SYNTHESIS AND CHARACTERIZATION OF TITANIUM CARBIDE REINFORCED COPPER BASED METAL MATRIX COMPOSITE

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Abstract - *Copper based materials are widely used in industrial applications due to its high electrical and thermal conductivities, low cost and ease of fabrication. However, t he relatively low hardness,low strength and poor wear resistance limiti ts extensive applications. These shortcomings could be avoided by the incorporation of hard ceramics into the copper matrix. In recent years, researchers are focusing on development of copper based insitu metal matrix composites owing to its several advantages over exit techniques .In-s itu method of composite manufacturing involves synthesis offine, homogenously distributed; thermodynamically stable reinforced particles within the matrix material. In-situ composites exhibits good bond between matrix and reinforcement with isotropic properties. In the present investigation,Copper-10wt% TiCin-situ metal matrix composite was synthesized by mixing copper, hexaflurotitanate and graphite powder in stochiometric proportionate temperature of 1100oC using stir casting route. Both copper matrix and copper-TiC composite were subjected to microstructure studies, x-ray diffraction analysis, hardness and tensi le test. All the tests were conducted as per ASTM standards. Optical micrograph shows fine and uniform distribution of TiC particles throughout the matrix alloy. X-ray diffraction analysis confirmed the formation of Titanium carbide particles. Developed Composite exhibit a significant improvement in hardness and ultimate tensile strength when compared with unreinforced copper.*

***Key Words*: Copper, Titanium carbide Powder, etc...**

1. INTRODUCTION

Here we have taken copper because it is an radiant material for a verity of demands in power and engineering industries, because of its superior thermal and electrical conductivities in inclusion to chemical stability. The copper is a soft metal and have less high-temperature strength that tends to failure of components in operation. The problems takes such as corrosion and minor overhead thermal properties, that which suffered from copper-based alloys ie., bronzes and brasses. Hence it's become a task to upgrade the rised temperature properties of Copper also copper-based alloys without affecting the high electrical and thermal conductivities and corrosion resistances. Ceramic particulates in Copper based MMC's have radiant more interest during last few years. These composite materials have high temp strength and fine micro structural stability, excellent thermal and electrical conductivity. Titanium carbide is an radiant ceramic material having high modulus, melting temperature and hardness. In recent years, copper-based MMC's containing Titanium carbide (Ti C) particles have largely been look over due to their possible applications such as high performance switches, heat exchangers, electrical sliding contact, electrodes, resistance welding electrodes, motors, etc... Adding of TiC particles is possessed to improve stiffness, hardness, wear and tensile properties and in composite the coefficient of thermal expansion is minimized. In addition to that the reduction of thermal and electrical conductivities because of containing of TiC in copper matrix has been observed that their is a comparison less in many other ceramics reinforcment particles. Addition of Titanium carbide particles in matrices metal like copper Cu by external means creates the problems due to the high contact angle between the TiC particles and Cu melts like segregation of a dispersed phase and poor(TiC/matrix) interfacial bonding. Like same, the inferior mechanical properties are attained in a synthesized composite. For reducing these seriousness of the above problems is suggested the in situ of dispersed phase is generated. The self-propagating high temperature synthesis (SHS) processes is a important method in generation of titanium carbide In situ metal matrices. The chemical reaction is exothermic between reactant materials in this process. The process helps in reducing in energy, cost and time. Within matrix the size and contents of the dispersed phase can be controlled thoroughly by this SHS process. The upgraded bond strength between the reinforcement and thus the matrix by in situ generation within matrix due to using of a thermodynamically stable reinforcement (80%

content) by using SHS process. In various previous investigations, by powder metallurgy Cu-TiC is synthesized by using SHS, therefore the composites with high porosity are produced by elemental powders is mixed, compacted and sintered. To reinforce the wetability of a reinforcing phase due to adding reactive elements like Ni,Zr,V,Ti,Cr,Al ,etc.in melted of Cu/Ti/Fe/Ni . How ever, any attempts not sems to been done to research the effect of Al adding on the micro structural characteristics and properties of Cu-TiC composites in situ. No examining takes palce of composite characteristics. This is because of the actual fact that during the low quantity of TiC formation the heat that generated is suited insufficient to support the reaction for the needed time, degree. From above vission, to synthesize Titanium carbide particles by in situ generation conducted by doin SHS process in molten Cu and followed by casting.

1.1 Objective

1. Preparation of charge (Cu+TiC) & casting. Fabrication of specimen for wear test according to dimensions specified by the testing laboratory.
2. Investigating presence of Cu-TiC in the prepared specimen using XRD & EDAX method.
3. Conducting wear analysis, analyzing surface characteristics of wear specimens after wear test using SEM.
4. Tabulating & evaluation of results and concluding.

2. LITERATURE REVIEW

[1](oct2018)Multiobjective optimization,of insitu process parameters in preparation of Al-4.5%Cu–TiC MMC [2](Jan 2014) Cu-TiO2 composite as fabricated by SHS method [3] (may 2018) Fabrication of copper–TiC–graphite hybrid metal matrix composites through microwave processing [4] (Aug 2018) Microstructural Characterization and Sliding Wear Behavior of Cu/TiC Copper Matrix Composites Developed Using Friction Stir Processing [5] (Feb 2015) Characterization of Newly produced Semisolid Stir Joining Method for Cast Cu Base Alloy (Cu-Al- Si-Fe) and Effect of Stirrer Type on Uniformity of Microstructure[6] (Aug 2013) Modeling the abrasive wear characteristics of *in-situ* synthesized Al–4.5%Cu/TiC composites.

3. Methodology

3.1. Stir casting

Stir casting is a method in which the composite material fabricated by which the molten matrix is mixed by a ceramic particles by means of mechanical stirrer. Stir casting is the liqid state fabricating method is a cost effective and economical.

3.2. Materials used to prepare Composites

Here we used base alloy as copper alloy for Titanium Carbide as reinforcement materials. Titanium Carbide powder particles size are 50microns. The base metal Cu is a non heat treatable alloy. It has good casting properties, corrosion resistance average strength and ductility. The copper weight, titanium carbide are calculated by the stochiometric ratio with reference to the chemical reaction:

$$3Cu+2TiC \Rightarrow Cu_3Ti$$

The elemental weight composition for different compositions is as shown below:

1. 0% - Pure copper.
2. 2.5% - 30g of TiC with 951g of copper.
3. 5% - 60g of TiC with 910g of copper.
4. 7.5% - 80g of TiC with 855g of copper.
5. 10% - 120g of TiC with 800g of copper.

Table -1: Properties of Matrix & Reinforcing materials

Material	Density Gm/cm²	Melting point °C
Copper	8.92	1083
TiC	4.79	1660

3.3. Raw Materials

For the preparation of the specimens totally 6 kgs of copper and 1/2 kg of TiC was purchased, which were weighted as per the above mentioned composition details.

3.4 Melting process

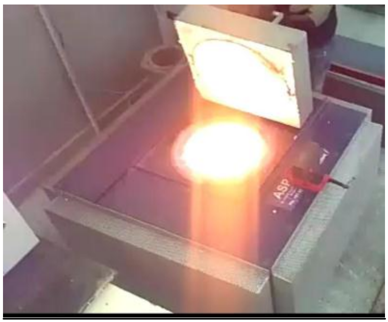
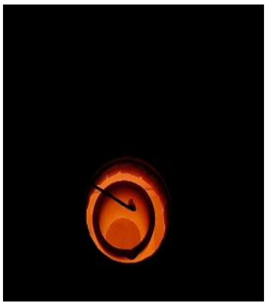


Fig-1: Melting of Copper Alloy

After the moulds are prepared the material is first preheated, the dies is heated to remove the moisture if present in it. The crucible is heated to a temperature and copper is added for melting to a temperature more than 1083c.

3.5. Mixing and Pouring

After the copper is melted the reinforced materials like Titanium Carbide is added to the molten copper and it is heated above 1200°C. The molten materials is mixed with reinforced materials with the help of a manual stirrer and stirred throughly for 5 minutes.



After the material are mixed and the molten metal is taken from crucible and poured in to the dies

3.6. Cast Product

Fig-2: Cast product

After the cooling process the material is removed from the die, which was cleaned by using the sand paper to remove the dust and unwanted material present on the dies to get a better cast product. The final cast product is shown the figure above.

4. Test Conduction

4.1. X-Ray Diffraction Test

For determining the dimension of unit cell and crystalline material phase can done by best suitable method is called X-ray powder diffraction test.

4.2. Scanning Electron Microscopy

The scanning electron microscope(SEM) uses a focused beam of high-energy electronsto produce a veriety of signals at solid specimen's surface.

4.3. Energy Dispersive X-ray Spectroscopy

Energy-dispersive X-ray Spectroscopy (EDS) is a dicator used to separate characteristic-rays of various elements into an energy spectrum EDS software will used in system to analyze the energy spectrum in order to determine the plenty of specific elements. EDS is used in finding the chemical composition of materials down to a spot size of a few microns, and to create element composition on raster areas.

4.4. Wear Analysis

Wear is the slowly deformation or removal , damaging of solid surfaces of material. Due to wear can cause mechanical (erosion) or chemical (corrosion). The process of wear is related to tribology

5. Result and Discussion

5.1. X-ray Diffraction Test

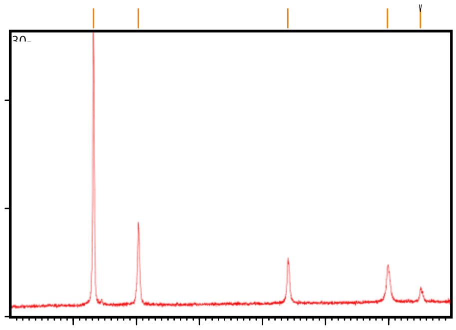


Fig -3: Graph for XRD test of 10 % Reinforcement

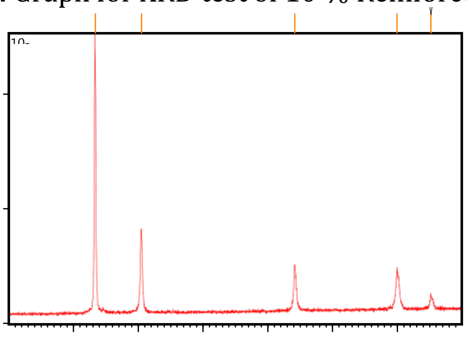


Fig -4: Graph for XRD test of 7.5 % Reinforcement

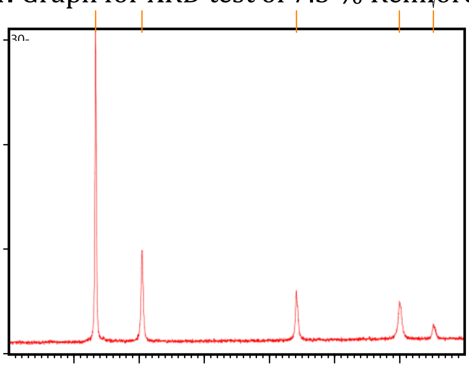


Fig -5: Graph for XRD test of 5 % Reinforcement

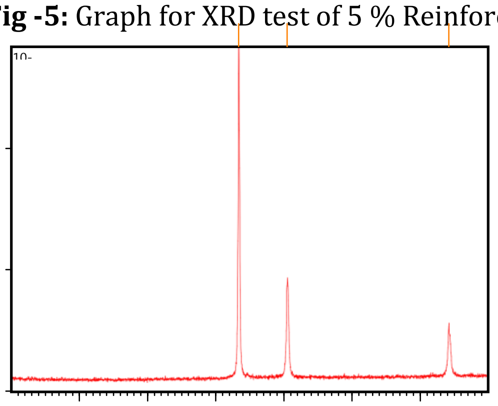


Fig -6: Graph for XRD test of2. 5 % Reinforcement

Discussion: From the above graphs we can know the presence of Cu, TiC in all the samples and mainly the formation of the Titanium Carbide can be observe(C2T).

5.2. Energy Dispersive X-ray Spectroscopy

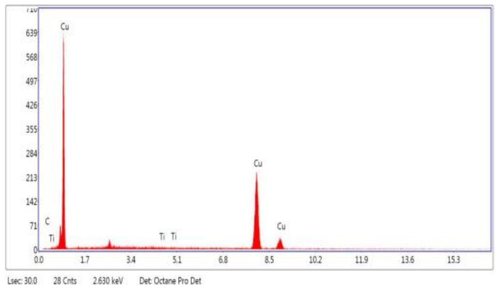


Fig -7: EDS test results for 10% Reinforcement

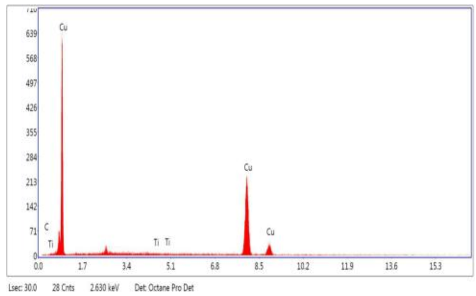


Fig -8: EDS test results for 7. 5% Reinforcement

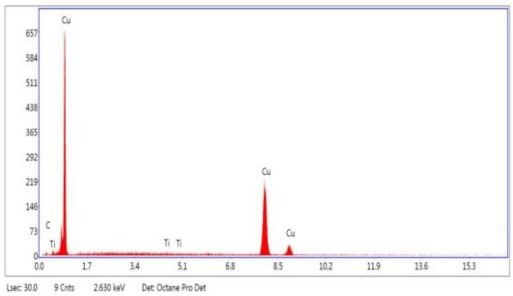


Fig -9: EDS test results for 5% Reinforcemen

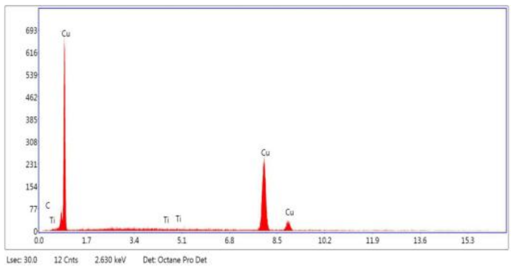


Fig -10: EDS test results for 2. 5% Reinforcement

Discussion: The EDAX test helps to find the presence of the matrix and reinforcement ie., Titanium carbide and copper.

5.3. Wear Test

Fig-11: Wear test characteristic graph for pure copper at 20N & 80N load and constant speed

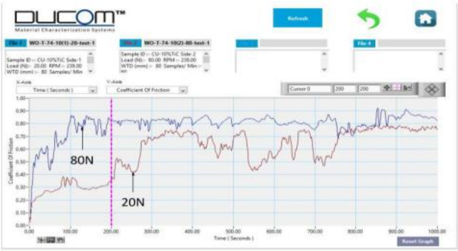


Fig-12: Wear test characteristic graph for 10% TiC at 20N & 80N load and constant speed

Fig-13: Wear test characteristic graph for pure copper and 10% TiC at 20N & 80N load and 382 & 239 RPM speed

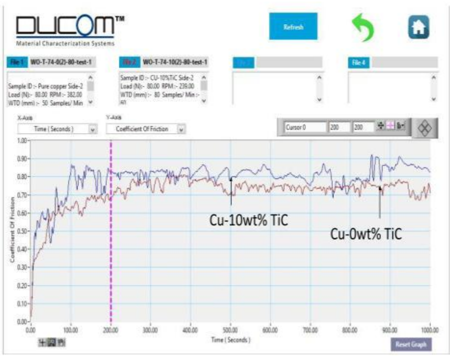


Fig-14: Compression B/W 10% TiC & Pure copper

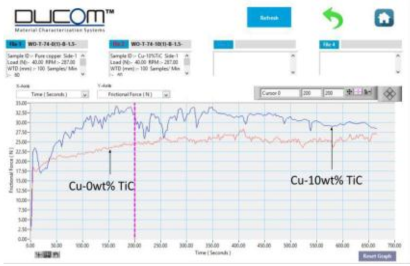


Fig-15: Compression B/W 10% TiC at 287 RPM & 40N

Fig-16: Wear test characteristic graph for pure copper at 20N & 80N load and constant speed

Discussion: From the above graphs we can conclude that as we add the reinforcement wear resistance increases.

5.4. Scanned Electron Microscope

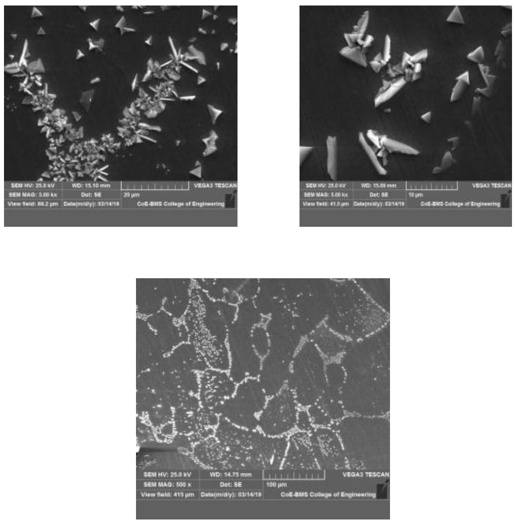


Fig-17. Grain Boundaries & Grain Structures for 2.5% TiC Reinforcement

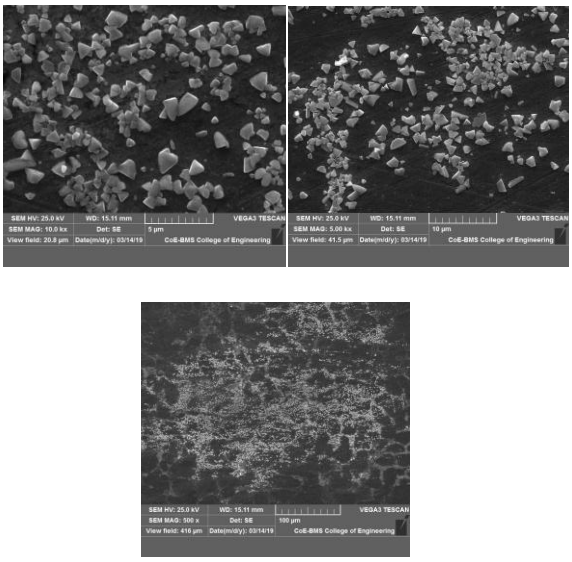


Fig-18. Grain Boundaries & Grain Structures for 5% TiC Reinforcement

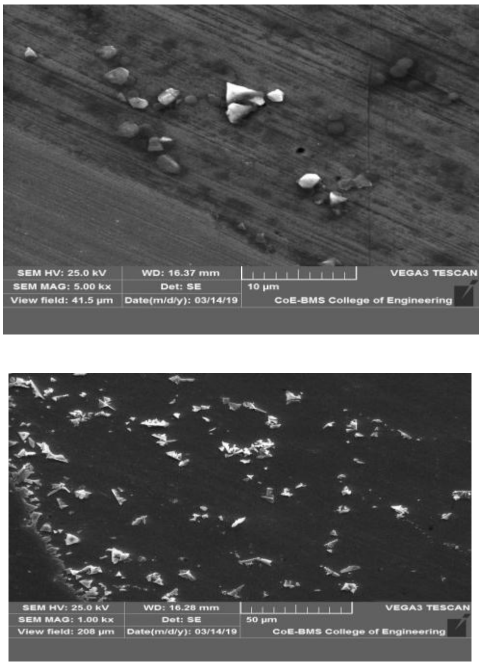
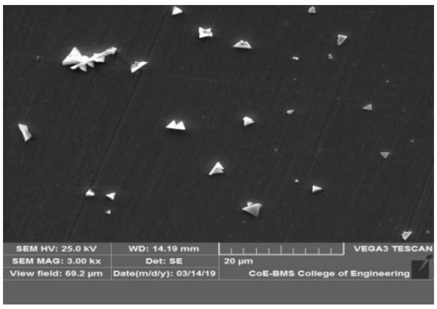


Fig-19. Grain Boundaries & Grain Structures for 7.5% TiC Reinforcement



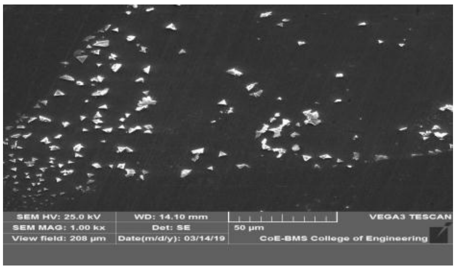


Fig-19. Grain Boundaries & Grain Structures for 10% TiC Reinforcement

Discussion: we see from the above figures that there is continues distribution of particles influence the properties of MMC

6. CONCLUSIONS

The following conclusions are drawn from the experiment conducted

When copper is heated to 1200°Cand the reinforcement is added it forms TiC in the INSITU condition when left for 20-30 minutes. As the percentage of titanium Carbide increases hardness of material increase due to increase in carbon content. When the percentage of reinforcement increases wear resistance increases and the wear of material decreases.

- ✓ To fabricate a electrical contact switch made of the presently prepared Cu-TiC MMC which have better strength.
- ✓ Investigation is carried with more different % weight of particles we can obtain good and maximum efficiency of results.
- ✓ Alloys can be replaced by Copper MMC which have better strength.

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