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RESEARCH PAPER

EFFECT OF SiO_2 SURFACE OXIDATION COATING OF SILICON CARBIDE PARTICLES REINFORCEMENT ON THE MECHANICAL PROPERTIES OF Al-2.5%Mg/xSiC_p DEVELOPED BY STIR CASTING METHOD

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ABSTRACT

The literature revealed that composites developed through stir casting process suffer some limitations such as low wettability and insufficient bonding between the molten Al and SiC_p and the formation of aluminium carbide (Al_4C_3) at the interface which degrades the mechanical performances of the composites. To overcome these challenges, this study used magnesium for improved wettability, heat treatment of reinforcement particles (SiC_p) and application of metallic (SiO_2) coating on the SiC_p before adding to melt for improving Al-SiC_p wettability in the manufacture of Al-2.5%Mg/xSiC_p composites. The SiC_p coating reduces direct interaction and promotes wetting between SiC_p and molten Al to develop Al-2.5%Mg/xSiC_p composites. The percentage weight of SiC_p varied from 5 wt% to 20 wt% (uncoated and coated) at 5 % intervals. The mechanical properties tests were conducted to examine the effects of coating and variation of volume percentage of SiC_p on the composites developed. The results obtained showed that the reinforced alloy with both uncoated and coated SiC_p performed favorably well compared to the control sample with 0% SiC_p. The improvement of interfacial strength was observed in the composites developed with coated SiC_p as the coating of SiC_p enhanced its diffusion with Al-2.5%Mg.

Keywords: surface coating, pre-treatment, surface oxidation, composite, stir casting

INTRODUCTION

The fabrication of composite materials is meant to produce materials with enhanced performances compared to its matrix alloy. It is observed that aluminium alloys are primary material of consideration for structural application but owning to their low strength behaviors, they are unsuccessful in service to meet the ever-increasing demands for high structural application performances [1-4]. Hence, ceramic particles like SiC_p are used as reinforcement to strengthening the aluminium alloys to meet high structural applications [5]. Silicon carbide particles (SiC_p) is one of the frequently used ceramic reinforcing material for composite production owing to its outstanding properties such as availability, high thermal properties, low cost, good corrosion resistance, high modulus and strength, and appropriate compatibility with aluminium matrix alloys. It has very good plastic forming capability, excellent wear resistance and heat applications [6].

Nevertheless, it was observed that there is a poor wettability of SiC_p with molten aluminium [7]. The poor wettability of SiCp in molten Al alloys poses a limitation in the development of Al-SiCp composites [8], which could be ascribed to a poor interfacial reaction, an insufficient interfacial contact, and weak bonding between the Al alloy matrix and the SiCp reinforcement [2, 9]. These poor wetting creates uneven dispersion of SiCp particles in the molten Al alloy matrix, thereby reduces mechanical performances and creates high porosity in the composites developed [10]. These undesired effects owning to interfacial bond reactions, which can hamper composite strength, need to be addressed by surface coating of the SiC_p particle. Surface treatments like preheating of the SiC_p particles, addition of some surface-active elements like magnesium and coating of SiC_p particles prior to dispersion into the molten Al alloy matrix are among methods of improving the wetting between the Al alloy matrix and the SiCp reinforcement, thereby creating quality mixing and easy retention of the SiC_p particles [11, 9].

Surface oxidation activates the surface as it replaces surface covalent bonds with surface ionic bonds possessing enhanced adhesion between the reinforcement particles and the matrix phases, thereby influence the composites mechanical properties [12]. Surface oxidation prevents the formation of an harmful Al_4C_3 from the chemical reaction during the production of composites by developing a silicon oxide layer between the SiC_p particles and the Al-Mg metallic matrix [2, 12], thereby influences the mechanical behaviors and performance of the composites developed. Also, Urena, 2014 reported that heat treatment of reinforcement particles prior to its dispersion into the molten aluminium assist their transfer by creating oxide formation. Heating of SiC_p particles to about 900 ºC aids in eliminating surface impurities as well as in the desorption of gases, thereby altering the surface compositions due to the formation of an oxide layer on the surface [14].

In this study, SiC_p was heated up to a temperature of 1300 ºC in a furnace where a thin layer of SiO_2 was formed on its surface. The SiO_2 treated (coated) SiC_p and untreated (uncoated) SiC_p were used as reinforcement in the production of Al-

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2.5%Mg/xSiC_p composites by varied the percentage weight of reinforcement from 5wt.% to 20wt.% SiC_p (uncoated and SiO_2 coated) at 5% intervals to produced eight (8) composites samples by stir casting process. The aim of this work is to study and compare the mechanical performance of uncoated and coated developed Al-2.5%Mg/xSiC_p composites, among other works conducted to evaluate the application potential of Al-2.5%Mg/xSiC_p since low strengths of the aluminium alloys limit their effective usage for marine structural materials/application. Hence, the desires for strengthening these aluminium alloys for effective light weight applications where high strength to weight ratio are essential, using suitable reinforcing elements such as carbides, oxides and nitrides are very desirable.

MATERIAL AND METHODS

Treatment and Surface Oxidation of SiC_p

Basically, oxidation can be defined as a reaction of metal and oxygen [2] but not limited to metal. In this study, the measured SiCp was heated in an Electrical Resistance Heating Furnace (Model: XD – 1700M, manufactured by Zhengzhou Brother Furnace Co. LTD) already set to a temperature of 1300 ^oC required for the surface oxidation to take place, where a thin layer of SiO_2 was formed on its surface. The furnace was set to heat the samples at a heating rate of 10 ^oC/min. The SiC_p samples were held at this temperature for 2 hours and then allowed to cool down in the air at room temperature. The SiO_2 layer acts as a barrier which prevents the direct contact between SiC_p and aluminium alloy during the production of the composites in the case of the coated samples [2, 15]. The oxidation of SiC_p begins at temperature above 600 ^oC in air where a silica-rich surface layer is formed. The weight gain of SiC_p powder increases with temperature until oxidized SiC_p is formed at around 1200 – 1300 ^oC when it is fully oxidized. It is in line with the following equation:

$$SiC\,(s) +\ 2O_2(g) \rightarrow\ SiO_2\,(g) +\ CO_2(g) \qquad (1.)$$

The surface oxidation of SiC_p is to prevent the formation of an harmful Al_4C_3 from the chemical reaction during the production of composites by developing a silicon oxide layer between the silicon carbide particles and the metallic aluminium matrix [2, 12]. During the production of Al-SiC_p metal matrix composites with the metal in molten state, the liquid aluminium seems to attack the silicon carbide particles (SiC_p) in the existence of the Al_4C_3 interphase, which can form by the reaction of aluminum with carbon during the process as illustrated in the equations below:

$$4\mathrm{Al}_{\,(l)}\ +\ 3\mathrm{C}_{\ s}\ \rightarrow\ \mathrm{Al_4C_3}_{\ (s)} \qquad (2.)$$

$$4\mathrm{Al}_{\,(l)}\ +\ 3\mathrm{SiC}_{\ s}\ \leftrightarrow\ \mathrm{Al_4C_3}_{\ (s)}\ +\ 3\mathrm{Si}_{\ (\text{in Liguid Al})} \qquad (3.)$$

The existence or formation of an aluminium carbide (Al_4C_3) compound damages the mechanical properties of the composites in brittle state. Al_4C_3 further reacts with liquid water (moisture) at the room temperature (ambient), thereby causing more damages and destructions to the composites as Al_4C_3 hydrolyzes liberating methane gas ($CH_{4(g)}$) as illustrated in the equations below:

$$\mathrm{Al_4C_3}_{\ (s)}\ +\ 18\mathrm{H_2O}_{(l)}\ \rightarrow\ 4\mathrm{Al(OH)_3}_{\ (s)}\ +\ 3\mathrm{CO_2}_{\ (g)}\ +\ 12\mathrm{H_2}_{\ (g)} \qquad (4.)$$

$$\mathrm{Al_4C_3}_{\ (s)}\ +\ 18\mathrm{H_2O}_{(g)}\ \rightarrow\ 4\mathrm{Al(OH)_3}_{\ (s)}\ +\ 3\mathrm{CH_4}_{\ (g)} \qquad (5.)$$

Production of Al-2.5%Mg/xSiCp Composites via Stir Casting Method

The pure aluminum samples used in this work was obtained from NOCACO, Kaduna. The Al-2.5%Mg alloy and Al-2.5%Mg/xSiC_p composite materials used in this research were produced by using stir-casting method at the Foundry Workshop of Hydraulic Equipment Development Institute (HEDI), Kano, Nigeria. The casting process involved the use of wooden patterns, a green sand mould prepared, melting of the materials using a diesel-fired crucible furnace and pouring of the molten melt into the prepared mould. Using a stir casting process, at a temperature of about 660 ^oC, pure aluminum was melted and mixed with 2.5 % Mg. To reduce surface tension, the matrix alloy was heated to a temperature of 800 ^oC above its melting point temperature for good wetting of the SiC_p reinforcement which was added. The composite mixture (Al-2.5%Mg/xSiC_p) were mixed thoroughly with stirrer, poured in a prepared mold and allowed to cooled down and solidified. The work developed Al-2.5%Mg/xSiC_p composites reinforced with both uncoated and coated (surface-oxidized) SiC_p. The work was designed by varying the weight percentage of reinforcement from 5 to 20 wt.% SiC_p (both uncoated and SiO_2 coated) at 5 % intervals.

The SiC_p particles were initially preheated and pretreated at a temperature of 1300 ^oC for surface oxidation prior to incorporation into the aluminium matrix composites. The nine samples produced were as in the Table 1.

Table 1 The Alloy and Composite Samples Developed

No	Samples	Specification
1	A	Al-2.5%Mg Alloy
2	B	Al-2.5%Mg/5wt%SiC_p Composite
3	C	Al-2.5%Mg/10wt%SiC_p Composite
4	D	Al-2.5%Mg/15wt%SiC_p Composite
5	E	Al-2.5%Mg/20wt%SiC_p Composite
6	F	Coated Al-2.5%Mg/5wt%SiC_p Composite
7	G	Coated Al-2.5%Mg/10wt%SiC_p Composite
8	H	Coated Al-2.5%Mg/15wt%SiC_p Composite
9	I	Coated Al-2.5%Mg/20wt%SiC_p Composite

X-ray diffraction (XRD)

X-ray diffraction (XRD) is a fast analytical system mainly employed for crystalline sample phase identification which provide data on the unit cell dimension. X-ray diffraction system is based on interference of X-rays and a crystalline material sample. It has three basic component parts: an X-ray tube, a sample/specimen holder, and an X-ray detector. Generally, diffraction systems relied on production of X-rays in the X-ray tube, which are directed at the materials being tested, and the diffracted rays created in return. These x-rays are filtered to give monochromatic radiation, which are made parallel to focus, and directed towards the specimen/sample under test. The angle between the incident rays and diffracted rays is a vital component of all X-ray diffraction system.

According to Bragg's Law ($n\lambda = 2d \sin \theta$), the direct effects of the incident rays with the test sample gives a constructive interference as well as the diffracted rays [30]. Bragg's Law explains the relationship between the electromagnetic radiation wavelength, the diffraction angle and the crystalline sample lattice spacing. The machine detects, processes and counts the diffracted X-rays produced, and converted the diffraction peaks to d-spacings for easy identification of the minerals as each mineral identified is with a set of distinctive d-spacings. Characteristically, the mineral identification is obtained by comparing d-spacings with the standard reference patterns, such as Joint Committee on Powder Diffraction Standards (JCPDS).

Scanning electron microscope (SEM)

SEM uses electrons for imaging. It is used for direct study of the surface of the materials as it projects and scans a focused stream of electrons over a surface to create an image. The electrons in the beam interact with the sample to produce various signals that are used to obtain information about the surface's topography and composition. The test was conducted using JOEL-JSM-7600F SEM with EDS Detector.

Mechanical Properties

Mechanical testing is very significant in developing and accessing fundamental behaviors of engineering materials and in controlling and monitoring the quality of materials for use in engineering design, structural and construction. The samples for the mechanical tests were prepared from the control matrix alloy sample (Al-2.5%Mg) and the composite samples (Al-2.5%Mg/xSiC_p) reinforced with 5-20 % of uncoated and coated SiC_p particles. The ultimate tensile strength, hardness value and impact energy of the matrix alloy and the composites were investigated and recorded as the test samples were prepared in line with the machine specifications of each test. The test samples are shown in Fig. 1.

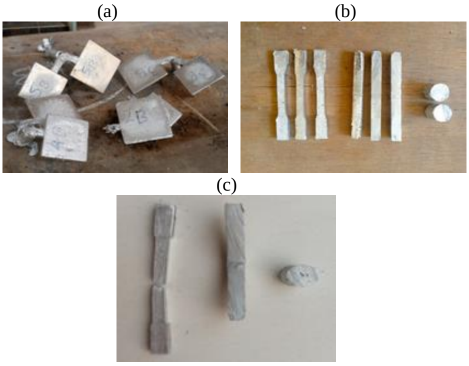

Fig. 1 (a) Raw Cast Materials, (b) Raw Test Samples, (c) Tested Samples

Tensile Test

Tensile testing provides details of the tensile mechanical properties of a material, which was prepared according to ASTM B557M. The tensile testing samples are of 100 x 10 x 6 mm, with a gauge length of 50 mm. The test was conducted by gripping each end of a reduced section specimen and slowly pulling it until catastrophic failure occurs with a Computerized Electromechanical Universal Testing Machine of Model WDW-100KN. Tensile test is a destructive engineering and materials science test whereby controlled tension is applied to a sample either as a load for proof testing or until it fully fails. This is one of the most common mechanical testing techniques and is used to find out how strong a material is and how much it can be stretched before it breaks. The test results were also recorded automatically by the machine for the nine (9) samples tested and presented in Table 2.

Hardness Test

The ability of a material to resist indentation or penetration is called hardness. Hardness testing is a test to determine the resistance a material exhibits to permanent deformation by penetration of another harder material. The hardness test was performed using the Indentec Universal Hardness Tester of Model 8187.5 LKV, according to the standard of hardness testing as per ASTM E18 based on Rockwell Hardness “B” Scale. The dimension of the prepared test samples was Diameter 20 mm x Height 12 mm. The hardness scale B was used for the tests, where the indenters are described as a diamond 1.6 mm diameter ball and the load applied is 100 kg. The minor load (preload) of 10 kg was applied to obtain the initial indent. 100 kg was then used to observe indent created by the major load. The final position reached by the indenter after elastic recovery of the materials was also recorded. The hardness of the test sample is the difference taken between preload and major load position measurements. The nine (9) samples developed were tested.

Impact Test

Impact testing is used to measure the impact toughness of the material. The purpose of an impact test is to determine the ability of the material to absorb energy during a collision. The test was performed with the Charpy Impact Tester of model Cat. Nr.412 with capacities of 15 J and 25 J. The samples prepared according to ASTM standard D-256. The samples were gripped on the machine and a load was applied to cause breakage. The sample size was 80 mm x 10 mm x 10 mm with a notch of 2 mm at 45° radii were place in a Charpy V-notch across the parallel jaw in the machine. The specimen was supported horizontally as a simple beam and fractured by a blow delivered in the middle by the pendulum. The impact energy recorded gives an idea of the energy required to break the notched specimen.

RESULTS AND DISCUSSION

Characterization of the Composite Materials

XRD of Uncoated SiC_p and SiO_2 Coated SiC_p

The XRD pattern of the coated and uncoated SiC_p given in Fig. 2(a) shows strong and sharp diffraction peaks, indicating the crystalline structure of the samples. The coated SiC_p, however, showed sharper and narrower peaks than uncoated SiC_p indicating better crystallinity [16], which usually corresponds to better mechanical properties when used as reinforcement [17]. Furthermore, the diffraction peaks at approximately 33.12, 35.08, 36.53, 39.03, 60.78, 66.67, and 72.67, can be indexed as (112), (212), (111), (200), (220), (311), (222) planes respectively. These reflections are in line with the Joint Committee on Powder Diffraction Standards (JCPDS) Card No. 96-900-6287. Furthermore, the comparison of the XRD patterns of the coated and uncoated SiC_p shows the presence of the new diffraction peak on the coated SiC_p at 22.5. This denotes the major reflection of SiO_2 based on the JCPDS card No. 96-900-6292, which was used in treating SiC_p in this study. The obtained result is in line with the findings of previous studies that characterized SiC_p and obtained similar reflections [17, 18].

XRD Pattern of the Samples Developed

Fig. 2(b) shows the XRD patterns of the samples developed that consist of the control alloy, uncoated and coated composites. From the result obtained, it was observed that with an increase in the composition of SiC_p for the coated and uncoated composites, there was an increase in the reflections of SiC_p with more visible peaks on the coated composites. Furthermore, the XRD plot shows the presence of Al with major peaks at 38.5, 45.11, 65.35, and 78.31 based on the JCPDS Card No. 04-0787.

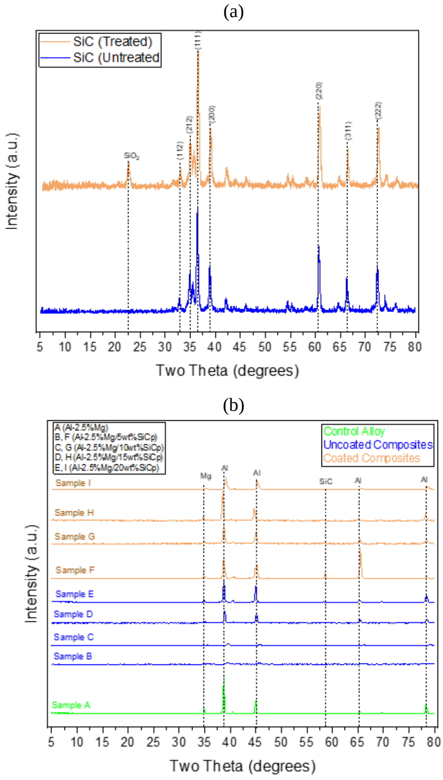

Fig. 2 (a) XRD Pattern of Uncoated SiC$_p$ and SiO$_2$ Coated SiC$_{p,}$ (b) XRD Pattern of the Samples Developed

SiC$_p$ was confirmed in the uncoated and coated composites respectively. These findings are in line with previous research results [19]. No new peak appeared in any XRD pattern, indicating that no new phase formation occurred during the sintering process. It can therefore be recognized that the fabricated composites were reinforced with SiC$_p$. The peak intensities of SiC$_p$ are distinctly visible, however, instead of the intensities increasing with an increase in SiC$_p$ for the uncoated composites, Sample F with 5 wt% of coated SiC$_p$ had the highest intensity of SiC$_p$. This denotes that the reinforcement was well dissolved within the matrix of Al-2.5%Mg alloy, based on the findings of [20].

SEM Analysis of Al-2.5%Mg Alloy Developed

The scanning electron microscopy (SEM) analysis was performed on the JOEL-JSM-7600F using backscattered and x-ray microanalysis with an Oxford EDS detector. The energy of the incident electrons was set to 15 keV. The microstructural investigation of the developed sample of control alloy using Scanning Electron Microscopy (SEM)/Energy Dispersive Spectrometer (EDS) is shown in Fig. 3 at a magnification of x28000 and 150 µm full length of the scale. The result shows that the control alloy without any form of SiC$_p$ reinforcement contains the particles of the Al_3Mg_2 phase as dark grey and forms chains along the Al/Al particles in line with the findings of [31].

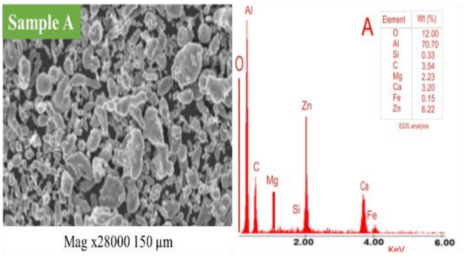

Fig. 3 SEM of Al-2.5%Mg alloy (Sample A)

Mechanical Properties of the Materials Developed

The mechanical test results (tensile, harness and impact tests) of the materials developed are presented in Table 2.

Table 2 Mechanical Test Results of the Developed Materials

Samples	**Specification**	**Tensile**			**Hardness**	**Impact**
		Tensile Strength (N/mm^2)	Yield Strength (N/mm^2)	Extension (mm)	Hardness Value (HRB)	Energy (J)
A	Al-2.5%Mg Alloy	80.29	75.33	13.00	10.23	14.70
B	Al-2.5%Mg/5wt%SiC$_p$	65.17	58.83	18.81	11.70	14.72
C	Al-2.5%Mg/10wt%SiC$_p$	88.08	71.33	18.28	11.56	14.77
D	Al-2.5%Mg/15wt%SiC$_p$	90.40	84.71	15.43	11.50	14.56
E	Al-2.5%Mg/20wt%SiC$_p$	78.19	39.14	21.90	11.00	14.68
F	Coated Al-2.5%Mg/5wt%SiC$_p$	76.33	70.67	8.85	12.50	22.34
G	Coated Al-2.5%Mg/10wt%SiC$_p$	131.83	114.33	12.36	12.00	21.90
H	Coated Al-2.5%Mg/15wt%SiC$_p$	116.90	110.70	9.33	12.20	22.17
I	Coated Al-2.5%Mg/20wt%SiC$_p$	69.08	64.50	14.24	12.07	21.60

Tensile Test

Tensile Strength

From the result obtained in Fig. 4 (a), it was noticed that with an initial addition of 5 wt% uncoated and coated SiC$_p$ reinforcement, the tensile strength of the composite decreased by 18.83 % and 4.93 % respectively. As the composition of the treated and untreated SiC$_p$ reinforcement was further increased up to 10 wt%, the tensile strength rose; nevertheless, the yield strength decreased up to 20 wt% SiC$_p$ reinforcement. Additionally, it was shown that treated SiC$_p$ reinforced composites outperform uncoated ones in terms of tensile strength, except at 20 wt% SiC$_p$ reinforcement. From Fig. 4 (a), at 5 wt% reinforcement loading, there was a 17.12 % increase in the tensile strength, at 10 wt% reinforcement loading, there was a 49.67 % increase in the tensile strength, at 15 wt% reinforcement loading, there was a 29.31 % increase in the tensile strength, while at 20 wt% reinforcement

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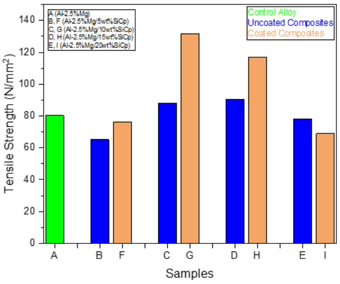
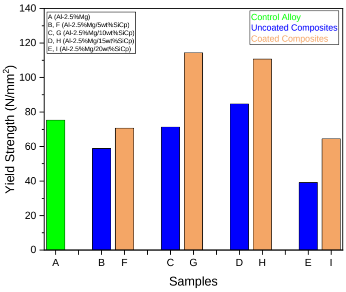
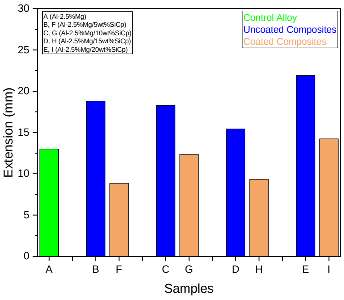
loading, there was 11.65% decrease in tensile strength. As a consequence, the outcome proved that SiC_p reinforcement on Al-2.5%Mg alloy affects its tensile strength positively. However, at higher composition, there was a negative effect. According to [20], who looked at the impact of SiC_p content and treatment on self-lubricating steel, uncoated SiC_p resulted in a more non-adhesive bonding relative to the coated ones.



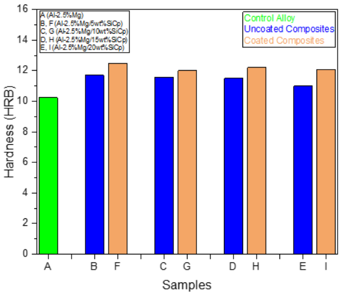
(a)



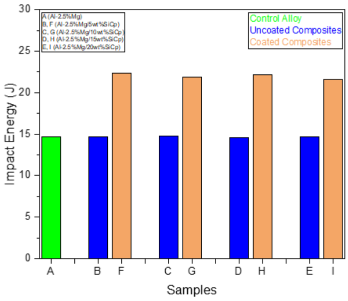
(b)



(c)



(d)



(e)

Fig. 4 (a – e) Variation of Mechanical Properties
(a) Variation of Tensile Strength against Developed Materials
(b) Variation of Yield Strength against Developed Materials
(c) Variation of Extension against Developed Materials
(d) Variation of Hardness Value against Developed Materials
(e) Variation of Impact Energy against Developed Materials

Yield Strength of the Developed Materials

From the result obtained in Fig. 4 (b), it was noticed that with an initial addition of 5 wt% untreated SiC_p reinforcement, the yield strength of the composite decreased by 21.9 %. Although with an additional increase in the composition of the untreated SiC_p reinforcement up to 15 wt%, the yield strength increased, afterwards, a drastic drop in the yield strength at 20 wt% untreated SiC_p reinforcement. A similar trend of the result was also observed when treated SiC_p was used as reinforcement. However, the composites reinforced with treated SiC_p have greater yield strength at all weight compositions compared to the untreated ones. From Fig. 4 (b), at 5 wt% reinforcement loading, there was a 20.13 % increase in the yield strength, at 10 wt% reinforcement loading, there was a 60.28 % increase in the yield strength, at 15 wt% reinforcement loading, there was a 30.68% increase in the yield strength, while at 20 wt% reinforcement loading, there was 64.79% increase in yield strength. Hence, the result established that SiC_p reinforcement on Al-2.5%Mg alloy has an impact on its yield strength. The reason for this trend of results is that untreated SiC_p results in a more non-adhesive bonding relative to the treated ones, as observed by [21] who considered the effect of SiC_p content and treatment on self-lubricating steel.

Extension of the Developed Materials

Fig. 4 (c) also depicts the result of the control alloy's extension into coated and uncoated composites. The extension of the composite rose by about 44.69 % with an initial addition of 5 wt% SiC_p reinforcement. However, when the weight of the untreated reinforcement increases, the extension characteristics decrease until it reaches 20 wt% untreated SiC_p reinforcement, at which point it increases. Surprisingly, the extension properties of the composites decreased when the alloy was reinforced with treated SiC_p. From, at 5 wt% reinforcement loading, there was a 52.95 % decrease in the Fig. 4 (c) extension value, at 10 wt% reinforcement loading, there was a 32.39 % decrease in the extension value, at 15 wt% reinforcement loading, there was a 39.53 % decrease in the extension value, while at 20 wt% reinforcement loading, there was 34.98 % decrease in extension value. This result is complimented by the higher hardness values associated with the coated composites. Hence, the result established that the treatment of SiC_p and its reinforcement on Al-2.5%Mg alloy has negatively influenced its extension. This implies that on treating the SiC_p reinforcement with SiO_2, the composite became less ductile as indicated by [22] who produced brittle cement-based composite using SiO_2.

Hardness Test

The result of the hardness test conducted, it was noticed that the hardness value decreases with an increase in the reinforcement from 5 wt% to 20 wt% for both coated and uncoated composites, although the control alloy with no reinforcement had the lowest hardness value. Furthermore, the composites reinforced with coated SiC_p have greater hardness values compared to the untreated ones. Similar results were observed by [23-26]. From Fig. 4 (d), at 5 wt% reinforcement loading, there was a 6.84% increase in the hardness value, at 10 wt% reinforcement loading, there was a 3.81% increase in the hardness value, at 15 wt% reinforcement loading, there was a 6.09% increase in the hardness value, while at 20 wt% reinforcement loading, there was 9.73 % increase in hardness. Hence, the result established that SiC_p reinforcement on Al-2.5%Mg alloy has an impact on its hardness. The reason for this trend of results is that uncoated SiC_p results in a more non-adhesive bonding relative to the coated ones, as observed by [21] who considered the effect of SiC_p content and treatment on self-lubricating steel.

Impact Test

Fig. 4 (e) also shows the outcome of the impact energy of the control alloy, coated and uncoated composites that were developed. It was noted in the result obtained that there is no trend of impact energy, as the impact energy does not increase or decrease as the amount of SiC_p reinforcement increases. Although the impact energy of the reinforced composites was higher than that of the Al-2.5%Mg alloy used as a reference, the influence of the reinforcing treatment was shown to have a substantial impact on impact energy. According to Fig. 4 (e), at 5 wt% reinforcement loading, the impact energy value increased by 51.77 %, at 10 wt% reinforcement loading, it increased by 48.27 %, at 15 wt% reinforcement loading, it increased by 52.27 %, and at 20 wt% reinforcement loading, it increased by 47.14 %. The outcome proved that the SiC_p's treatment and strengthening on the Al-2.5%Mg alloy had an effect on the impact energy. The mismatch of the materials that function as the barrier for the dislocation movement in the metallic matrix, so restricting the impact energy increase with the increase in SiC_p content, is the cause of the close impact energy of the composites with coated and uncoated SiC_p reinforcement. When SiC_p nanoparticles were utilized to strengthen the AZ31 Magnesium alloy, [27] obtained a similar outcome.

CONCLUSION

Al-2.5%Mg matrix composites reinforced with both uncoated and SiO_2 coated SiC_p particles were successfully produced by stir casting method. The XRD analysis (plot) shows the presence of Al with major peak intensities, also presence of Mg and SiC_p was also distinctly visibly noticed. XRD plots confirmed the presence of Al, Mg, and SiC_p in the uncoated and coated composites respectively. The work shows that addition of silicon carbide particles to Al-2.5%Mg enhances the mechanical properties such as tensile strength, hardness and impact energy of the composites developed. Within the range of 5 – 20 wt% of reinforcement considered, it is observed that for both uncoated and coated samples, the tensile strength and hardness value increases as the wt% of reinforced SiC_p particle increases up to 15 wt%. At 20 wt% tensile strength and hardness value decreased. The results revealed that the hardness of the composites developed with coated SiC_p are generally higher than composites developed with uncoated SiC_p. It also reveals that coating of the SiC_p significantly improved the impact energy of the composites developed compared to the composites developed from uncoated SiC_p. However, the extension properties were lower in the coated samples compared to the control sample but higher in the uncoated samples compared to the control samples and coated respectively. The coating enhanced diffusion of Al-2.5%Mg/xSiC_p particles. Thus, the improved composites interfacial strength and microhardness values obtained showed that composites developed can be adopted as an alternate monolithic alloy for structural and heavy machineries applications.

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