

Characterization of Cu Chips Producing Through High Energy Ball Milling

Prem kumar G ¹, Ragu M ², Sivakumar R³, Sasidharan S ⁴U.G. Student, Department of Mechanical Engineering, Muthyammal Engineering College, Rasipuram, Tamil Nadu^{1,2,3}Assistant Professor, Department of Mechanical Engineering, Muthyammal Engineering College, Rasipuram, India⁴

ABSTRACT: Nanomaterials are experiencing a rapid development in recent years due to their existing and/or potential applications in a wide variety of technological areas such as electronics, catalysis, ceramics, magnetic data storage, structural components etc. Mechanical alloying is a solid-state powder processing technique involving repeated Making of powder particles in a high-energy ball mill. Mechanical Alloying has now been shown to be capable of synthesizing a variety of equilibrium and non-equilibrium alloy phases starting from blended elemental or pre-alloyed powders. This proposed work is to produce Mechanical alloying materials from the copper chips through High Energy Ball milling. Micro crystalline copper powder was produced by copper chips have been taken by HEBM 5, 10, 15 and 20hr at constant speed of 250rpm with BPR 10:1 the grain size and microstructure of the copper samples determined by using SEM. Characterization and phase of copper materials investigated by using X-ray diffraction.

KEYWORDS: High Energy Ball milling, Copper chips, X-ray diffraction, Scanning Electron Microscope

I. INTRODUCTION

In recent years, nanocrystalline materials have drawn the attention of researchers in the field of materials science engineering due to its enhanced mechanical properties such as high strength and high hardness. However, the cost of nanocrystalline materials is prohibitively high, primarily due to the expensive equipments used and the low output. Recently, researchers have attempted to produce nanocrystalline materials through machining [1]. Synthesis of nanomaterials by a simple, low cost and in high yield has been a great challenge since the very early development of nanoscience[2]. X-ray diffraction is really a valuable technique technique for characterization in terms of materials microstructure. Indeed, the ball milling of metals or alloys induces extended variations in the intensity distribution of XRD diagrams [3]. Mechanical alloying has recently attracted considerable attention as researchers strive to enhance nanocomposite properties and extend their utility. The process can be performed at room temperature and homogeneous nanocomposite powders can be produced [4]

The aspect ratio of the reinforcement is an important quantity, because the degree of load transfer from the matrix to the reinforcement is directly proportional to the reinforcement aspect ratio. Thus, continuous fibers typically provide the highest degree of load transfer, because of their very high aspect ratio, which results in a significant amount of strengthening along the fiber direction [6] Particle or short fiber reinforced metals have a much lower aspect ratio, so they exhibit lower strengths than their continuous fiber counterparts, although the properties of these composites are much more isotropic [7]

II. EXPERIMENTAL DETAILS

Mechanical Alloying or High Energy Milling:

Mechanical alloying was originally invented as a method to manufacture oxide dispersion strengthened nickel alloys It is a high energy ball milling process, where alloying is the result of the repeated fracture and cold welding of the component particles. Highly metastable materials such as amorphous alloys and nanostructured materials can be prepared by the process. Scaling up to industrial quantities seems straight forward. In addition to attrition and agglomeration, high energy milling can induce chemical reactions, which can be used to influence the milling process and the properties of the product. This fact was utilized to prepare magnetic oxide-metal nanocomposites via

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

mechanically induced displacement reactions between a metal oxide and a more reactive metal. High energy ball milling can also induce chemical changes in non-metallurgical binary systems, including silicates, minerals, ferrites, ceramics, and organic compounds. The research area of mechanochemistry was developed to study and utilize these processes. As many mechanical alloying processes involve chemical changes, the distinction between mechanical alloying and mechanochemistry is often arbitrary.

The alloying process can be carried out using different apparatus, namely, attritor, planetary mill or a horizontal ball mill. However, the principles of these operations are same for all the techniques. Since the powders are cold welded and fractured during mechanical alloying, it is critical to establish a balance between the two processes in order to alloy successfully.

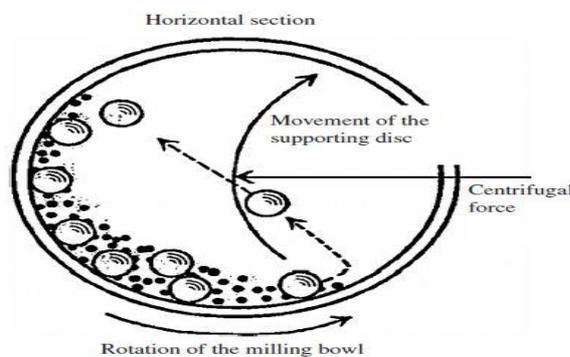


Fig.No:1.1 Schematic view of motion of the ball and copper chips

During the high-energy ball milling process, the powder particles are subjected to high energetic impact. Microstructurally, the mechanical alloying process can be divided into four stages: (1) initial stage, (2) intermediate stage, (3) final stage, and (4) completion stage.

1. At the initial stage of ball milling, the powder particles are flattened by the compressive forces due to the collision of the balls. Micro-forging leads to changes in the shapes of individual particles, or cluster of particles being impacted repeatedly by the milling balls with high kinetic energy. However, such deformation of the powders shows no net change in mass.
2. At the intermediate stage of the mechanical alloying process, significant changes occur in comparison with those in the initial stage. Cold welding is now significant. The intimate mixture of the powder constituents decreases the diffusion distance to the micrometer range. Fracturing and cold welding are the dominant milling processes at this stage. Although some dissolution may take place, the chemical composition of the alloyed powder is still not homogeneous.
3. At the final stage of the mechanical alloying process, considerable refinement and reduction in particle size is evident. The microstructure of the particle also appears to be more homogenous in microscopic scale than those at the initial and intermediate stages. True alloys may have already been formed.
4. At the completion stage of the mechanical alloying process, the powder particles possess an extremely deformed metastable structure. At this stage, the lamellae are no longer resolvable by optical microscopy. Further mechanical alloying beyond this stage cannot physically improve the dispersed distribution. Real alloy with composition similar to the starting constituents is thus formed.

Theoretical considerations and explorations of planetary milling process have been broadly studied in order to better understand and integrate the concept. Joisel's work is the first report to study the shock kinematics of a "satellite milling machine." This work focused on the determination of the milling parameters that were optimized for shock energy. The various parameters were determined geometrically and the theoretical predictions were examined experimentally using a specifically designed planetary mill. Schilz et al. reported that from a macroscopical point of view, the geometry of the mill and the ratio of angular velocities of the planetary to the system wheel played crucial roles in the milling performance. For a particular ductile-brittle Mg-Si system, the milling efficiency of the planetary ball was found to be heavily influenced by the ratio of the angular velocity of the planetary wheel to that of the system

International Journal of Innovative Research in Science, Engineering and Technology

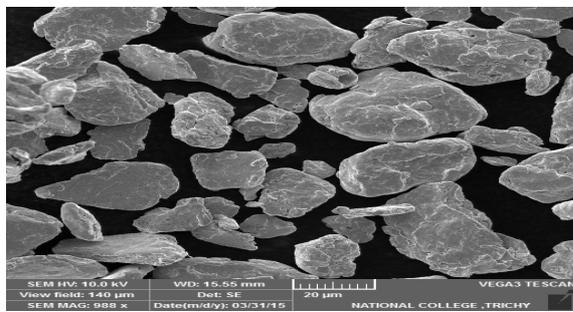
(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

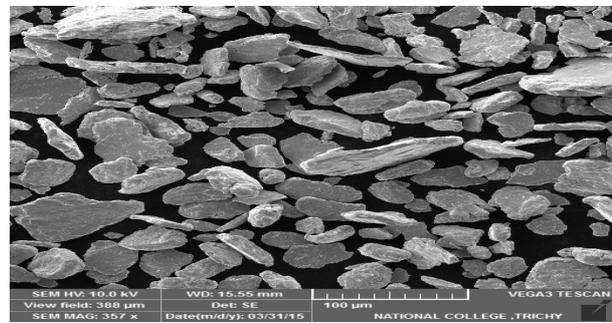
wheel as well as the amount of sample load. Mio et al. studied the effect of rotational direction and rotation-to-revolution speed ratio in planetary ball milling. Some more theoretical issues and kinematic modeling of the planetary ball mill were reported later in related references. Because mechanical alloying of materials are complex processes which depend on many factors, for instance on physical and chemical parameters such as the precise dynamical conditions, temperature, nature of the grinding atmosphere, chemical composition of the powder mixtures, chemical nature of the grinding tools, etc., some theoretical problems, like predicting equilibrium phase transitions under milling, are still in debate.

III. RESULTS AND DISCUSSION

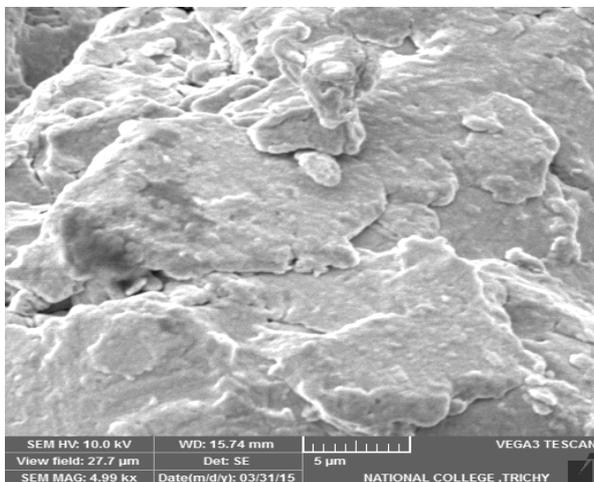
SCANNING ELECTRON MICROSCOPE FOR CU PARTICLES



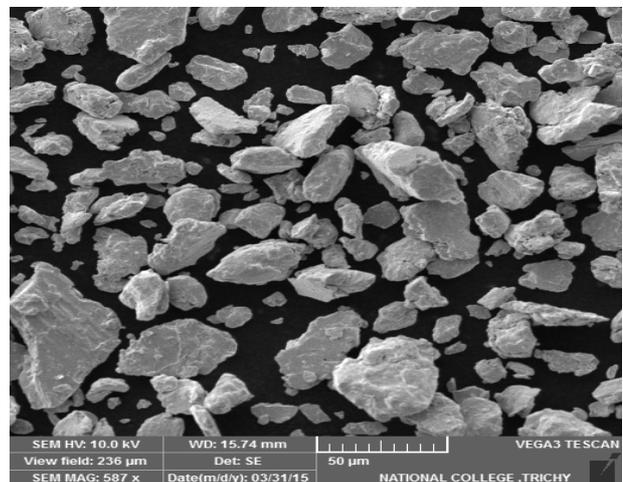
(a)



(b)



(c)



(d)

XRD RESULTS

Peak list for 10hr

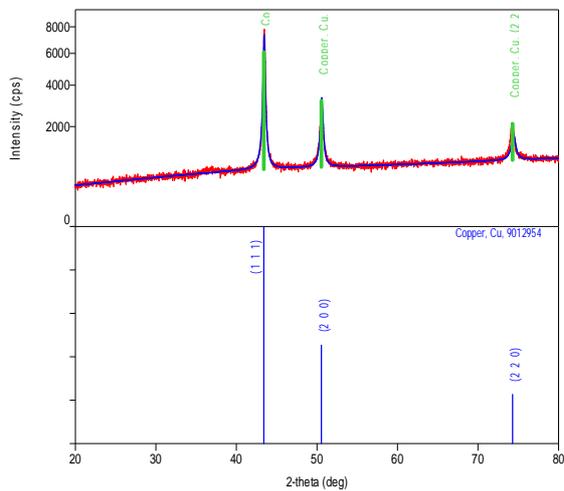
S.No	2-theta (deg)	D (ang.)	Height (cps)	FWHM (deg)	Int.I (cps deg)	Int.W (deg)	Asym.factor r
1	36.7 (3)	2.45(2)	30(9)	1.6(3)	52(14)	1.7(9)	1.2(11)
2	43.458 (4)	2.08066(18)	5343(116)	0.253(6)	2230(10)	0.417(11)	1.31(10)
3	50.557 (13)	1.8039(4)	1570(63)	0.396(15)	10296(10)	0.66(3)	1.1(2)
4	74.200 (14)	1.2770(2)	945(49)	0.43(3)	688(10)	0.73(5)	1.01(19)

Table 1 Peak list for 10hr

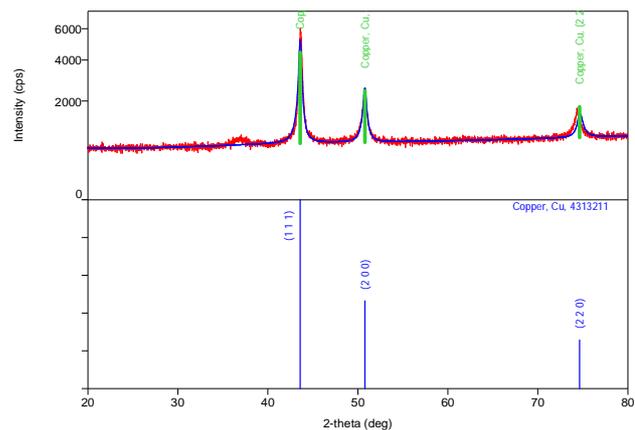
Peak list for 20hr

S.No	2-theta (deg)	D (ang.)	Height (cps)	FWHM (deg)	Int.I (cps deg)	Int.W (deg)	Asym.factor
1	36.82(14)	2.439(9)	83(14)	1.60(12)	146(16)	1.7(5)	1.0(3)
2	43.620(8)	2.0733(4)	3788(97)	0.347(9)	2197(13)	0.564(18)	1.15(13)
3	50.712(18)	1.7987(6)	1015(50)	0.587(19)	965(11)	0.95(6)	1.03(16)
4	74.34(2)	1.2749(3)	605(39)	0.57(4)	630(12)	1.04(9)	0.79(15)

Table 2 Peak list for 10hr



(e) Peak list for 10hr



(f) Peak list for 20hr

Figure a, SEM morphology of copper samples after 10 hours of high energy ball milling. In contrast, the case with 10:1 BPR-250 rpm and 10 hours revealed a totally different microstructure (140µm 998x). Figure b, In contrast, the case with 10:1 BPR-250 rpm and 10 hr revealed a totally different microstructure (388µm 357x). Figure c, SEM morphology of copper samples after 20hours of high energy ball milling. In contrast the case with 10:1 BPR-250rpm and 20 hr revealed a totally different microstructure (5µm 357x). Figure d, In contrast, the case with case 10:1 BPR-250 rpm and 20hr revealed a microstructure (236µm, 4.99x).

Figure e, Shows the peak values of XRD for 10 hours and 250rpm are given in the table 1 with theta values and height of the peak then Asym. Factor, FWHM (deg), Int. I(cps deg), Int. W(deg). Figure f shows the peak values of XRD for 20 hours and 250rpm are given in the table 2 with the theta values and height of the peak then Asym. Factor, FWHM (deg), Int. I(cps deg), Int. W(deg).

IV. CONCLUSION

The various synthesis process of micro powder and journal related to mechanical alloying process are studied, based on the literature support copper and copper alloys identified. In this proposed work a systematic view of the basic concept of mechanical milling, historical view and applications of mechanical milling in the synthesis of various copper chips, and various structures have been studied.

From SEM graph grain size value obtained directly based on this SEM Result decrease the grain size during HEBM was expected based the results captured through diffraction it has been surely that grain size of copper chips reached to

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

micro level at 20hr. Then XRD peaks 10hr value is 2.45 μ m and micro size 200 μ m, 20hr value is 2.43 μ m and micro size 75 μ m and finally peaks have been decreases so 20hr is the better micro material stage based on the above results.

REFERENCES

1. Brouisol. British Patent No. 392556, 1931.
2. Canano Technologies, 230 Metcalf Street, P.O. Box 911, Tweed, Ontario, K0K 3J0.
3. Drescher, W. H., "Speeding up your computer in the 21st Century using Copper ICs," Innovations, Copper Development Association Inc., January 2000.
4. N.Muthukrishnan & M. Murugan & K. Prahlada Rao "Machinability issues in turning of Al-SiC (10p) metal matrix composites" Int J Adv Manuf Technol (2008) 39:211
5. J.T. Lin, D. Bhattacharyya, C. Lane "Machinability of a silicon carbide reinforced aluminium metal matrix composite" Wear 181-183 (1995) 883-888
6. R.Venkatesh, A.M.Hariharan, N.Muthukrishnan "Machinability Studies of Al/SiC/ (20p) MMC by Using PCD Insert (1300 grade)" Proceedings of the World Congress on Engineering 2009 Vol II WCE 2009, July 1 - 3, 2009, London, U.K.
7. Mahamani.A "Machinability Study of Al-5Cu-TiB₂ In-situ Metal Matrix Composites Fabricated by Flux-assisted Synthesis" Journal of Minerals & Materials Characterization & Engineering jmmce.org, Vol. 10, No.13, pp.1243-1254, 2011
8. Sujit Das, R. Behera, G. Majumdar, B. Oraon, G. Sutradhar "An experimental investigation on the machinability of powder formed silicon carbide particle reinforced aluminium metal matrix composites" International Journal of Scientific & Engineering Research Volume 2, Issue 7, July-2011 I ISSN 2229-5518
9. Farzana Hussain, Mehdi Hojjati, Masami Okamoto, Russell e. gorga "Review article: Polymer-matrix Nanocomposites, Processing, Manufacturing, and Application: An Overview" Journal of Composite Materials 2006; 40; 1511 DOI: 10.1177/0021998306067321
10. N. Muthukrishnan & M. Murugan & K. Prahlada Rao "An investigation on the machinability of Al-SiC metal matrix composites using PCD inserts" Int J Adv Manuf Technol (2008) 38:447-454 DOI 10.1007/s00170-007-1111-z
11. M. Ramezani, T. Neitzert "Mechanical milling of aluminum powder using planetary ball milling process" journals of achievements in materials and manufacturing engineering volume 55 issue 2 december 2012
12. Jarmila Degmov'a, J'org Finnberg, Stefan Roth "(FeSm) - (FeALPCBSiGa) Composites prepared by hot-pressing of ball milled powders" Journal of ELECTRICAL ENGINEERING, VOL. 58, NO. 2, 2007, 118-120
13. Kyoung-Muk Lee, Seh-Min Oh, and Sung-Man Lee, "Electrochemical Properties of Carbon Composites Prepared by Using Graphite Ball-milled in Argon and Air Atmosphere" Bull. Korean Chem. Soc. 2008, Vol. 29, No. 6 1121
14. N. Hari Babu, Zhongyun Fan, and Dmitry G. Eskin "Application of external fields to technology of metal matrix composite materials" TMS2013 Annual Meeting Supplemental Proceedings, TMS (The Minerals, Metals & Materials Society), 2013
15. Yousef Mazaheri, Fathallah Karimzadeh*, Mohammad-Hosein Enayati "Nanoindentation Study of Al₃Si- Al₂O₃ Nanocomposite Prepared by Ball Milling" Materials Sciences and Applications, 2010, 1, 217-222 doi:10.4236/msa.2010.14034 Published Online October 2010 (<http://www.SciRP.org/journal/msa>)
16. J. Bhatta, N. Balachandera, S. Shekhera, R. Karthikeyan, D.R. Peshwea, B.S. Murtyb "Synthesis of nanostructured Al-Mg-SiO₂ metal matrix composites using high-energy ball milling and spark plasma sintering" Journal of Alloys and Compounds 536S (2012) S35- S40
17. S.Senthil babu, B K.Vinayagam "Study of some parameters on drilling of Al based Metal Matrix Composites - a review" International Journal of Scientific & Engineering Research Volume 3, Issue 7, June-2012 I ISSN 2229-5518
18. R.Karthigeyan, G.Ranganath, S.EzhilVannan, S.Paul Vizhian, K.Annamalai "Review of Al Metal Matrix Composite and Basalt Fiber as a New Reinforcement for MMC" Life Science Journal 2013;10(7s)
19. Hartaj Singh, Sarabjit, Nrip Jit, Anand K Tyagi "An Overview of Metal Matrix Composite: Processing and Sic based Mechanical Properties" Journal of Engineering Research and Studies E-ISSN0976-7916
20. Christopher Kingston, Richard Zepp, Anthony Andrady "Release characteristics of selected carbon nanotube" C A R B O N 6 8 (2 0 1 4) 3 3 - 5 7
21. Sanjay Kumar, Amit Tirpude, Manju Taxak, Nagaiyar Krishnamurthy "Hydrogen absorption kinetics in powdered V + 80 wt.% LaNi₅ composite" Journal of Alloys and Compounds 580 (2013) S179-S182.