DOI: https://doi.org/10.46632/jmc/1/2/2

Journal on Materials and its Characterization
Vol: 1(2), 2022
REST Publisher; ISSN: 2583-6412
Website: https://restpublisher.com/journals/jmc/

Production and TOPSIS Method of metal matrix composite materials

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Abstract: *Metal matrix composites a great deal of new engineering applications because of their superb design characteristics. Above all, MMC made of aluminum has the benefit of being lightweight. There are numerous structural uses for aluminum alloy matrix composites, including in the automotive, aerospace, and space industries. To achieve the desired mechanical and physical qualities, the MMC matrix's material and reinforcement material mix is crucial. Si: Silicon is the electropositive element that is most prevalent in the crust of the Earth. It is an extremely fragile metal with a metallic sheen. Though occasionally divalent, it usually has a tetravalent composition in its compounds and only exhibits electropositive chemical activity. Cu: Due to its superior conductivity and ductility, copper is mostly used in electrical generators, home and auto wiring, and wires for electronics like radios, TVs, computers, lighting, and motors. Fe: Metals containing iron are referred to as ferrous metals. Null non-ferrous metals. Whether foundries specialize in or both metals are one of the key specialized differences. Any metal containing iron is considered a ferrous metal; non-ferrous metals are not included. Al: Bauxite is a mineral from which aluminum is extracted. The Bayer process transforms bauxite into aluminum oxide (alumina). Afterwards, the Hall-Harold method and electrolytic cells are used to transform the alumina into aluminum metal. Zi: A German surname that has been spelled Zink, Zink, Zincked, and Zinced in the past. Evaluation; Today, a lot of academics are interested in the field of application-based material selection. The primary considerations in choosing a proper material are density, strength, melting point, and price. Beneficial traits, such as toughness and strength, require higher priority values than properties with lower values (density and cost are called useless attributes). One of the known classical MCDM methods for optimal solution (TOPSIS) is the order efficiency technique by similarity. TOPSIS is a chosen alternative positive ideal. A negative ideal is also the shortest distance from the solution. The idea is to stay away from the other side based solution. [17] According to the TOPSIS method, the observed selective hybridization, the ranking of different methods in the models is generally very high with the highest ranking. From the result, it is seen that Si is showing the highest value for Cu is showing the lowest value. Resulting in Si ranked first, there Cu has low rank.*

Keywords: *Silicon, copper, Aluminum, Zink, MCDM method.*

1. Introduction

Metal matrix composites have many new engineering applications because of their superb design characteristics. Above all, MMC made of aluminum has the benefit of being lightweight. There are numerous structural uses for aluminum alloy matrix composites, including in the automotive, aerospace, and space industries. To achieve the desired mechanical and physical qualities, the AHMMC matrix's material and reinforcement material mix are crucial. To get the best outcomes, aluminum hybrid metal matrix composites (AHMMCs) should be produced with the best matrix material. Like other composites, metal matrix composites (MMCs) offer much better qualities than traditional monolithic materials, including high strength, stiffness, and weight reduction. Although continuous fiber reinforcement offers the best reinforcing (in a particular direction), particulate-reinforced materials are more desirable because of their affordability, isotropic characteristics, and capacity for uniform processing. Particle-reinforced metal matrix composites' mechanical behavior has been studied extensively to understand it. In this review, we make an effort to highlight significant elements of the experimental, analytical, and computational characteristics of MMCs' mechanical behavior. We focus on tensile, creep, and fatigue behavior with a focus on particle-reinforced light alloy matrix systems. Metal matrix composites (MMCs), which combine high strength with outstanding corrosion resistance, are appealing materials for a variety of technical applications. Composites are appropriate for particular applications when taking into account the reinforcement type, shape, and size parameters, which might vary, in addition to matrix qualities. The comparatively high cost of MMCs is one factor that has so far prevented their widespread usage. This is large because high-quality composites are currently produced using expensive processing methods. This research examines a relatively inexpensive stir casting method for the manufacture of silicon carbide/aluminum alloy MMCs The presentation and discussion of technical difficulties relating to consistent reinforcement distribution, good moisture content between materials, and low porosity materials. Al-7075 needs additional reinforcing because it has numerous applications. When desired single and multiple reinforcing particles are added, Si, Cu, Fe, Zn, and aluminum alloys are produced with multiple properties. Aluminum alloy is employed as the matrix material (continuous phase) (individual element non-metallic ceramics). It is stronger than the base alloy material when it is an alloy. This development in alloy materials was necessary due to the quickly evolving technology in numerous application domains. The ability of MMC to affect physical qualities (thermal expansion, density), mechanical properties (tensile and compressive behavior), tribal properties, and other features have recently attracted study interest. A variety of automobile and other ground transportation applications use metal-matrix composites (MMCs). An overview of the main MMC applications in land transportation is given in this article. The primary benefits of MMCs over traditional materials include their high strength-to-weight ratio, enhanced mechanical and thermal properties, enhanced fatigue and creep capabilities, enhanced wear resistance, and general property tolerance. The deployment of MMC will be aided by lower manufacturing costs for MMC components because the transportation sector is highly cost-sensitive.

2. Material And Methods

Application-based material selection is a popular field of study for many scientists today. The primary considerations in choosing a proper material are density, strength, melting point, and price. Alternative; Si: Silicon is the electropositive element that is most prevalent in the crust of the Earth. It is an extremely fragile metal with a metallic sheen. Though occasionally divalent, it usually has a tetravalent composition in its compounds and only exhibits electropositive chemical activity. Cu: Due to its superior conductivity and ductility, copper is mostly used in electrical generators, home, and auto wiring, and wires for electronics like radios, TVs, computers, lighting, and motors. [1]Fe: Metals containing iron are referred to as ferrous metals. Null non-ferrous metals whether foundries specialize in or both metals are one of the key specialized differences. Any metal containing iron is considered a ferrous metal; non-ferrous metals are not included. Al: Bauxite is a mineral from which aluminum is extracted. The Bayer process transforms bauxite into aluminum oxide (alumina). Afterward, the Hall-Harold method and electrolytic cells are used to transform the alumina into aluminum metal. Zi: A German surname that has been spelled Zink, Zink, Zincked, and Zinced in the past. Here the name may have evolved as a nickname for someone with a singularly sharp nose. Today Zinger is German slang for a hooter. Evaluation; Today, a lot of academics are interested in the field of application-based material selection. The primary considerations in choosing a proper material are density, strength, melting point, and price. Beneficial traits, such as toughness and strength, require higher priority values than properties with lower values (density and cost are called useless attributes). Result of normalizing the matrix; Positive best solution and matrix normalization; Calculation of Positive ideal solution and negative ideal solution separations alternative from PIS and NIS. Proximity in Descending Order to Obtain Substitution [1] The TOPSIS method introduced has proposed several solutions for solving criterion decision problems. According to this technique, the best alternative is closer to a positive ideal solution exists and a negative one is far from the ideal solution. [2] Attempts were made to optimize the approach to multiple responses using the Sorting by Similarity of Best Solution (TOPSIS) preference technique. They concluded that this method is capable of improving the problem in any way and has any number of answers. [3] The scope of the present work is thermal performance CFWCT and MCDM-TOPSIS, to investigate the optimal operating conditions of a cooling tower, operated using an established method at a specific location. Heat and mass were provided in the CFWCT exchange equations and the thermal efficiency of the CFWCT was evaluated with fill height. [4] These MCDM techniques are frequently applied conservatively, which results in approximations of unsatisfactory solutions. The design of experiments and topics methods is therefore covered in this study. Create regression meta-models to look for the best parameter settings for the EDM and WEDM NTM processes using the computed TOPSIS scores. [5] Create regression meta-models using the calculated TOPSIS scores to look for the best parameter settings for the EDM and WEDM NDM processes. [6] A comprehensive weight is calculated between two probability distributions using relative entropy. Based on the calculated comprehensive weights, air quality measurement is evaluated using the TOPSIS system [7] which has wide excellent applications and multi-attribute decision-making models. In this manner, replaces evaluated attributes, and every problem is a geometric system of n-dimensional space with points. [8] Applied fuzzy topics and network optimization techniques in deep multiple or body placement problem selections of shaft location based on TOPSIS system, and highway superstructure selection in the conceptual design of the bridge as an optimization-based method for their solution. [9] Measured impacts using the TOPSIS method and water level in combination with qualitative and weighted value sets of objective and subjective values. [10] SCR is estimated using the Fuzzy TOPSIS technique. A common TOPSIS method of SCR estimation is a linguistic limitation in handling ambiguity or imprecision of estimation. To overcome this limitation, the Fuzzy-TOPSIS method is adopted. Linguistic terms and criteria are used to assess risk factor ratings and weights. [11] Proposed an optimization method for determining the extended TOPSIS weight information model under a neutrosophic set with unknown weights, time, measurements, and unknown weights. [12] Choose the best option to meet the specified requirements. To examine options from numerous alternatives, the TOPSIS approach is employed. In this way, the best option is chosen and chosen based on the ranking of compromise. [13] Spatial-temporal CV-TOPSIS Method for Flood Characteristics Disaster Risk Assessment In the first part, each year was considered as an observer for the economy, and 263 observations of flood risk using the TOPSIS method were analyzed to obtain scores. [14]. It aims at the evaluation of distance performance using the DEA method in the academic year of academic departments of public universities in Turkey's TOPSIS method. This results in efficient decision-making. The study compares and ranks the units, [15] the software establishes the weights for the chosen variables using the AHP approach candidate's criteria Final ranking technologies and hierarchy. [16] One of the known classical MCDM methods for optimal solution (TOPSIS) is the order efficiency technique by similarity. TOPSIS is a chosen alternative positive ideal. A negative ideal is also the shortest distance from the solution. The idea is to stay away from the other side-based solution. [17] According to the TOPSIS method, the observed selective hybridization, the ranking of different methods in the models is generally very high with the highest ranking.

3. Analysis And Discussion

TABLE 1. Data set

	DATA SET				
	Cost	**Density**	**Tensile Strength**	**Hardness**	**Melting Point**
Si	321.08	321.00	139.53	29.15	22.05
Cu	219.12	254.21	142.97	33.69	27.30
Fe	234.08	326.11	122.58	29.18	23.10
Al	232.17	122.33	128.28	24.60	17.59
Zi	233.33	123.24	186.41	27.96	18.89

Table.1 shows the Metal matrix composite in TOPSIS method on the Alternative: Si, Cu, Fe, Al, Zi. Evaluation Preference: Cost, Density, Tensile Strength, Hardness, Melting Point data set**.**

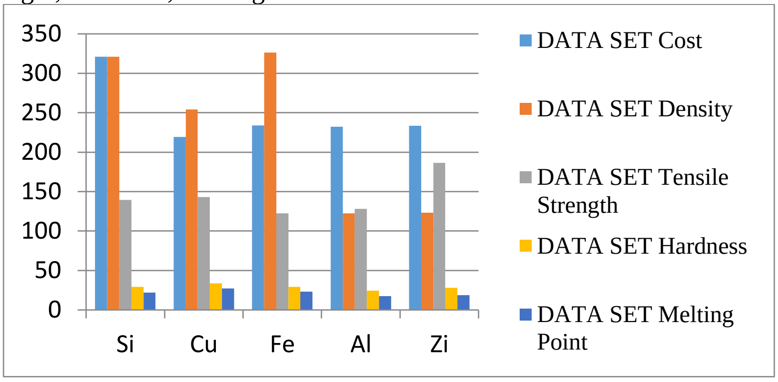

FIGURE 1. Data set

Figure.1 shows the Metal matrix composite in TOPSIS method on the Alternative: Si, Cu, Fe, Al, Zi. Evaluation Preference: Cost, Density, Tensile Strength, Hardness, Melting Point data set**.**

TABLE 2. Squire Rote of matrix

103092.3664	103041.0000	19468.6209	849.7225	486.2025
48013.5744	64622.7241	20440.4209	1135.0161	745.2900
54793.4464	106347.7321	15025.8564	851.4724	533.6100
53902.9089	14964.6289	16455.7584	605.1600	309.4081
54442.8889	15188.0976	34748.6881	781.7616	356.8321

Table 2 shows the Squire Rote of matrix value

TABLE 3. Normalized Data

Normalized Data				
Cost	**Density**	**Tensile Strength**	**Hardness**	**Melting Point**
0.5728	0.5726	0.2489	0.0520	0.0393
0.3909	0.4535	0.2550	0.5184	0.5537
0.4176	0.5817	0.2187	0.4490	0.4685
0.4142	0.2182	0.2288	0.3785	0.3567
0.4162	0.2198	0.3325	0.4302	0.3831

Table 3 Normalized Data shows the informational set for the Metal matrix composite in TOPSIS method on the Alternative: Si, Cu, Fe, Al, Zi. Evaluation Preference: Cost, Density, Tensile Strength, Hardness, Melting Point Normalized Data.

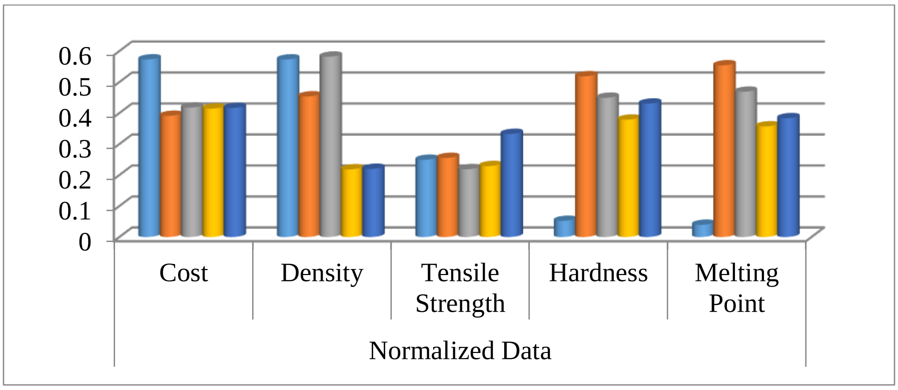

FIGURE 2. Normalized Data

Figure. 2 Normalized Data shows the informational set for the Metal matrix composite in TOPSIS method on the Alternative: Si, Cu, Fe, Al, Zi. Evaluation Preference: Cost, Density, Tensile Strength, Hardness, Melting Point Normalized Data.

TABLE 4. Weight

Weight				
0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25

Table 4 shows the Weight ages used for the analysis. We have taken same weights for all the parameters for the analysis.

TABLE 5. Weighted normalized decision matrix

Weighted normalized decision matrix				
0.1432	0.1432	0.0622	0.0130	0.0098
0.0977	0.1134	0.0638	0.1296	0.1384
0.1044	0.1454	0.0547	0.1123	0.1171
0.1035	0.0546	0.0572	0.0946	0.0892
0.1041	0.0550	0.0831	0.1076	0.0958

Table.5 shows the weighted normalized decision matrix.

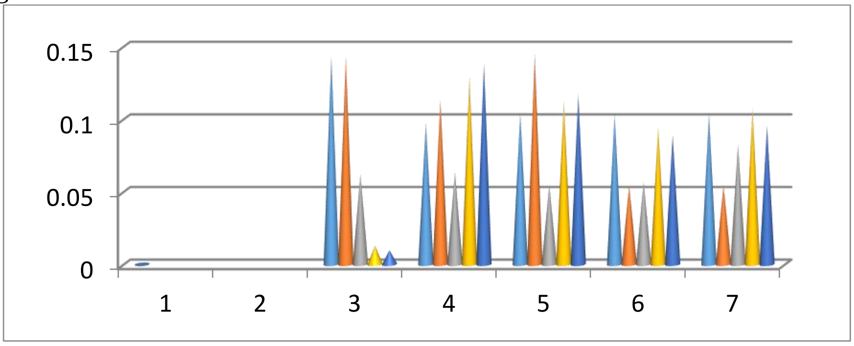

FIGURE 3. Weighted normalized decision matrix

Figure.3 shows the weighted normalized decision matrix.

TABLE 6. Positive Matrix

Positive Matrix				
0.1432	0.1454	0.0831	0.0130	0.0098
0.1432	0.1454	0.0831	0.0130	0.0098
0.1432	0.1454	0.0831	0.0130	0.0098
0.1432	0.1454	0.0831	0.0130	0.0098
0.1432	0.1454	0.0831	0.0130	0.0098

Table 6 shows the Using the selected Linguistic evaluations of decision makers Convert to quantitative values fuzzy number positive matrix.

TABLE 7. Negetive matrix

Negetive matrix				
0.0977	0.0546	0.0547	0.1296	0.1384
0.0977	0.0546	0.0547	0.1296	0.1384
0.0977	0.0546	0.0547	0.1296	0.1384
0.0977	0.0546	0.0547	0.1296	0.1384
0.0977	0.0546	0.0547	0.1296	0.1384

Table 7 shows the Calculate aggregated Negative matrix

TABLE 8. SI Plus & SI Negative

	SI Plus	Si Negative
Si	0.0210	0.2003
Cu	0.1833	0.0595
Fe	0.1539	0.0952
Al	0.1532	0.0607
Zi	0.1614	0.0562

Table 8 shows the Alternative: Si, Cu, Fe, Al, Zi. Evaluation Preference: Cost, Density, Tensile Strength, Hardness, Melting Point SI Plus & SI Negative.

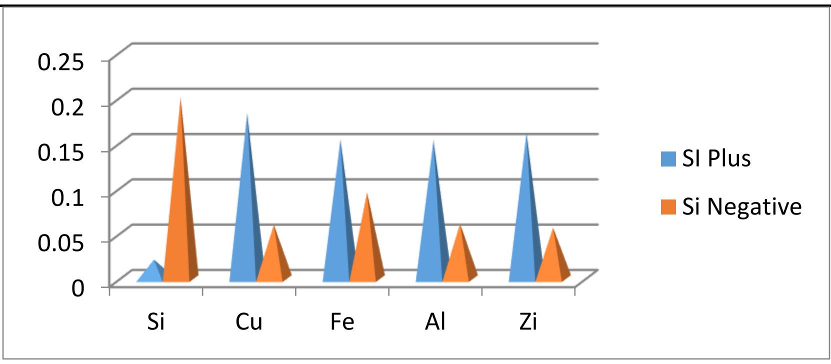

FIGURE 4. SI Plus & SI Negative

Figure 4 shows the Alternative: Si, Cu, Fe, Al, Zi. Evaluation Preference: Cost, Density, Tensile Strength, Hardness, Melting Point SI Plus & SI Negative.

TABLE 9. Ci

	Ci
Si	0.9050
Cu	0.2451
Fe	0.3821
Al	0.2839
Zi	0.2582

Table.9 shows the Metal matrix composite in TOPSIS method on the Alternative: Si, Cu, Fe, Al, Zi. Evaluation Preference: Cost, Density, Tensile Strength, Hardness, Melting Point Ci.

TABLE 10. Rank

	Rank
Si	**1**
Cu	**5**
Fe	**2**
Al	**3**
Zi	**4**

Table 10 shows the final result of this paper the Si= first rank, Cu= fifth rank, Fe=second rank, Al=third rank, Zi=forth rank On the Si highest value Cu lowest value.

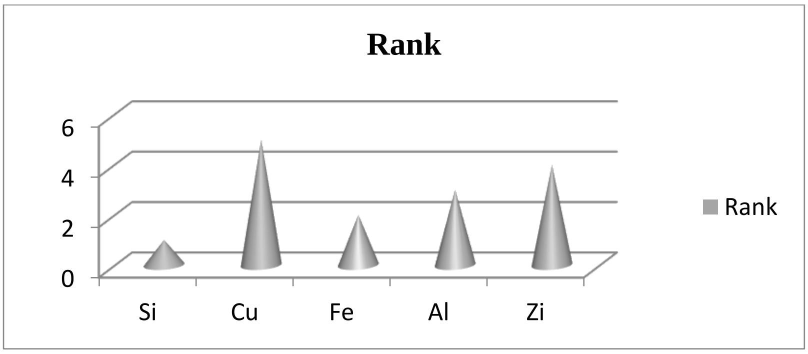

FIGURE 5. Rank

Figure.5 shows the final result of this paper the Si= first rank, Cu= fifth rank, Fe=second rank, Al=third rank, Zi=forth rank. From the result, it is seen that Si is showing the highest value for Cu is showing the lowest value.

4. Conclusion

Metal matrix composites are widely adopted thanks to their superior design characteristics, in numerous novel technical applications. Above all, MMC made of aluminum has the benefit of being lightweight. There are numerous structural uses for aluminum alloy matrix composites, including in the automotive, aerospace, and space industries. To achieve the desired mechanical and physical qualities, the AHMMC matrix's material and reinforcement material mix are crucial. To get the best outcomes, aluminum hybrid metal matrix composites (AHMMCs) should be produced with the best matrix material. Like other composites, metal matrix composites (MMCs) offer much better qualities than traditional monolithic materials, including high strength, stiffness, and weight reduction. Although continuous fiber reinforcement offers the best reinforcing (in a particular direction), particulate-reinforced materials are more desirable because of their affordability, isotropic characteristics, and capacity for uniform processing. Particle-reinforced metal matrix composites' mechanical behavior has been studied extensively to understand it. In this review, we make an effort to highlight significant elements of the experimental, analytical, and computational characteristics of MMCs' mechanical behavior. Si: Silicon is the electropositive element that is most prevalent in the crust of the Earth. It is an extremely fragile metal with a metallic sheen. Though occasionally divalent, it usually has a tetravalent composition in its compounds and only exhibits electropositive chemical activity. Cu: Due to its superior conductivity and ductility, copper is mostly used in electrical generators, home, and auto wiring, and wires for electronics like radios, TVs, computers, lighting, and motors. Fe: Metals containing iron are referred to as ferrous metals. Null non-ferrous metals whether foundries specialize in or both metals are one of the key specialized differences. Any metal containing iron is considered a ferrous metal; non-ferrous metals are not included. Al: Bauxite is a mineral from which aluminum is extracted. The Bayer process transforms bauxite into aluminum oxide (alumina). Afterward, the Hall-Harold method and electrolytic cells are used to transform the alumina into aluminum metal. Zi: A German surname that has been spelled Zink, Zink, Zincked, and Zinced in the past. One of the known classical MCDM methods for optimal solution (TOPSIS) is the order efficiency technique by similarity. TOPSIS is a chosen alternative positive ideal. A negative ideal is also the shortest distance from the solution. The idea is to stay away from the other side-based solution. [17] According to the TOPSIS method, the observed selective hybridization, the ranking of different methods in the models is generally very high with the highest ranking. From the result, it is seen that Si is showing the highest value for Cu is showing the lowest value.

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