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Investigation on Al5052-Cu Alloy and Preparation Through Stir Casting Process

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ABSTRACT
Advanced materials possess unique properties that make them highly desirable for various applications. These properties may include low weight, low cost, wear resistance, corrosion resistance, and high strength, among others. One such advanced material is an aluminum metal alloy, which can be fabricated using the stir stir-casting process.
Stir casting is a cost-effective and straightforward method of manufacturing aluminum metal alloys. In this project, we aim to fabricate an Al5052-Cu alloy using stir casting. By varying the weight percentages of Cu (0%, 3%, 4%, 5%, 6%, and 7%), we investigated these different compositions that affect the alloy's mechanical properties.
To achieve this, the fabricated alloys are subjected to physical testing to determine theirtensile strength, impact strength, hardness, shear test, and microstructure. Through these tests, we can gain insights into how the different weight percentages of Cu affect the alloy's mechanical behavior.
Overall, this project seeks to explore the potential of stir casting to manufacture advanced materials and contribute to the development of Al5052-Cu alloys with improved mechanical properties.
The results showed such the tensile strength, impact strength, and shear strength of the alloy metal increased with the increase in the copper powder content up to a certain point (5% copper powder). Beyond 5% copper powder content the strength properties started to Decrease. The hardness of the alloy metal also increased with the increase in the copper powder content up to 5% & then started to decrease beyond that.
Keywords: *Aluminum5052, copper metal powder, tensile strength, impact test, shear test,hardness test (Brinell), microstructure.*

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I. INTRODUCTION:

Aluminum alloys are used in many engineering applications due to their high strength-to-weight ratio, good corrosion resistance, and excellent thermal conductivity. However, the low hardness and wear resistance of aluminum alloys limit their use in some applications. Various strengthening techniques have been developed to improve the mechanical properties of aluminum alloys, including alloying, heat treatment, and mechanical treatment. Among these techniques, the addition of copper (Cu) has proven to be an effective method for improving the mechanical properties of aluminum alloys. Al5052 is a commonly used aluminum alloy containing Magnesium (Mg) and Chromium (Cr) as the main alloying elements. Adding copper to Al5052 can increase its strength and wear resistance.

Al5052-Cu alloy has been extensively studied for various engineering applications such as aircraft structures, automotive parts, and marine applications. The Al5052-Cu alloy showed better mechanical properties than the Al5052 alloy due to the precipitation-promoting effect of copper. Blend Molding is one of the most widely used methods for manufacturing metal matrix composites (MMC). Stir casting is a simple and inexpensive method of manufacturing MMC that involves mixing reinforcement particles with a molten metal matrix and then mixing this mixture to evenly distribute the particles throughout the matrix. The stir-casting process was used to produce Al5052-Cu alloys with different Cu contents and particle sizes. The mechanical properties of Al5052-Cu alloys obtained by the stir casting method have been studied by many researchers. In this study, Al5052-Cu alloys were produced by mixed casting. The influence of Cu content and particle size over the microstructure and mechanical properties of Al5052-Cu alloy was studied. This study aims to optimize the process parameters to produce Al5052-Cu alloys with improved mechanical properties for potential engineering applications. The following sections describe the details of the experiment, including materials and methods, and the results obtained from the study.

II. LITERATURE REVIEWS

N. Valibeygloo et al [1] The microstructure and mechanical properties of Al-4.5 WTA were studied. Cu alloy reinforced with various volume fractions (1.5% v/v, 3% v/v, 5% v/v) of alumina nanoparticles produced in the mixed casting process were tested. Calculated Amounts of aluminum oxide nanoparticles (approx. ? 50 nm) were ground in a ball mill with aluminum powder inside in a planetary ball mill for 5 h, then the packets of crushed powders were introduced to cast alloy Al-4.5 Cu weight. Microstructural studies of nanocomposites have shown the homogeneity distribution of alumina nanoparticles in a 4.5 WTA Al matrix. Cu.

Abhijeet Bhowmik et al. [2] In observing the trend in the manufacturing industry, an integral part of the development of any economy, we have witnessed the use of new and advanced materials, especially alloys. They are characterized by low weight and good durability. The desired properties can be achieved with alloys. Various practical aspects such as marine applications, exposure to high temperatures, etc. require both strength and corrosion resistance.

Ashish Kumar Khandelwal et al. [3] Investigated the modernization and development of new technologies in the field of manufacturing, there is a strong need for new and advance materials to be analyzed and studied to get the most out of the benefits of new technologies. Instead of this if we talk about non-ferrous materials which have some unique properties as compared to ferrous materials. In non-ferrous materials, a very promising material is aluminum alloy Al5052 which has good corrosion resistance, especially in marine atmosphere.

Gadudasu Babu Rao et al. [4] The coveted use of aluminum composites is increasing and used extensively in the aerospace, automotive, and marine industries due to its inherent properties. MoS2-reinforced aluminum composites with high wear and corrosion are manufactured by mixing with their mechanical properties and microstructure are tested. The rate of reinforcement addition was adjusted in the range of 0 WTA to 6 WTA in 2 WTA increments.

Mohammed Hayajneh et al. [5] Investigated the potential of utilizing neural networks in the prediction of wear loss quantities of some aluminum–copper– silicon carbide composite materials has been studied in the present work. Effects of the addition of copper as an alloying elementand silicon carbide as reinforcement particles to Al–4 wt.%Mg metal matrix have been investigated. Different Al–Cu alloys and composites were subjected to a dry sliding wear test using pin-on-disk apparatus under 40 N normal load with the rotational speed of counter face diskof 150 rpm at room conditions (∼20 ◦C and ∼50% relative humidity).

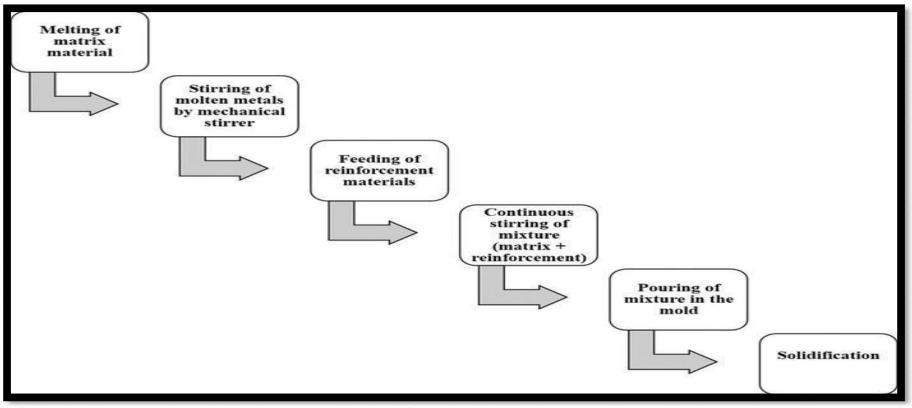
Jagannath Mohapatra et al. [6] Research on aluminum alloy-based metal matrix composites plays an important role in automotive, aerospace, military, and structural applications due to their improved mechanical and biological properties compared to base aluminum alloys. To improve the mechanical and biological properties, it is necessary to add appropriate reinforcement to the aluminum alloy to produce composite materials. Current research is focused on improving the mechanical properties and wear resistance of Al-4.5%Cu alloy fused with 5% Tic metal matrix composite (MMC) in situ using Friction Stir Processing (FSP) techniques is strengthened. Suitable for automotive and aerospace applications. The composites produced (Al-4.5% Cu/5% Tic) were hot rolled to remove defects such as porosity and voids. Experiments were performed with a pin-on-disc device on sandpaper, varying the applied load and sliding distance.

III. METHODOLOGY

1. Material selection and preparation: The first step is to select the materials that will be used in the study. For this investigation, aluminum alloy 5052 and copper powder will be used as the base materials. The purity of the materials should be checked and ensured. The aluminum alloy 5052 and copper powder should be weighed and mixedin the desired weight percentages (0, 3, 4, 5, 6, and 7%). The mixing process should be carried out in a controlled environment to avoid any contamination.

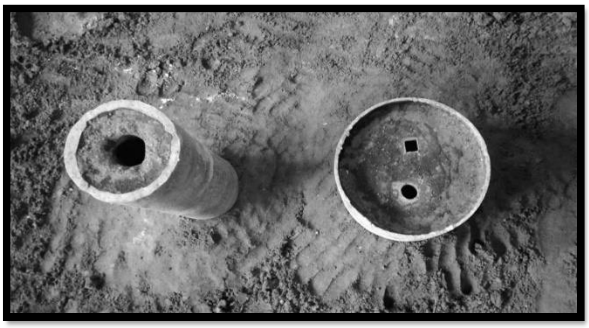
Aluminum5052 metal   Copper metal powder

2. Stir casting: The next step is to prepare the composite material by applying the stir casting process. In this process, the aluminum alloy 5052 and copper powder are melted and mixed using a stirring rod. The temperature and stirring speed should be controlled during the process. The mixture should be stirred until the copper powder is evenly dispersed throughout the aluminum alloy matrix. The composite material should be cast into a suitable mold and allowed to cool.



Steps involved in castings.

3. Sample preparation: After the composite material has solidified, samples for testing should be prepared. The samples can be prepared using a variety of techniques, such as cutting or milling. The size and shape of the samples should be standardized to ensure consistency in the test results.



Preparation of mold   Solidification metal

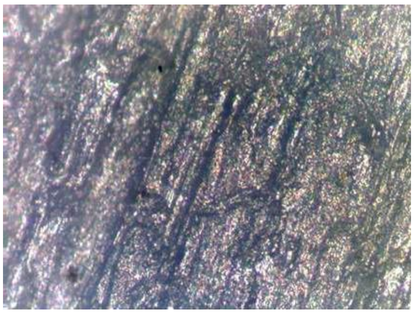
4. Mechanical testing: The mechanical properties of the composite material should be tested using standardized methods. Tensile, impact, shear, and hardness tests should be conducted on the samples using appropriate testing equipment. The test conditions, such as temperature and loading rate, should be standardized to ensure accurate and consistent results. The data collected from the tests should be recorded and analyzed.

5. Microstructural analysis: Microstructural analysis can provide valuable information about the composite material. The microstructure of the samples can be analyzed using techniques such as optical

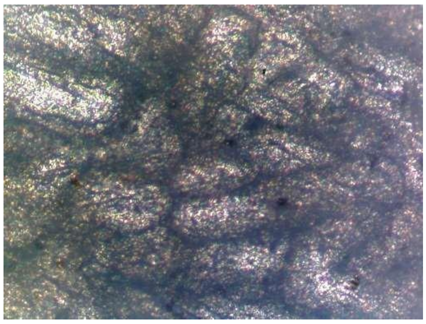
microscopy or scanning electron microscopy (SEM). The analysis should focus on the distribution of the copper particles within the aluminum alloy matrix and the quality of the interface between the particles and the matrix.

IV. RESULTS AND DISCUSSIONS

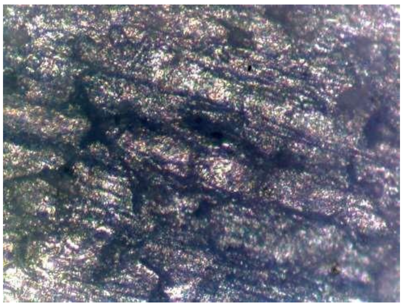
1. Mechanical properties: The tensile, impact, shear, and hardness (Brinell) tests were conducted on the samples. The results showed that the tensile strength, impact strength, and shear strength of the alloy metal increased with the increase in the copper powder content up to a certain point (5% copper powder). Beyond 5% copper powder content, the strength properties started to decrease. The hardness of the alloy metal also increased with the increase in the copper powder content up to 5% and then started to decrease beyond that.
2. Microstructural analysis: The microstructural analysis showed that the copper particles were well dispersed in the aluminum alloy matrix with up to 5% copper content. Beyond that, agglomeration of copper particles was observed, which could be the reason for the decrease in the strength properties of the alloy metal.



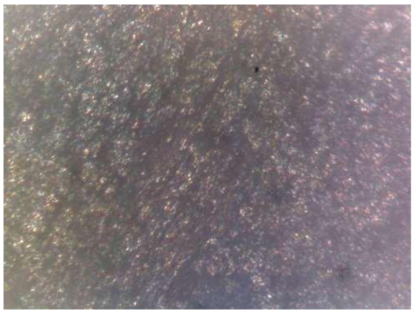
Pure Al5052



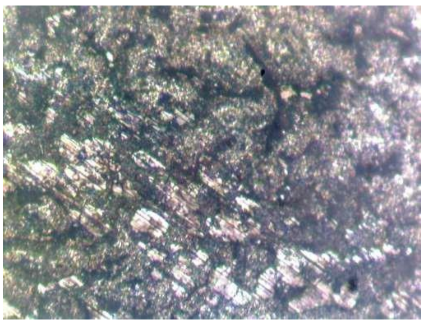
Al5052 97%+Cu 3%



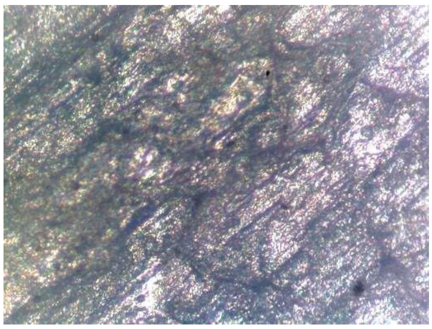
Al5052 96%+Cu 4%



Al5052 95%+Cu 5%



Al5052 94%+Cu 6%



Al5052 93%+Cu 7%

3. Statistical analysis: The statistical analysis of the data revealed that there was a significant effect shows that the copper powder content on the mechanical properties of the alloymetal. The increase in the copper powder content b y up to 5% increased the strength properties of the alloy metal.
4. Discussion: The results suggest that the addition of copper powder up to 5% can significantly enhance the mechanical properties of aluminum alloy 5052. The increase in the strength properties of the alloy metal can be imputed to the strengthening effect of the copper particles in the aluminum alloy matrix. However, beyond 5%

copper content, the agglomeration of copper particles leads to a decrease in the strength properties of the composite material. Therefore, the optimum copper powder content for enhancing the mechanical properties of aluminum alloy 5052 through the stir-casting process is 5%.

V. CONCLUSION

In conclusion, the investigation on the preparation of aluminum alloy 5052 and copper powder composites through the stir-casting process showed that the addition of copper powder up to5% can significantly improve the mechanical properties of the composite material. The increasein the strength properties of the alloy metal can be imputed to the strengthening effect of the copper particles in the aluminum alloy. However, beyond 5% copper content, the agglomeration of copper particles leads to a reduction in the strength properties of the alloy metal.

The microstructural analysis showed that the copper particles were well dispersed in the aluminum alloy matrix with up to 5% copper content. Beyond that, the agglomeration of copper particles were observed, which could be the reason for the decrease in the strength properties of the alloy metal. The statistical analysis of the data revealed that there was a significant effect of the copper powder content on the mechanical properties of the alloy metal.

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