hours of milling the size of the particles are reduced to 50.5 in 4 hours and 42.2 in 8 hours of milling.



It is found that due to the particles were reinforced with the matrix powders the agglomeration of particles takes place as it took delay in reinforcement. This behavior may arise possibly due to hard reinforcement particles which may

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accelerate milling action since they act as milling media during mechanical alloying. It is apparent for the composite that the average size of particles increases as a result of welding of flattened particles.

VII CHALLENGES & CONCLUSION

A unique combination of two metals, a ceramic and an allotropic form of carbon was tried in this experimental work. Several proportions of the aforesaid combinations at nano scale were tried. From these the superplastic forming plays an imperative role in the production of complex shapes in the aluminium alloys. From this research it is proposed that superplastic forming of composites along with its process parameters can be determined. In addition to that the prediction of failure of the composite materials during superplastic forming is very limited from this research. From this research we can able to find the optimum conditions to attain maximum formability along with minimal forming time. From the result of the test, the subsequent conclusions are made. The ultimate tensile strength of the sample A is 247 MPa which is comparatively above that of existing light weight stainless steel with 120 MPa. The impact load of sample A is 20 Joules which is quite greater than the impact load of stainless steel which is 29 Joules. From the Flexural test, it is clear that the ultimate stress of sample A is 186.8 MPa which is higher than the stainless steel. The toughness and ductility of the aramid fiber are reasonably high.

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of the person by analyzing the text messages and also processing emoticons. Emoticons are very common tokens in any text message.