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INVESTIGATION OF FLEXURAL STRENGTH FOR CARBON REINFORCED ALUMINIUM NANO COMPOSITE

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ABSTRACT

The main objective is to fabricate a carbon reinforced aluminium nano composite using powder metallurgy process. This can be used to increase the material properties which are of mechanical and thermal relatives. Manufactured Multi walled carbon nanotubes(CNT) of three types were taken. The aluminium is used as matrix and a carbon nanotube of 3 different proportions is used as reinforcement. The specimen is manufactured using the powder metallurgy process. The fabrication of the material includes various steps like ball milling, compacting and sintering. The analysis is done after manufacturing of the specimen using the flexural testing machine which shows the stress in a material just before it yields.

Keywords: Powder metallurgy, CNT, Flexural strength, Stress, Yield.

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1. INTRODUCTION

Aluminium or aluminum is denoted by the symbol AL whose atomic number is 13. It is silvery-white in colour. It is also nonmagnetic and ductile metal among the boron group. It is also recorded as the abundant element on the earth followed by the oxygen and silicon in the first. As per the physical properties Aluminium is best for its low density and it has also the ability to resist with corrosion by the phenomenon of passivation. Aluminium and alloys of aluminium plays a vital role in the automobile industries, Aerospace applications, Construction industries such as frames and facades.

Carbon nanotubes are denoted by CNT which were the allotropes of carbon and are cylindrical nanostructure in its appearance. It is divided into two categories which are multi walled carbon nanotubes and single walled carbon nanotubes. As the major difference observed among these is the single walled carbon nanotubes(SWNT) consists of single graphene cylinder whereas the mutli walled carbon(MWNT) nanotubes consists of several concentric graphene cylinders. It was observed that orbital hybridization describes that the chemical bonding is the best in the nanotubes. Also there are several divisions which are types involved in their evolution/extraction process the types are classified into five based on their outer diameter as purity and length also based on the extraction process involved [3].

Considering these into account as owing to its high strength-to-weight ratio the composite can be evolved considering aluminium as the matrix due to its abundant availability and multi walled carbon nanotubes as the reinforcement for this process. The powder metallurgy process is selected for the manufacturing process [4].

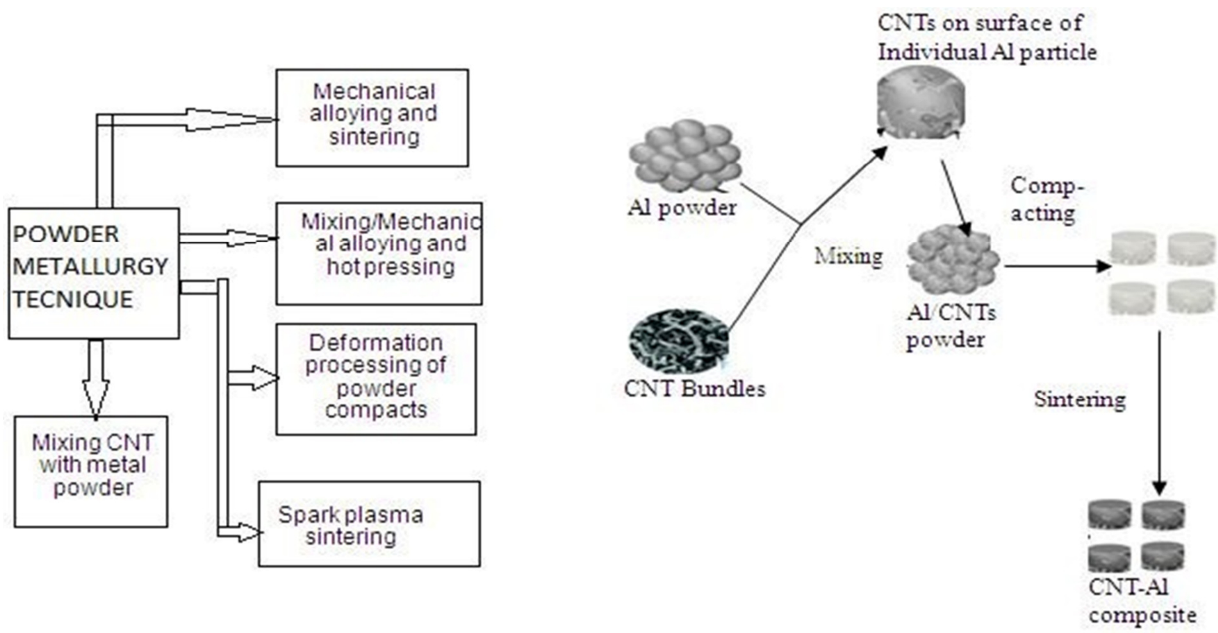


Figure 1 Fabrication of carbon reinforced aluminium nano composite.

2. LITERATURE REVIEW

The attention towards carbon nanotubes (CNTs) has been increased in recent years as the composites and their usage are also increasing day by day. Carbon nanotubes have high mechanical and thermal properties. As they have high strength, high aspect ratio [1]. There is a fine Refinement in crystallite size (~320 nm) and there is also an increase in yield strength (~77%), tensile strength (~52%), ductility (~44%) and hardness (~45%) which was observed in the characterization process evolved for the carbon nano composites [2].

3. METHODOLGY

The study starts with selection of the materials specification and the composites for manufacturing the composite in according to the strict formulation and the standard compositions are considered based on the weight volume density relation. The specifications of the material considered and the composition accordance to the standardization are given below.

Aluminium Specifications:

- Grade – Laboratory grade
- Purity - 99.0%

Multi Walled Carbon Nanotubes:

Table 1 specifications about the CNT used in the process

S. No	Specifications	Type-I	Type-III	Type-V
1	Length	10-30 µm	10-30 µm	10-30 µm
2	Outer Diameter	<8 nm	10-20 nm	30-50 nm
3	Purity	Min 95 %	Min 95 %	Min 95 %

CALCULATIONS:

Density of Aluminium (Al) = 2.707 g/cm^3

Volume of Pellet (v) = l * b * h

Take l = 40mm, b = 10mm, h = 5 mm

Volume (v) = 40* 10* 5

= 2000mm^3

Mass of Pellet (m) = p * v

= (2.707/1000) * 2000

= 5.414gms

Here we have considered 3 different compositions by varying CNT percentages (1%, 1.5%, 2%) and also addition of Al will also changes with respect to percentages of CNT the detailed amount of mass is given through the tabular column given below.

Table 2 Detailed calculations results based on mass, density& volume

S. No	Percentage of cnt (%)	Mass of cnt (gms)	Mass of rectangle (gms)	Mass of aluminium (gms)
1	1	0.05414	5.414	5.3598
2	1.5	0.08121	5.414	5.33279
3	2	0.10828	5.414	5.30572

Powder metallurgy is considered as one of the best and cheap production process based on the economic aspects for the fabrication of composites. As the powder metallurgy process involves three consecutive steps that are to ball milling, compaction and sintering. The process methodology used is given in the figure 1. After the completion of this process the analysis is done as follows. Flexural strength is the modulus of rupture or bend strength or transverse rupture strength is known as flexural strength. It is defined as the stress in a material just before it yields in a flexural test. The most frequently employed test is transverse bending test, in which a specimen having circular or rectangular cross section is bent until fracture or yielding using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of yield. It is measured in terms of stress, as given in the figure. [5]

Where F = load applied on the specimen b = breadth of the specimen
d = depth of the specimen/thickness L = length of the specimen

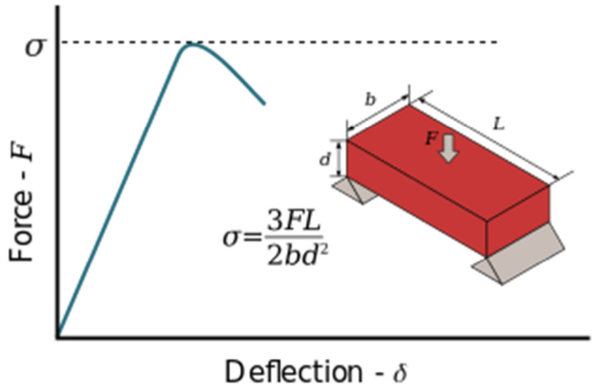


Figure 2 Plot of Flexural strength to me measured.

The specimen which is going to be tested is placed on the simply supported beam and it is placed under the application of load apparatus which is the flexural testing machine and through the control panel the load is applied on the specimen and the deflection along the specimen is calculated. Repeat this process for different types of specimens.

4. RESULTS

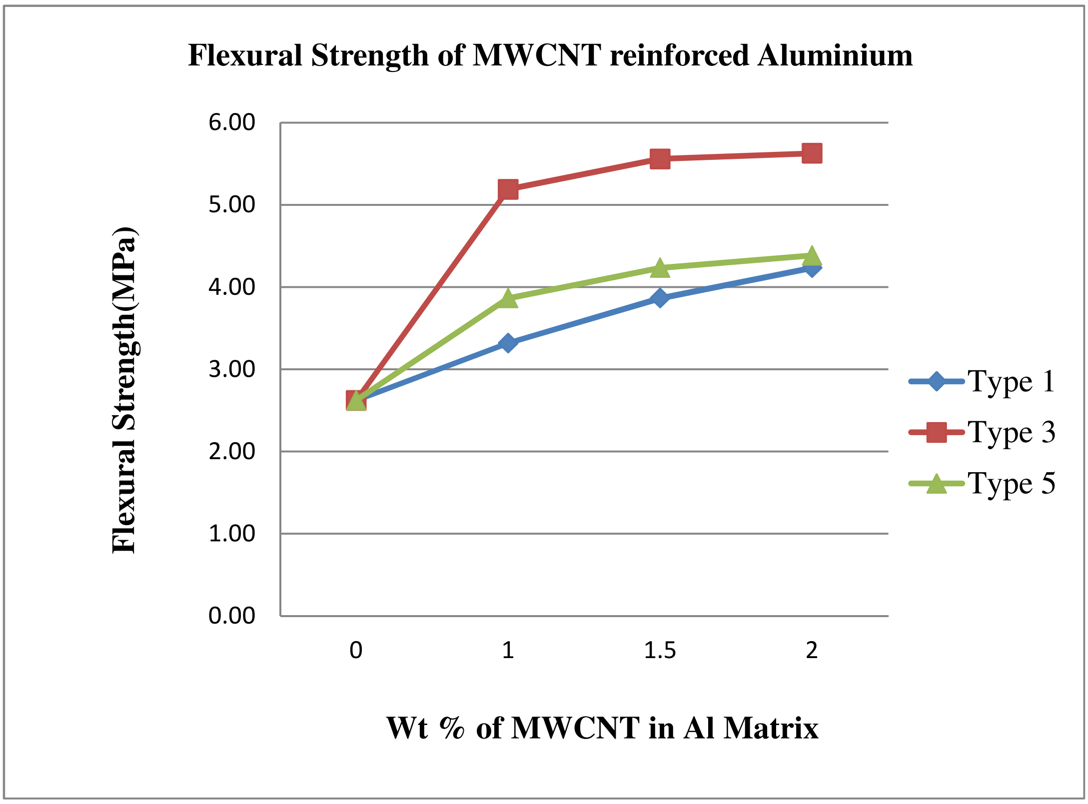
Table 3 results about the specification of the machine used for flexural testing and the strength obtained by the respective specimen

Sample name	Length (mm)	Breadth (mm)	Thickness (mm)	Load(N)	Flexural strength(N/mm sq)
Aluminium	40.00	10.20	6.50	1.92	2.62
Type 1-1%	40.00	10.20	6.50	2.43	3.32
Type 1-1.5%	40.00	10.20	6.50	2.83	3.87
Type 1-2%	40.00	10.20	6.50	3.10	4.23
Type 3-1%	40.00	10.20	6.50	3.80	5.19
Type 3-1.5%	40.00	10.20	6.50	4.07	5.56
Type 3-2%	40.00	10.20	6.50	4.12	5.63
Type 5-1%	40.00	10.20	6.50	2.83	3.87
Type 5-1.5%	40.00	10.20	6.50	3.10	4.23
Type 5-2%	40.00	10.20	6.50	3.21	4.38

Table 4 (results about the flexural strength of the types of CNT composition with the respective to their weight percentages)

Weight Percentage of MWCNT in Al	Flexural strength (N/ mm sq)		
	Type 1	Type 3	Type 5
0	2.62	2.62	2.62
1	3.32	5.19	3.87
1.5	3.87	5.56	4.23
2	4.23	5.63	4.38

PLOT OF GRAPH FOR ALL TYPES OF SPECIMENS FOR THE FLEXURAL STRENGTH:



Graph 1 Relation between weight percentage and flexural strength for types of aluminium composites used.

5. CONCLUSION:

The experimentation clearly shows that adding 2% CNT composition for the specimen gives the good strength but it was also clear that using type 3 carbon nanotube gives the high yield strength to the specimen. Thus a carbon reinforced aluminium composite which is manufactured with type 3 CNT gives more strength and much flexible and increase in the reinforcement mass among them gives the better results.

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