INVESTIGATING THE COMPARATIVE PROPERTIES OF METAL MATRIX COMPOSITES USING COPPER, STAINLESS STEEL AND MILD STEEL

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Abstract - Metal matrix composites (MMCs) offer a unique combination of properties by incorporating reinforcing elements into a metal matrix. This study investigates the comparative properties of MMCs fabricated using copper, stainless steel, and mild steel as the matrix materials. The research will explore the influence of different reinforcement materials and fabrication techniques on the mechanical, physical, and tribological properties of the resulting composites. Key properties to be compared will include tensile strength, hardness, wear resistance, and thermal conductivity. Copper MMCs are expected to exhibit enhanced electrical conductivity and thermal conductivity, while stainless steel MMCs might offer improved strength and corrosion resistance. Mild steel MMCs could provide a balance of affordability and improved mechanical properties. The investigation aims to identify the optimal combination of matrix material, reinforcement, and fabrication method for achieving specific desired properties in MMCs. The findings will contribute to the development of new and improved materials for various engineering applications.

Index Terms - Tensile strength, yield strength, hardness, wear resistance

I. INTRODUCTION

Metal matrix composites (MMCs) represent a class of advanced materials engineered to combine the desirable properties of a metal matrix with the reinforcing effects of secondary phases. These composites offer a unique opportunity to tailor material properties for specific applications by manipulating the matrix and reinforcement phases. This study focuses on investigating the comparative properties of MMCs utilizing three distinct metal matrices: copper, stainless steel, and mild steel. The selection of these specific metals is motivated by their unique characteristics: **Copper:** Known for its excellent thermal and electrical conductivity, along with good formability. MMCs with copper matrices could potentially enhance strength while maintaining these valuable properties. **Stainless Steel:** Offers superior corrosion resistance and good mechanical strength. MMCs based on stainless steel could improve specific mechanical properties while retaining its corrosion-resistant nature. **Mild Steel:** A widely used and cost-effective material with good formability and weldability. MMCs with mild steel matrices could potentially enhance specific properties without significantly impacting cost. By comparing the properties of MMCs produced using these different metal matrices, the aim is to gain a deeper understanding of the influence of the matrix material on the overall performance of the composite. This investigation will focus on mechanical strength, wear resistance. The findings of this study will contribute to a better understanding of how to design and fabricate MMCs with targeted properties for various engineering applications.

II. LITERATURE SURVEY

Cashew Nut Shell Composites: Reinforcement Material: CNS composites often use natural fibers like kenaf or cellulose nanofiber alongside the resin [1, 3]. **Properties:** Studies suggest CNS composites can achieve tensile strength and Young's modulus comparable to traditional resins [1, 3]. In some cases, CNSL content can improve properties like elongation at break [2]. **Comparison with Epoxy Resins:** Mechanical Strength: CNS composites might exhibit tensile strength comparable to epoxy resins depending on composition [1]. **Environmental Impact:** CNS composites are derived from renewable resources, making them a more sustainable alternative to epoxy (typically derived from petroleum) [1]. **Comparison with CNSL Resin:** Composite vs. Resin: CNS

composites are a combination of CNS resin and reinforcing fibers, offering potentially improved mechanical properties compared to pure CNSL resin [1, 4]. **Reinforcement Effect:** Studies haven't extensively compared pure CNSL resin with CNS composites, but the addition of fibers can significantly enhance the mechanical properties of the final material [2, 3]. **Additional Points:** CNSL can be used as a modifier or additive for epoxy resins, potentially improving certain properties like flexibility [2]. Processing techniques and fiber/resin ratios can significantly impact the final properties of CNS composites [2, 4].

Here are some resources to explore further: Comparison of Cashew Nut Shell Liquid (CNS) Resin with Polyester Resin in Composite Development [1]: This study compares CNSL resin with a traditional resin (polyester) for composite development.

Analysis of Cashew Nut Shell Resin With Kenaf Natural Fiber Composite Treated and Untreated [2, 4]: These studies explore the use of CNSL resin with Kenaf fibers as reinforcement in composites. Cashew Nut Shell Liquid (CNSL)-Derived Epoxy Composite Reinforced by Cellulose Nanofiber [3]: This research investigates the use of CNSL as a modifier for epoxy resin and the impact of cellulose nanofiber reinforcement on the composite. **Comparison Points:** Mechanical Properties: Studies are needed to directly compare the mechanical properties (tensile strength, flexural strength, impact strength) of CNS composites to both pure epoxy and CNSL resins. Processing: The processing techniques and requirements for fabricating CNS composites compared to epoxy and CNSL resin composites should be explored. **Cost Analysis:** A cost analysis comparing CNS composites, epoxy, and CNSL resin composites would be valuable, considering the potential economic benefits of CNS as a natural resource.

III. Problem Identification

- Metal Matrix Composites (MMCs) offer a unique opportunity to combine the desirable properties of different metals. This research project aims to investigate and compare the properties of MMCs fabricated using three common matrix materials: copper, stainless steel, and mild steel.
- A comparative understanding of the mechanical, physical, and potentially corrosion resistant properties of MMCs with different metal matrices.
- Identification of the strengths and weaknesses of each MMC type.
- Recommendations for utilizing these MMCs in various engineering applications based on their property profiles.

IV. Aim and Objective

AIM: This research project aims to compare the properties of metal matrix composites (MMCs) fabricated using three different matrix materials: copper, stainless steel, and mild steel. MMCs are a class of composite materials where a reinforcing material is embedded within a metal matrix. By incorporating different reinforcement materials, we can achieve superior properties compared to the base metal alone. The selection of copper, stainless steel, and mild steel as the matrix materials offers a diverse range of properties. Copper boasts excellent electrical and thermal conductivity, while stainless steel offers superior corrosion resistance. Mild steel, on the other hand, is known for its affordability and good formability.

OBJECTIVE: The overall objective of this investigation is to understand how the choice of reinforcement material (stainless steel vs. mild steel) affects the properties of copper matrix composites (CMCs) compared to unreinforced copper. Here's a breakdown of some specific objectives:

- Compare the tensile strength, yield strength, and ductility of CMCs with different reinforcements to unreinforced copper.
- Evaluate the impact of reinforcement volume fraction on the mechanical properties of the CMCs.

V. Methodology of the Work

VI. EXPERIMENTAL WORK

Design and Prepare mould box:

- Here we are using Acrylic Sheet to make the mould box
- AutoCAD Software is used to draw required dimension/Design (250mm x 250mm) & export it as dxf file format.
- CO2 Laser Cutting Machine is used to cut the design and suitable adhesive used to stick the mould box.

Preparation of Composite

- Teak wood as powdered to 0.2mm also Cashew nut shell as powdered to 2-3mm by the help of pulverizer.
- For Synthetic Composite we tried 1:1, 2:1, 3:2 ratio of Epoxy (R:H 10:1) and Teak wood powder.
- For Natural Composite we planned 1:1, 2:1, 3:2 ratio of CNSL and Cashewnut Shell Powder (Including Catalsyt)
- Using Resin Transfer Moulding the required shape as been obtained.

Remove / Cut the Composite for testing

- Drawn the dimension on the composite material (plate) as per ASTM Standard.
- We cut the material using Hacksaw machine as per the dimensions.

Testing & Compare the properties

- Here we performed the following test over the composite material.
- Tensile & Compression Test
- Impact & Water Absorption Test

VII. CONCLUSIONS

This study investigated the comparative properties of metal matrix composites fabricated using copper, stainless steel, and mild steel as the matrix. Stainless steel reinforcement likely resulted in the greatest increase in mechanical property, while mild steel offered a material property. Copper composites exhibited reduce time due to reasons related to copper's properties. Further research is needed to explore the effect on the properties of these composites.

VIII. REFERENCES

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