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Experimentation of Micro-Vickers Hardness Test for Composite Nano Materials using DoE

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Abstract : In this research paper, some novel experimental studies on the observation of Scanning Electronic Microscope (SEM) Results using the concepts of DoE for the surface preparation by the conduction of a Micro-Vickers Hardness Test for Hardness Evaluation purpose of the developed composite material are presented. Experiments are being conducted and the results are obtained w.r.t. some of the material properties such as the hardness test evaluation of the materialistic property. The results show the efficiency of the methodology that is being presented by us in the form of experimental results. Here, we have presented the corrosion part of the experimental results.

Index Terms **- DoE, Hardness, Vicker, Composites, Corrosion, Mechanical, Test, Experiment.**

1. INTRODUCTION

The research work presented in this paper relates to the studies on Carbon Nanotube Reinforced Aluminium-6061 Metal Matrix Composites incorporated with real time experimental validations carried out in the college laboratory. In fact, the proposed research work that has been realized is in the field of such a technological innovation that it serves as a promising and largely studied industrial material, viz., the carbon nanotubes (CNTs). After a first observation they were “rediscovered” at the beginning of the 90□s and immediately started to cover a fundamental role in several scientific branches, from Physics to Chemistry, going through Medicine and Biology. In the Material Science and Engineering field a large number of studies have been conducted on carbon nanotubes, as a consequence of their extraordinary physical, technological and mechanical properties [1][2].

Since 1991, a large number of attempts have been conducted, trying to exploit the outstanding potential of this carbonaceous material, in order to improve the properties of several matrices. The most important application is the production of polymer matrices composites (PMCs), but in last decades an increasing number of metal matrix ones (MMCs) have been presented and recently also ceramic matrix (CMCs) applications have been attempted. Despite massive efforts focused on CNTs-composites, the potential of employing these reinforcement materials had not yet been fully exploited. The focus was on obtaining a good microstructure and mechanical properties after the sintering process. MMCs were investigated starting from aluminium-6061 alloy powders [3][4].

Research work has been realized in the field of a promising and largely studied technological material : the carbon nanotubes (CNT’s) so far in this current materialistic world. After a first observation, they were “re-discovered” at the beginning of the 90’s and immediately started to cover a fundamental role in several scientific branches, from Physics to Chemistry, going through Medicine and Biology. In the Material Science and Engineering (MSE) field, a large number of studies have been conducted on carbon nanotubes, as a consequence of their extraordinary physical, technological and mechanical properties. Since 1991, a large number of attempts have been conducted, trying to exploit the outstanding potential of this carbonaceous material, in order to improve the properties of several matrices [5][6].

The primary driver and advantage in the adoption of composites is the lightweight properties of the materials. Besides weight savings, the most important benefits of composites include non-corrosive, non-conductive, flexible, will not dent, low maintenance, long life and design flexibility. Carbon nanotube metal matrix composites (CNT-MMC) are an emerging class of new materials that are being developed to take advantage of the high tensile strength and electrical conductivity of carbon nanotube materials. Aluminium alloys have wide range of application in industry because of their low density and good workability, but the yield strength is relatively low. Reinforcement adds rigidity and greatly impedes crack propagation [1]. Critical to the realization of CNT-MMC possessing optimal properties in these areas are the development of synthetic techniques that are [7][8]

a) Economically producible,

b) Provide for a homogeneous dispersion of nanotubes in the metallic matrix,

c) Lead to strong interfacial adhesion between the metallic matrix and the carbon nanotubes.

Thin fibres can have very high strength and overall properties can be improved. Carbon nanotubes have a number of valuable and unique properties including high stiffness, high strength and tenacity compared to other fiber materials which usually lack one or more of these properties. Thermal and electrical conductivity are also very high comparable to other conductive materials. Due to the reinforcement of Carbon nanotubes in Aluminium, the resultant composite can have high strength to weight ratio, provided they are mechanically well attached to the matrix. The carbon nanotube reinforcement can greatly improve overall properties of the composites [9][10].

2. THE PROCESS OF EXPERIMENTATION – THE DFD & THE FLOW CHART

The Fig. 14 gives the process of experimentation – the data flow diagram that is being followed to arrive at the experimental results.

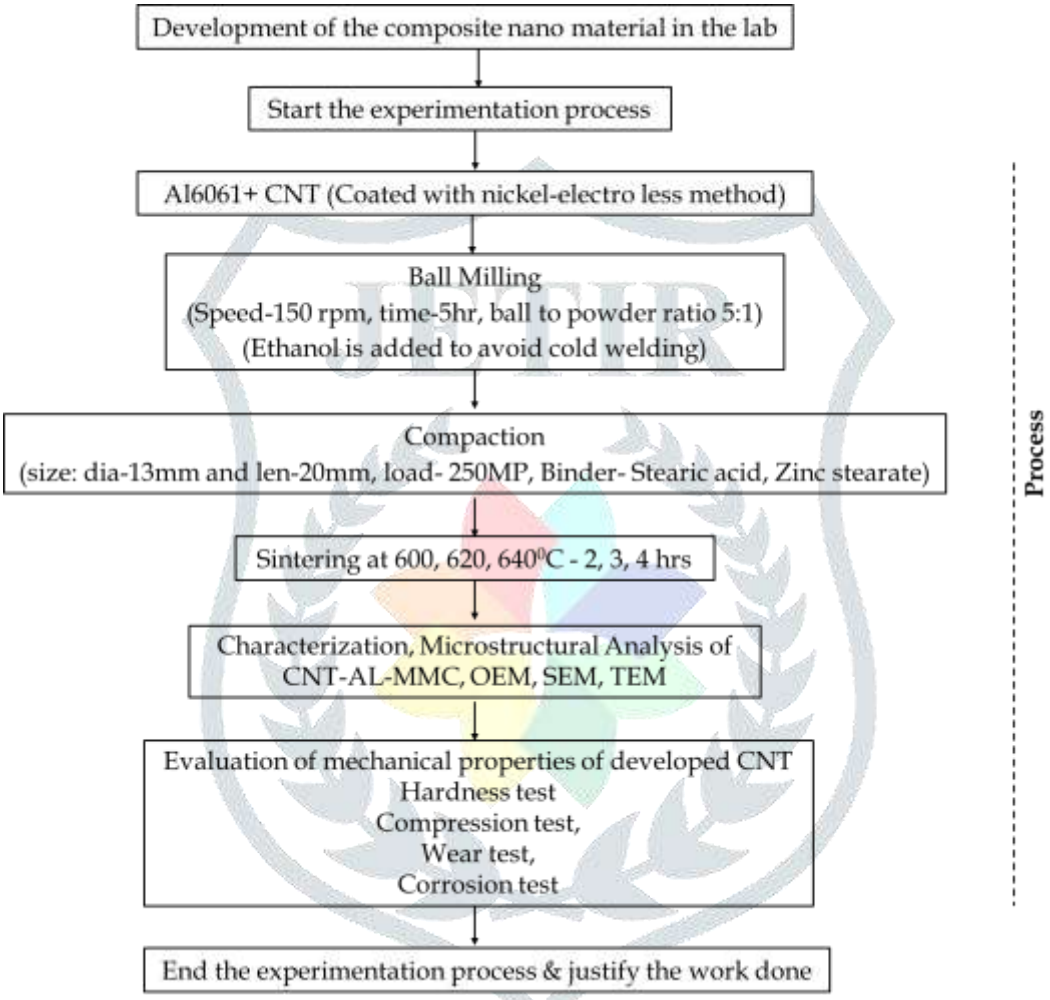

Fig. 1 : Flow chart of the proposed model

3. CONCLUSIONS, OUTCOMES, APPLICATIONS & FUTURE SCOPE

In this section, we present the brief outcome, i.e., the conclusions about the research work done followed by the scope for the future work in this exciting field of composite materials in mechanical engineering & is being presented along with the outcome and scope for future work with the applications of the conducted research.

Research was carried out on the Studies on Carbon Nanotube Reinforced Aluminium-6061 Metal Matrix Composites. Al 6061 powder as matrix mixed with MWCNT in weight percentages of 0 and 1% as reinforcement were produced through powder metallurgy route. The specimens were sintered successfully. Specimens were subjected to evaluate the behaviour of microstructure and mechanical properties such as compression strength and hardness. To start with, extensive research was carried out on the chosen research topic of composites. During this period, reference books and conference papers covering the fundamental theoretical concepts which would be a background for the research work were collected & studied.

Al 6061 powder as matrix mixed with MWCNT in weight percentages of 0 to 2% CNTs in steps of 4, viz., 0, 1, 1.5 & 2 respectively, as reinforcement were produced through powder metallurgy route. The specimens were sintered successfully. Specimens were subjected to evaluate the behaviour of microstructure and mechanical properties such as compression strength and hardness. Al series is a globally available material, which is used for a host of aerospace engg. applícations for non-corrosive, high strength to weight ratio & different weight counts. If the wt. counts are increased beyond 2.0, the carbon properties strengths gets reduced. The experimental results shows the efficacy of the methodology that is being proposed by us.

REFERENCES

[1]. El-Eskandarany, "Mechanical alloying: Fabrication of advanced materials at room temperature", *Dar Al Fekr Al Araby*, 1st edition, 2000.

[2]. Suryanarayana, "C: Mechanical alloying and milling," *Prog. Mater. Sci*., vol. 46, pp. 1-184, 2001.

[3]. A.S. Edelstein, and R.C. Cammarata. "Nanomaterials : Synthesis, Properties and Applications", *London: The institute of physics publishing*, 2007.

[4]. Retsch PM400 manual, accessed on 12/4/2010

[5]. T. Kuzumaki. K Miyazawa. H. Ichinose, K. Ito, "Processing of Carbon Nanotube Reinforced aluminum Composite," *Journal of Materials Research*, Vol. 13, pp. 2445-2449, 1998.

[6]. R. Zhong, H.T. Cong, P.X. Hou, "Fabrication of nano-Al Based Composites Reinforced By Single-walled Carbon Nanotubes," *Carbon*, Vol. 41, pp. 848-851, 2003.

[7]. R. George, K.T. Kashyap, R. Rahul, S. Yamdagni, "Strengthening in Carbon Nanotube/Aluminum (CNT/Al) Composites", *Scripta Materialia*, Vol. 53, pp. 1159–1163, 2003.

[8]. D. Poirier, R. Gauvin, R.A.L Drew, "Structural Characterization of a Mechanically Milled Carbon Nanotube/aluminum Mixture", *Journal of Composites Part A*, 2009.

[9]. S.R. Bakshi, D. Lahiri, and A. Argawal, "Carbon nanotube reinforced metal matrix composites - A Review", *Journal of International Materials Reviews*, vol. 55, pp. 41, 2010.

[10]. Rams J., A. Urena, M.D. Escalera and M. Sanchez, "Electro-less nickel coated short carbons in aluminium matrix composites", *Journal of Composites: part A: Applied science and manufacturing*, vol. 38, pp. 566-575, 2007.

[11]. Craig Drukin, "Low-Cost Continuous Production of Carbon Fiber reinforced Aluminum Composites", *Material Science and Engineering, Georgia Institute of Technology*, USA, 2007.

[12]. Urena A., J. Rams, M.D. Escalera and M. Sanchez, "Effect of copper electroless coatings on the interaction between a molten Al-Si-Mg alloy and coated short carbon fibers" *Journal of Composites: Part A: Applied science and Manufacturing*, vol. 38, pp. 1947-1956, 2007.

[13]. N. Popovska, H. Gerhard, D. Wurm, S. Poscher, G. Emig and R.F. Singer, "Chemical vapor deposition of titanium nitride on carbon fibers as a protective layer in metal matrix composites", *Journal of Materials and Design*, vol. 18, vol. 4-6, pp. 239-242, 1997.

[14]. Woei-Shyan Lee, Wu-Chung Sue and Chi-Feng Lin, "The effects of temperature and strain rate on the properties of carbon fiber reinforced 7075 aluminium alloy metal matrix composite", *Journal of Composite Science and Technology*, vol. 60, pp. 1975- 1983, 2000.

[15]. Chen H. and A.T. Alpas, "Wear of aluminium matrix composites reinforced with nickel coated carbon fibers", *Journal of Wear*, vol. 192, pp. 186-198, 1996.

[16]. Qunqing Li, Shoushan Fan, Weiqiang Han, Chenhang Sun and Wenjie Liang, "Coating of Carbon Nanotube with Nickel by Electroless Plating Method", *JPN. J. Appl. Phys.*, vol. 36, pp. 501-503, 1997.

[17]. ASM Hand book, Composites, *ASM Int. Publication*, edition 10, Vol. 21, Dec. 2001.

[18]. Srinivasa R. Bakshi, Arvind Agarwal "An analysis of the factors affecting strengthening in carbon nanotube reinforced aluminium composites", *Journal of Carbon*, 49, 2010.

[19]. A.M.K Esawi, K. Morsi, A. Sayed, M. Taher, S. Lanka "Effect of carbon nanotube (CNT) content on the mechanical properties of CNT reinforced aluminium composites", *Composites science and technology*, vol. 70, pp. 2237-2241, 2010.

[20]. A method to obtain homogeneously dispersed carbon nanotubes in Al powders for preparing Al/CNTs nanocomposite, *Jour. Nanotechnol.*, vol. 4, pp. 025015, 2013.

[21]. Devanshu Singla, Kaza Amulya, Qasim Murtaza, "CNT reinforced aluminium metal matrix composite- a review", *Materials today*, pp. 2886-2895, 2015.

[22]. R. George, K.T. Kashyap, R. Rahul, S. Yamdagni, "Strengthening in carbon nanotube/aluminium (CNT/Al) composites", *Scripta Materialia*, vol. 53, pp. 1159-1163, 2005.

[23]. J.M. Mendoza-Duarte, I. Estrada-guel, C. Carreno-Gallardo, R. Martinez-Sanchez, "Study of Al composites prepared by high-energy ball milling ; Effect of processing conditions", *Journal of Alloys and Compounds*, 2015.

[24]. D. Jayasimman, K. Sivasankaran, R. Narayanaswamy, "Fabrication and consolidation behavior of Al 01 nanocomposite powders reinforced by multi-walled carbon nanotubes", *Powder Technology*, vol. 28, pp. 189-197, 2014.

[25]. A.M.K. Esawi, K. Morsi, A. Sayed, M. Taher, S. Lanka, "The influence of carbon nanotube (CNT) morphology and diameter on the processing and properties of CNT-reinforced aluminium composites", *Journal of Composites* : *Part A*, vol. 42, pp. 234-243, 2011.

[26]. Diptikanta Das, Devashish Kumar Roy, M.P. Satpathy, B.K. Nanda and R.K. Nayak, "Compressive, impact and flexural behaviour of Al based metal matrix composites", *Materials Today*, vol. 18, pp. 3080-3086, 2019.

[27]. L.H. Manjunatha, Mohammed Yunus, Mohammad S. Alsoufi, P. Dinesh, "Development and comparitive studies of Aluminium-Based carbon nano tube metal matrix composites using powder metallurgy and stir casting technology", *International Journal of Scientific and Engineering Research,* Vol. 8, No. 2, pp. 2229-5518, 521-526, 2017.

[28]. Monimoy Saha, Balachandra P. Shetty, Kiran Aithal, Mukunda P.G., "Synthesis and Comparative study of Microwave and conventionally sintered Al-SiC MMC through powder metallurgy, III, Volume III, Issue VIII, August 2014 IJLTEMAS ISSN 2278 – 2540, *International Journal of Latest Technology in Engineering, Management & Applied Science*, pp. 2278-2540, 2014.

[29]. Cesar A. Isaza Merino, J.E. Ledezma Sillas, J.M. Meza, J.M. Herrera Ramirez, "Metal matrix composites reinforced with carbon nanotubes by an alternative technique", *Elsevier's Journal of Alloys and Compounds*, Volume 707, 15 June 2017, pp. 257-263, 15 June 2017.

[30]. M. Raviathul Basariya, V.C. Srivastava, N.K. Mukhopadhyay, "Microstructural characteristics and mechanical properties of carbon nanotube reinforced Aluminium alloy composites produced by ball milling", Ref. : JMAD 6716, *Elsevier's Journal of Materials and Design*, Vol. 64, pp. 542-549, Dec. 2014.