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Manufacturing of a New Generations from the Recycled AL Scrape Reinforced with AL_2O_3 - GNS Composite Powder by Vortex Technique for Automotive Spare Parts

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Abstract- This research addresses the urgent challenges facing the materials and metallurgical industries, driving manufacturers to seek innovative solutions for material recycling. Aluminum scrape in used to manufacture a composite material with a high mechanical properties and good corrosion resistance to be suitable material for fabrication of automotive spare parts. Al scrape in melted at 800 °C, then reinforced with 5, 10 and 15 % from the hybrid Alumina – GNS composite powder prepared by mechanical milling technique by 1:10 ball to powder ratio 350 rpm for 24 hr. To solve the non-wettability problem between the hybrid ceramic reinforcement with the melted Al scrape, it was coated with 10% nano Ag by electroless chemical deposition technique. A vortex method was used to used, in which a mechanical string with 600 rpm for 10 minutes was achieved. Roman spectrum analysis confirmed the flack structure of the GNS. Both hardness and wear resistance were improved by the gradually increasing of (Al_2O_3-GNS) percentage. The microstructure also achieved a good and homogeneous distribution of the reinforcements in the Al matrix and the good Ag coating process. The corrosion rate was decreased by increasing the (Al_2O_3-GNS) rates.

Keywords- Powder Metallurgy Technique; Aluminum; Graphene nanosheets; Silver nano coat; Mechanical recycling; Circular economy; Additive manufacturing; Mechanical properties; Corrosion resistance.

1. INTRODUCTION

Today, there is increasing demand for research on finding new materials superior to conventional materials. In these studies, aluminum-based composite materials have been gaining greater attention, especially in the aviation, space, and automotive industries. These composites combine the great strength of Al_2O_3 - GNS composite powder and the ductility of the metallic AL matrix. Their advantage over ferrous materials is the weight reduction, leading to lower moment inertia and fuel consumption, and better corrosion resistance [1-4]. Many techniques have been developed for manufacturing of particulate-reinforced MMCs, such as powder metallurgy and squeeze casting. Stir casting (vortex technique) is generally accepted as a commercially practicable method. Its advantages lie in its simplicity, flexibility, and applicability to large-volume production. This process is the most economical of all the available routes for MMC production and allows very large-sized components to be fabricated [5-11]. However, several difficulties in stir casting technique are of concern, which is (i) Chemical reactions between the reinforcement material and the matrix alloy, (ii) Porosity in the cast MMC between the two main substances, and (iii) Difficulty in achieving a uniform distribution of the reinforcement material [5-9]. Therefore, been revolutionizing traditional manufacturing processes to align with environmental stewardship and economic viability [12]. One such paradigm shift is the using of the recycled materials to fabricate high-performance components [13], thereby mitigating the environmental footprint associated with traditional manufacturing practices while enhancing the mechanical properties and functionality of automotive spare parts [14]. In this vein, the amalgamation of recycled aluminum (Al) scrap with advanced reinforcement materials, such as aluminum oxide (Al_2O_3) nanoparticles and graphene nanosheets (GNS) [15], presents a transformative avenue for the production of next-generation automotive components [16] with low density and high mechanical properties. The synthesis of composite materials comprising recycled aluminum scrap and nanostructured reinforcements signifies a departure from conventional approaches, ushering in a new era of sustainable manufacturing processes in the automotive sector [17]. Leveraging the principles of circular economy, wherein waste materials are repurposed and reintegrated into the production cycle [18], this innovative manufacturing technique not only addresses the pressing challenge of aluminum waste management but also fosters the creation of value-added products with enhanced mechanical strength, thermal stability, and corrosion resistance [19, 20]. Central to this transformative endeavor is the vortex technique, a novel processing methodology that harnesses the kinetic energy of high-speed fluid flow to achieve homogenous dispersion and interfacial bonding of nanostructures within the aluminum matrix [21]. By capitalizing on the synergistic effects of vortex-induced fluid dynamics and the unique properties of Al_2O_3-GNS composite powder [22, 23], this technique enables the fabrication of lightweight yet robust automotive spare parts capable of withstanding demanding operational conditions while simultaneously reducing material waste and energy consumption [24]. This process was applied to enhance the wettability of ceramic particles with molten aluminum [25]. After casting, warm equal channel angular pressing (ECAP) and hot extrusion processes were applied to investigate their effects on the mechanical properties of the final composites. It was revealed that both warm ECAP and hot extrusion have a strong influence on increasing the mechanical properties mainly due to decreasing the number of porosities and the grain refinement of the particles [25]. This paper the elucidates the intricate manufacturing process involved in the production of recycled aluminum scrap reinforced with different ratios from Al_2O_3-GNS composite powder using the vortex technique for automotive spare parts applications. Through a comprehensive exploration of material synthesis, process optimization [26, 27], and performance characterization [28]. It also, endeavors to unveil the transformative potential of this sustainable manufacturing approach in revolutionizing the automotive industry's supply chain dynamics [29], fostering resource conservation, and promoting the adoption of eco-friendly practices across the manufacturing landscape [30, 31]. By delving into the intricacies of material science, mechanical engineering, and sustainable manufacturing practices, this paper seeks to inspire future research endeavors aimed at harnessing the power of recycled materials and advanced nanocomposites to drive innovation, sustainability [32], and resilience in the automotive industry [33]. Through collaborative efforts between academia, industry stakeholders [34], and policymakers, the vision of a circular automotive manufacturing ecosystem anchored in sustainability, efficiency, and technological advancement can be realized [35], heralding a new era of automotive engineering excellence and environmental stewardship. Therefore, the main aim of this research is the manufacturing of new generations from the recycled AL scrape reinforced with Al_2O_3 - GNS composite powder by vortex technique with high hardness, high corrosion resistance and superior mechanical properties suitable for the automotive spare parts as an alternative light weight material to the iron spare parts.

2. METHODS AND EXPERIMENTAL PROCEDURE

I. Materials Used

For the metal matrix composite, the base matrix selected is Aluminum foil obtained in the form of ingots and the reinforcement chosen is Al_2O_3 of the size 150-250 microns, providing optimal reinforcement properties for our composite. Also, graphene nano sheets powder (GN) with a particle size of 30 nano-meters and a remarkable purity level of 99.9%, is incorporated as a primary reinforcing agent alongside recycled material. Silver nitrate as a precursor to silver nanoparticles, supplemented with a 33% ammonium solution and formaldehyde was used as a both for the electroless chemical deposition of 10% nano silver layer on the Al_2O_3 & GNS surfaces to improve the wettability of them with the AL matrix. All chemicals used in this research were supplied from (El Gomhouria Company) in Egypt country

II. Sample preparation

The development of a novel Al_2O_3-GNS, hybrid ceramic material, entails a meticulously designed process aims at enhancing both its structural integrity and surface characteristics. Initially, the Al_2O_3 and GNS powders undergo mechanical grinding for a duration time of 8 hours with a rotational speed of 350 rpm [26], effectively reducing the particle size of alumina. The resulting composition consists of 97.5 wt.% Al_2O_3 and 2.5 wt.% GNS, with grinding conducted using 10-mm diameter ceramic alumina balls in a stainless-steel container, maintaining a ball-to-powder ratio of 10:1. To ensure the purity of the Al_2O_3-GNS hybrid particles, surface treatment procedures are meticulously executed. Initially, the particles undergo stirring in a 10% NaOH solution followed by in immersion acetone for 1 hour to eliminate any impurities [37]. Subsequently, the particle surfaces undergo activation and metallization via an electroless nano silver-plating method. This involves dissolving silver nitrate in water, adjusting the pH to 11 with ammonia solution, introducing the Al_2O_3-GNS hybrid particles, and adding formaldehyde as a reducing agent. Following thorough washing, the coated particles are subjected to drying in an electric oven at 80°C for 2 hours, ensuring the completion of the surface modification process. This comprehensive approach guarantees the attainment of high-purity Al_2O_3-GNS hybrid particles with enhanced structural integrity and surface properties, paving the way for their utilization in a diverse array of advanced applications in automotive sectors, to reduce the weight of the automotive to decrease the fuel compositions [38].

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III. Sample production

The aluminum scrap undergoes a comprehensive cleaning protocol meticulously designed to eradicate any residual dust and oils. This cleansing process involves a meticulous washing with acetone, followed by thorough drying to ensure pristine surface conditions. Subsequent to the cleaning phase, the prepared aluminum is compressed into uniform cubes. These precisely dimensioned cubes are then subjected to a meticulously controlled melting process, attaining a temperature of 800 degrees Celsius to achieve complete liquefaction [39]. Maintaining the molten aluminum at a steady temperature is imperative to ensure uniform mixing and homogeneity throughout the alloy. Simultaneously, a carefully calibrated powder mixture comprising Al_2O_3-GNS is meticulously prepared, with varying weight ratios of 5%, 10%, and 15% relative to the samples. Once the molten aluminum reaches a homogenous state, the pre-mixed powder additives are methodically introduced into the alloy, accompanied by continuous stirring. This gradual incorporation prevents agglomerations and facilitates thorough dispersion of the powder within the aluminum matrix. The stirring process continues for a duration of 10 minutes, meticulously monitored to prevent overcooling and maintain optimal processing conditions. The capsulation process of both the ceramic Al_2O_3 & GNS nano particles with 10 % nano Ag enhances solve the nano-wettability problem of them with AL matrix due to the high surface energy owing to their different reduce. Upon achieving a homogeneous distribution of the Al_2O_3-GNS powder additions, the molten alloy is carefully poured into a preheated mold, meticulously prepared to prevent any defects in the final sample. Employing a controlled cooling process enables gradual solidification, thereby minimizing residual stresses and ensuring robust metallurgical bonding between the aluminum matrix and the Al_2O_3-GNS reinforcement. This meticulous methodology ensures the production of high-quality composite samples suitable for comprehensive characterization and evaluation in our research study [40].

IV. Metallurgical and mechanical properties

To examine the microstructure of the prepared samples, they are polished using 4 grades of emery Sic papers and then SEM observations were carried out using a machine model (QUANTA FEG 250) and TEM observations of the samples were identified with a high magnification. To know the macro-hardness of the Al- Al_2O_3-GNS composites, the specimens prepared are tested under a Vickers hardness tester. The casted samples obtained are prepared with the required dimensions of 10mm x 16mm diameter on a lathe machine. The specimens are disc polished on a disc polishing machine using graphite water as a coolant for rotating the mukamal clothed disc. The polished samples are etched using Keller's reagent and then placed on the table of the Vicker's tester under the load of 1 kg for a dwell time of 10 sec is applied to the specimen. Transverse tensile test has been carried out using a tensile machine model (Universal Testing Machine WDW-300 China). Also, the corrosion behavior of Prepared samples using an electrochemical corrosion testing apparatus model (Auto lab NOVA 2.1.5) in 3.5 wt.% NaCl solution at room temperature was established.

3. RESULTS AND DISCUSSIONS

I. Powder investigation

Figure 1 shows a comprehensive analysis derived from scanning electron microscope (SEM) and transmission electron microscope (TEM) examinations of both primary and mixed powder samples. In Figures a, b and c detailed visual representations depict the morphologies of the Al_2O_3 powder, and graphene nano layers, respectively. Notably, the graphene nano layers exhibit a tightly packed structure, while Al_2O_3 particles display irregular shapes. Given the nano-sized nature of the ground and mixed powders (Al_2O_3-GNs), TEM was employed for in-depth examination. A 3D image provides insights into the ground Al_2O_3-GNs, revealing the intricate interactions between graphene-coated Al_2O_3 molecules, leading to the formation of layered structures. Importantly, free graphene layers are discernible within the composite, indicating a complex interplay between the two constituents. During the milling process, the high friction generated between graphene and alumina particles induces a sliding motion of the graphene flakes, resulting in the encapsulation of some alumina with the GNS particles while releasing others. After the milling procedure, Figure d, show cases the mixing levels between Al_2O_3 and graphene (Al_2O_3-GNS), alongside aluminum, which indicates satisfactory homogeneity within the compound. Figure d demonstrates that the milling process has achieved a well-mixed, uniform distribution of Al_2O_3, graphene, and aluminum, confirming a satisfactory level of homogeneity in the composite material. This detailed analysis not only elucidates the microstructural evolution and interfacial interactions within the Al_2O_3 graphene nano sheet composite powder but also highlights its potential for diverse applications in various industrial sectors.

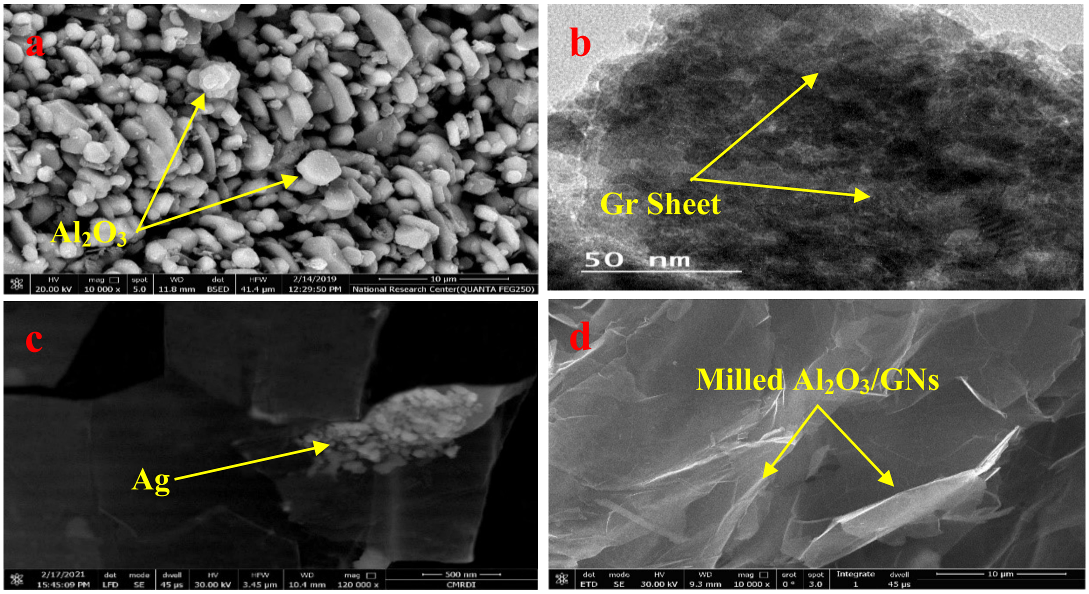

Fig. 1. SEM (BSE) and TEM micrograph detectives of as received and electroless powders

The transmission electron microscopy (TEM) is used to examine the microstructure of the prepared composite materials, unraveling intricate details of its morphology. Figure 2. shows the TEM image, providing a comprehensive visualization of the characteristic features inherent in the mixture. Also, a Raman analysis to corroborate the formation of GNS within the composite structure. The Raman spectrum depicted in Figure c, unequivocally confirmed the presence of graphene, as evidenced by distinct its peaks. Through a meticulous examination of the microstructure, the distribution and arrangement of the constituent elements within the mixture, The TEM analysis reveals the detailed microstructure of the composite, while the Raman spectrum confirms the presence and proper integration of graphene nano sheets, highlighting the material's composition and potential applications.

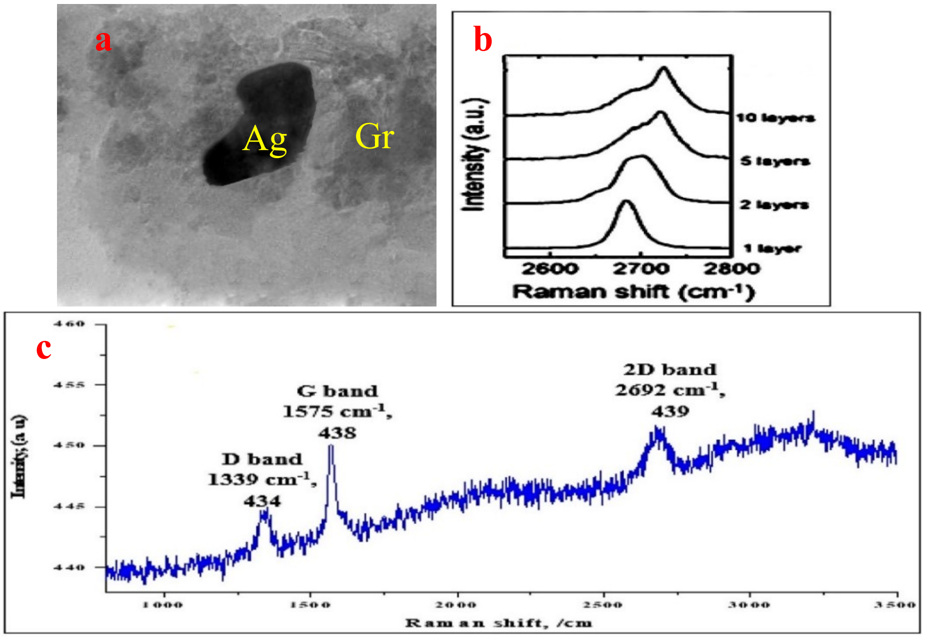

Fig. 2. (a) TEM and (b) Raman analysis of the hybrid (Al_2O_3-GNs) Ag

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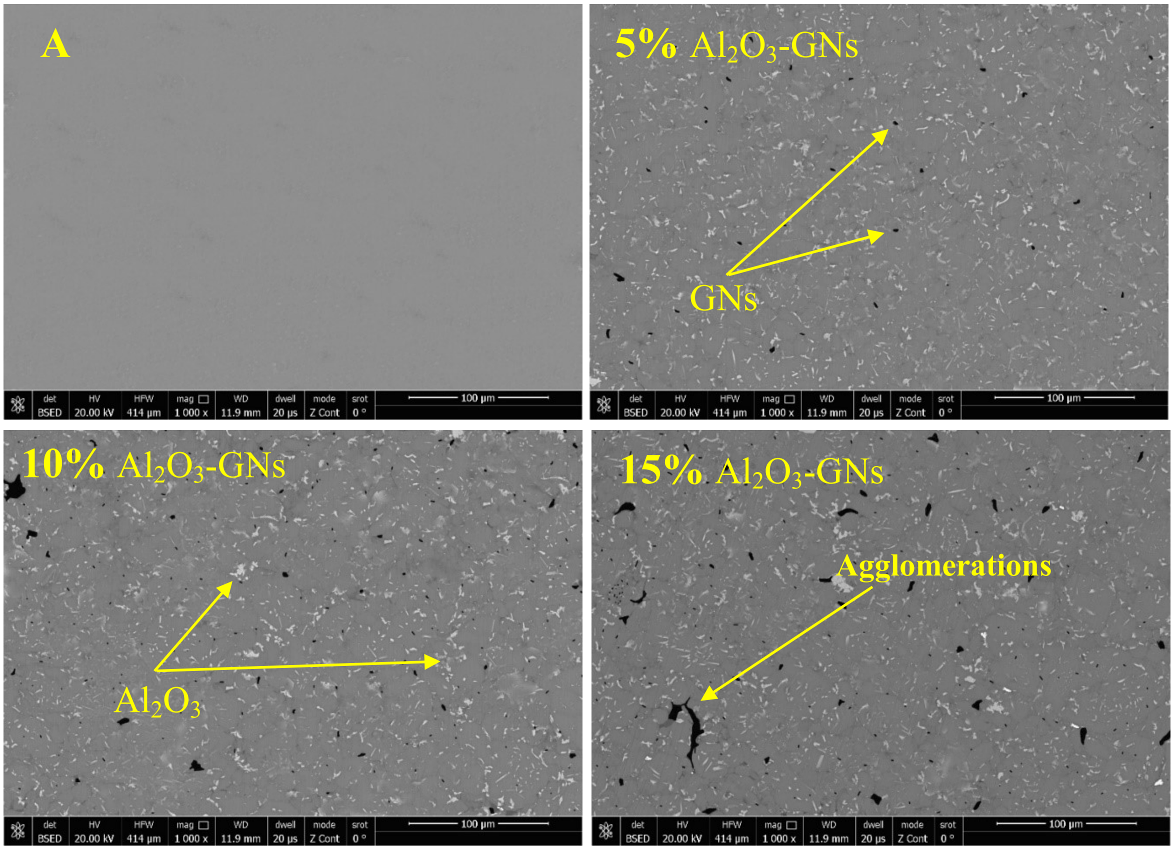
II. Microstructure observations of the prepared samples

After completing the initial preparatory steps involving polishing and etching, a comprehensive investigation into the microstructural attributes of various aluminum-based samples was initiated, encompassing both pure casted aluminum specimen and Al/(Al_2O_3-GNS) nano composites. The microstructural analysis, as illustrated in Figure 3, played a crucial role in elucidating the intricate nuances of the internal architecture and coherence of these composite materials. Examination of the microstructure of pure casted aluminum revealed a notable absence of porosity or fissures, indicating a well-structured, homogeneous morphology. However, upon closer scrutiny of the microstructure of the as-cast hybrid reinforcement specimens, significant enhancements were observed in both the dispersion of the hybrid reinforcement and its adhesion to the aluminum base metal. This observation indicates that the hybrid reinforcement materials were evenly distributed and strongly bonded to the aluminum base, which is crucial for improving the overall mechanical properties of the composite. For the AL- Al_2O_3-GNS composites, it is observed that both Al_2O_3 & GNS are well-distributed all over the AL matrix without any aggregations. This enhancement in adhesion can be attributed to the electroless coating of nano silver metal, which effectively improves the wettability of particle surfaces of Al_2O_3 & GNS with the AL matrix, in which these ceramic particles with its high surface energy with the AL matrix with its metallic nature. The improved adhesion is due to the electroless nano silver coating, which enhances the wettability between the Al_2O_3 and GNS particles and the aluminum matrix by reducing the surface energy mismatch between the ceramic particles and the metallic matrix. Furthermore, the meticulous stirring mechanism employed during the casting process further facilitated the uniform dispersion of Al_2O_3-GNS throughout the matrix. The findings underscore substantial advancements in the distribution of hybrid reinforcement within the aluminum matrix, along with enhanced cohesion. These results validate the effectiveness of the stirring process during sample casting in enhancing the structural integrity and mechanical properties of the composite material.



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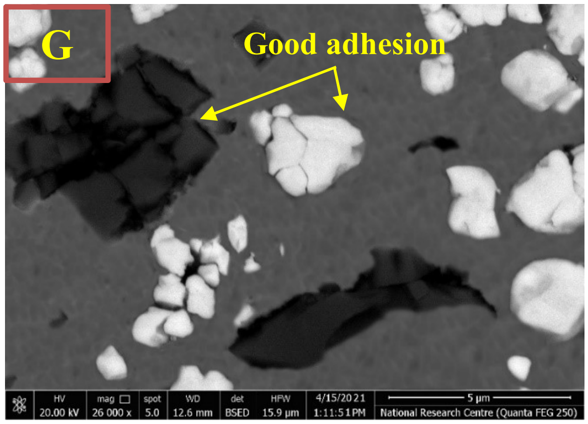
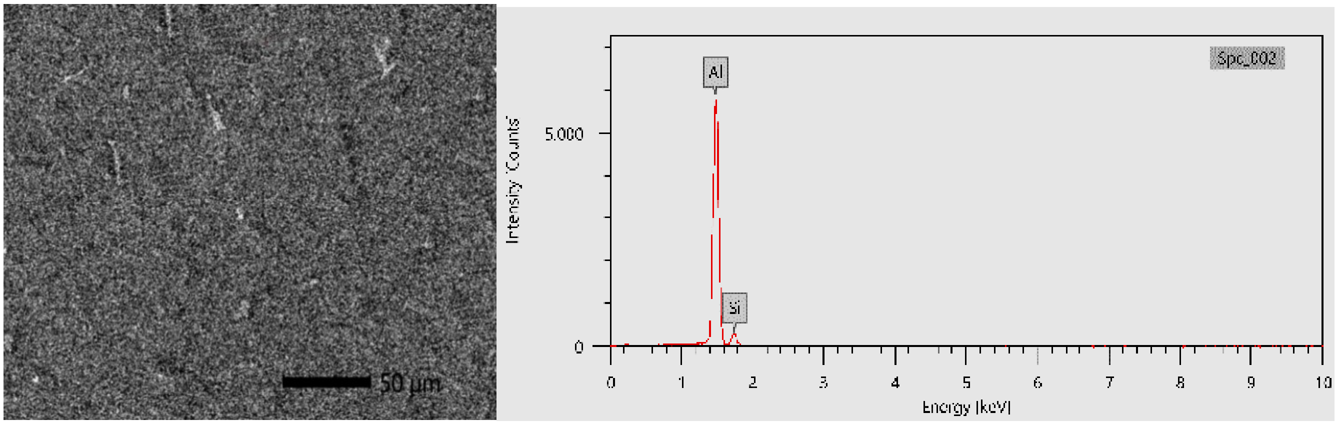


Fig. 3. SEM (BSE) micrographs of the fabricated nano-composites

The investigation commenced with an initial analysis utilizing energy-dispersive X-ray spectroscopy (EDAX) in conjunction with scanning electron microscopy (SEM), as depicted in Figure 4. This comprehensive analysis unveiled the predominant composition revealing it to be primarily comprised of an aluminum-silicon alloy. To delve deeper into the spatial distribution of graphene, alumina, and silver within the newly synthesized hybrid material, additional mapping and EDAX analyses were conducted. The findings elucidated a well-dispersed distribution of these elements, indicative of thorough stirring during the casting process. Notably, the weight-dominance of alumina, existing in the form of aluminum and oxygen, underscores its significance within the compound. Furthermore, the micro dispersion of graphene flakes within the alumina matrix yielded a weight fraction of 15 wt.%, highlighting its effective reinforcement role. Additionally, the successful incorporation of silver, employed in the surface coating of the hybrid materials, was confirmed at a weight percentage of 2.5%, validating the efficacy of the electroless deposition process. This confirms that the electroless deposition process effectively coated the hybrid materials with silver, achieving the targeted weight percentage. These findings not only affirm the synthesis methodology but also furnish crucial insights into the elemental composition and distribution within the hybrid material, thereby laying a robust foundation for subsequent characterization and performance evaluation endeavors.



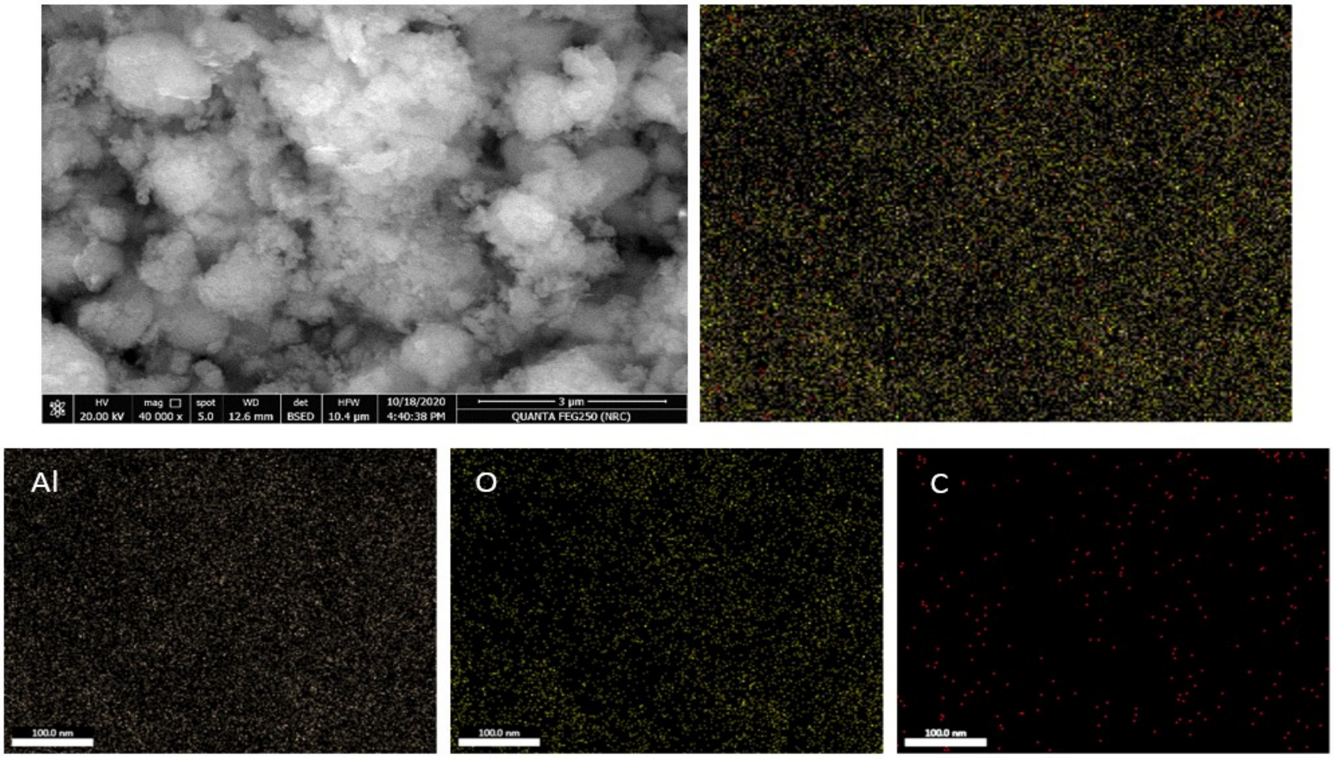


Fig. 4. Mapping and EDAX analysis of Al /Al2O3-GNs

III. Hardness Measurements samples

Figure 5. shows a comprehensive analysis of the hardness values derived from cast aluminum specimens, offering invaluable insights into the mechanical characteristics of the fabricated samples. The Figure shows that the hardness increases gradually increasing the percentage of the Al_2O_3-GNS hybrid reinforcement gradually up to 10 wt.%, then decreases for 15 wt.%. The hardness profile of sintered nanocomposites unveils a remarkable enhancement in aluminum hardness upon reinforcement with 10 wt.% Al_2O_3-GNS hybrid, escalating from 72.34 to 111.2, corresponding to a substantial improvement of 36.18%. This notable augmentation can be ascribed to the synergistic interaction between Al_2O_3 particles and the aluminum substrate, fostering the formation of robust interfacial bonds that fortify the material's strength and hardness. The incorporation of alumina particles engenders a refinement in grain size and densification, impeding the movement of slip faults responsible for metal deformation. Furthermore, the presence of Graphene nanosheets (GNS) further reinforces this bond, imparting heightened material stiffness. Also, both Al_2O_3-GNS are a ceramic material which have a high hardness more than AL. So, reinforcing the ductile AL with both of them in a homogenous manner improves greatly the hardness of the overall the prepared composites [21]. However, upon escalating the content of the Al_2O_3-GNS hybrid to 15 wt.%, a marginal decline in hardness to 108 was observed. This is may be attributed to the fact that, coating S 10 wt.% from Al_2O_3-GNS with 10% nano Ag is enough for the complete capsulation of them with Ag. But for 15 wt.% - 10 % nano Ag is not enough, so some agglomerations take place [21]. This phenomenon is attributed to the formation of agglomeration in the aluminum matrix, giving rise to defects and heterogeneities in material properties. These defects act as focal points for stress concentration, thereby weakening the overall stiffness of the material. Additionally, the grain refinement process serves to mitigate structural defects and augment material density, culminating in a more cohesive microstructure characterized by enhanced resistance to deformation and improved hardness. Furthermore, it is pertinent to explore the impact of processing parameters, such as sintering temperature, compaction pressure, and particle size distribution, on the mechanical properties of the fabricated nanocomposites to elucidate the underlying mechanisms

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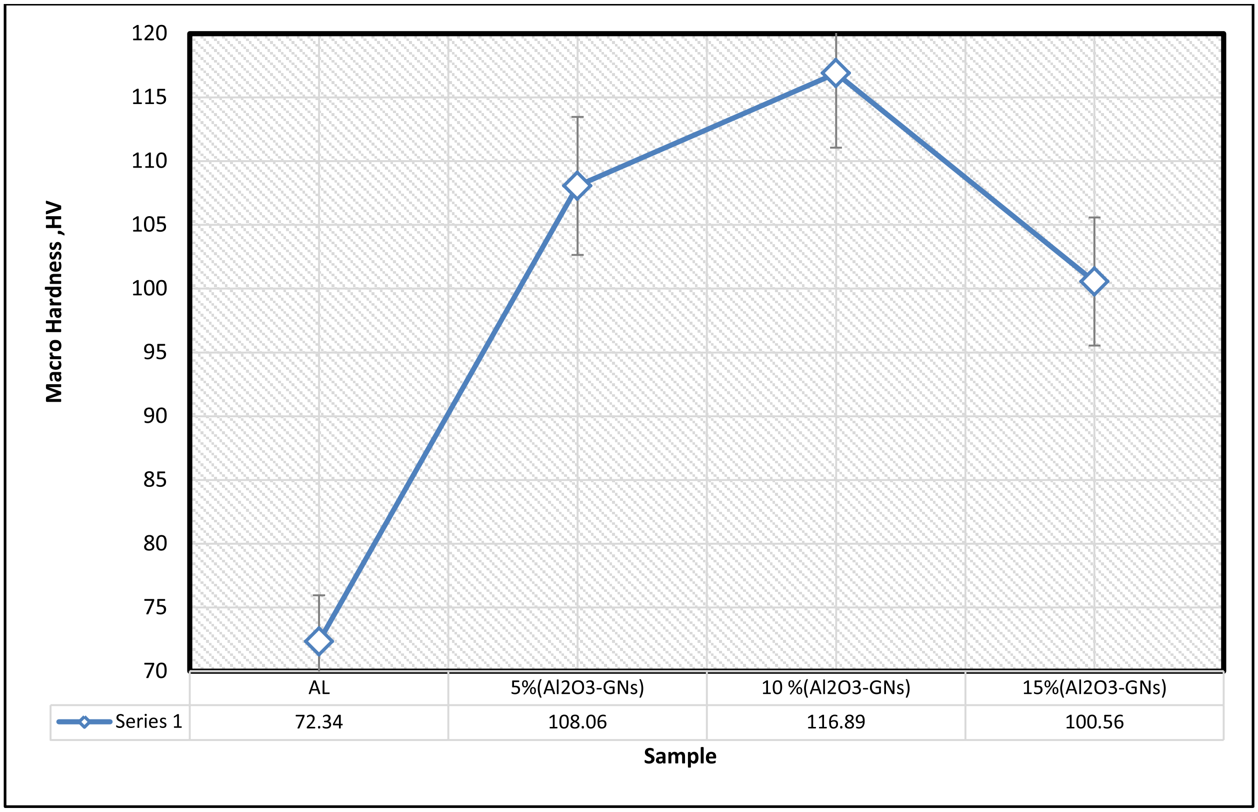
governing their performance and durability in practical applications. it can be noticed that, the hardness of the prepared samples is about 116.8 Hv , it is higher than that of pure Al. As the hardness of Aluminum Cylinder Head of the automotive is about 98 Hv, so the prepared Al- Al_2O_3-GNS composite is a suitable material for the manufacturing of com shalt by a high mechanical property.



	AL	5%(Al2O3-GNs)	10 %(Al2O3-GNs)	15%(Al2O3-GNs)
Series 1	72.34	108.06	116.89	100.56

Fig. 5. Macro-hardness measurements of the nanocomposites.

4. TENSILE STRENGTH

Figure 6. shows the tensile testing offering insights into the mechanical properties of the specimens, including yield strength, ultimate tensile strength (UTS), and elongation. The specimens were fortified with hybrid Al_2O_3-GNS at varying proportions of 5%, 10%, and 15 wt.%. Examination of the results indicates a significant enhancement in the mechanical performance? with Al_2O_3-GNS-reinforced cast AL matrix demonstrating improvements up to 12% compared to the non-reinforced counterparts. Particularly noteworthy is the performance of samples reinforced with 10 wt.% Al_2O_3-GNS, exhibiting an impressive UTS of 88.83 MPa, a substantial increase compared to the pure aluminum sample with a UTS of 54.97 MPa. This enhancement is ascribed to the synergistic interaction between Al_2O_3 particles and graphene nanoparticles embedded within the aluminum matrix. With a uniform dispersion, hindering sliding movement between aluminum grains and consequently bolstering material resistance, while graphene particles form thin layers on aluminum grain surfaces, enhancing cohesion and preventing grain separation. All the above results can be mainly attributed the good surface modification of both Al_2O_3-GNS by coating with 10 % nano Ag layers, which prevents their aggregations & facilitate their dispersion homogeneously in the AL-matrix [21, 42, 43]. Moreover, the integration of Al_2O_3-GNS facilitates grain refinement in the aluminum matrix, contributing to heightened fracture strength [43, 44]. From Figure 6 one can, be notice that all the three mechanical parameters concluded from this curve which are the UTS, yield strength & elongation are increased gradually by reinforcing AL matrix with the hybrid Al_2O_3-GNS up to 10 % then they are decreased for 15 %. This may be attributed to (as mentioned previously) to the agglomerations takes place for 15 % hybrid ratios due to in complete encapsulation of them with the nano Ag in which some of the Al_2O_3-GNS particles surfaces are not coated, so the

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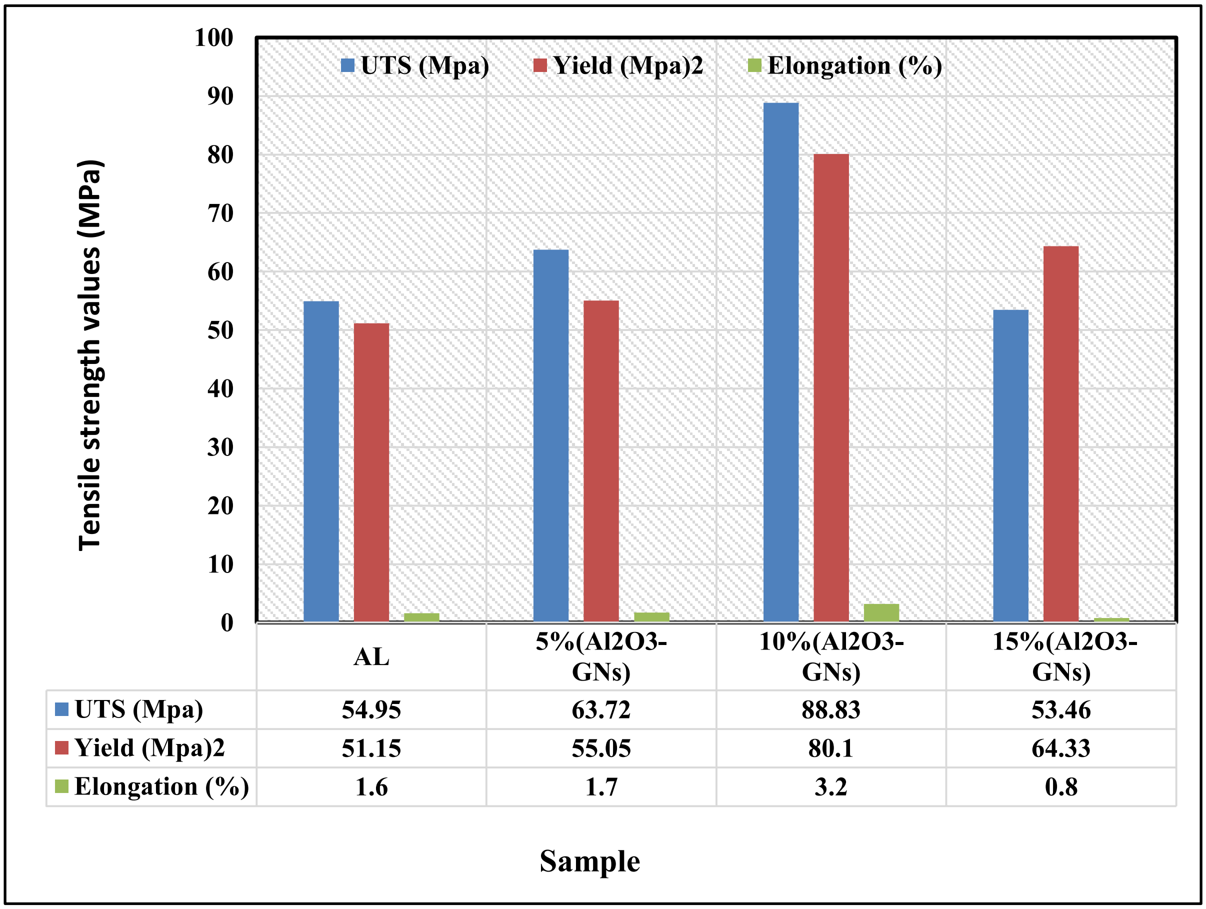
surface energy because higher consequently agglomerations take place. However, it is crucial to recognize that the observed decline in UTS may arise from the elevated accumulation rates of Al_2O_3-GNS during recycling processes. The accumulation of nanoparticles could lead to increased grain size and diminished material homogeneity, rendering the material more susceptible to breakage. This underscores the critical necessity of rigorously controlling nanoparticle dispersion and accumulation levels to ensure uniformity and uphold mechanical integrity throughout recycling procedures. Further investigation into optimization strategies for nanoparticle dispersion and recycling protocols is imperative to mitigate potential degradation in mechanical properties and maximize the durability and sustainability of reinforced aluminum materials.



	AL	5%(Al2O3-GNs)	10%(Al2O3-GNs)	15%(Al2O3-GNs)
UTS (Mpa)	**54.95**	**63.72**	**88.83**	**53.46**
Yield (Mpa)2	**51.15**	**55.05**	**80.1**	**64.33**
Elongation (%)	**1.6**	**1.7**	**3.2**	**0.8**

Fig. 6. Tensile testing of cast sample

5. Corrosion behavior

Figure 7. shows an in-depth analysis of the polarization curve patterns obtained from pristine cast aluminum and cast aluminum fortified with 15% Al_2O_3-GNS, offering valuable insights into the corrosion dynamics observed when these samples are subjected to a 3.5% NaCl solution within an electrochemical cell. The results delineate notable discrepancies in polarization resistance between the un-reinforced cast aluminum and its reinforced counterparts, as indicated by distinct voltage and current profiles. Furthermore, the strengthening treatment administered to the cast-reinforced sample induces further alterations in its polarization resistance, underscoring the intricate interplay between material composition and corrosion behavior. Employing the Tafel method, as detailed in Table 1. enables a deeper exploration of two noteworthy phenomena. Firstly, the incorporation of the novel hybrid reinforcement (Al_2O_3-GNS) into pristine die-cast aluminum yields a substantial reduction in corrosion rate (CR). Specifically,

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while the unaltered as-cast sample exhibits a CR of 3.124 mm/year, the introduction of the hybrid mixture precipitates a remarkable decrease in CR to 0.215 mm/year, translating to a significant 93.11% reduction. This reduction is attributed to the inherent high corrosion resistant properties of the (Al_2O_3-GNS) due to their ceramic nature and the enhanced adhesion between the matrix and reinforcement facilitated by the Ag coating. The robust bonding of Al_2O_3-GNS at grain boundaries serves as an effective barrier against solution ingress, thereby mitigating corrosion. These findings underscore the considerable potential of the novel hybrid reinforcement (Al_2O_3-GNS) to enhance the corrosion resistance of aluminum alloys significantly. Further elucidation of these mechanisms not only enhances our understanding of wear phenomena but also propels advancements in the development of robust and resilient materials tailored for diverse industrial applications. It also must be mentioned that the good manufacturing parameters, helps in the production of AL- Al_2O_3-GNS composite with the lowest porosity and good densification which prevents the incorporation of the 3.5% NaCl corrosive medium from intrance inside the sample core so corrosion decreases. This comprehensive investigation lays the groundwork for future research endeavors aimed at harnessing the full potential of hybrid reinforcements for corrosion mitigation and material enhancement.

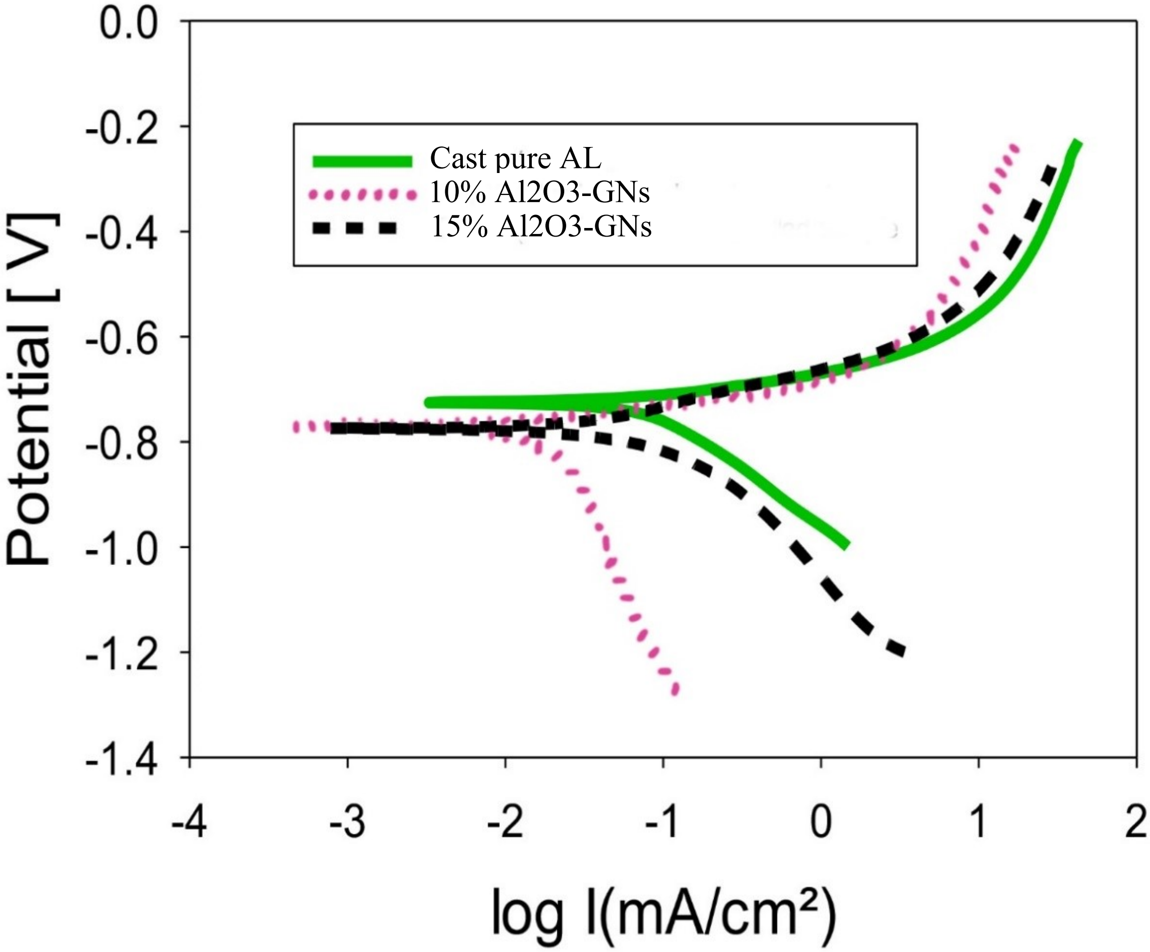

Fig. 7. Potentiodynamic polarization curves of as-cast pure Al, 15 wt.% (Al_2O_3-GNS).

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Table 1. Corrosion parameters of nanocomposites.

Samples	**E_{corr} (mV)**	**I_{corr} (mA/cm^2)**	**R_p ($Kohm.cm^2$)**	**Corrosion rate (mm/year)**
Cast Pure Al	**-797.9**	**0.2817**	**227.78**	**3.124**
15 wt.% (Al_2O_3-GNs)-cast	**-769.5**	**0.0197**	**1.43**	**0.215**

6. CONCLUSION

In this study, an Al-based composite reinforced with (Al_2O_3-GNS) hybrid ceramic composite nano particles were fabricated using the vortex casting method. The composites, which are produced by stir (vortex) casting, have good mechanical properties. Based on the obtained results, the following outcomes are drawn:

1. The milling process between Al_2O_3-GNS facilitates the deposition of some exfoliated graphene layers on the surfaces of alumina particles, enhancing the mechanical performance of the composite.
2. To solve the non-wettability problem between the hybrid ceramic reinforcement with the melted Al scrape, it was coated with 10% nano-Ag by electroless chemical deposition technique. A vortex method was used to use, in which a mechanical string with 600 rpm for 10 minutes was achieved.
3. Raman spectrum analysis confirmed the flack structure of the GNS. improving both hardness and tensile strength gradually increasing by (Al_2O_3-GNS) percentage up to 10 %, then are decreased for 15 %.
4. The microstructure shows a good and homogeneous distribution of the reinforcements in the Al matrix and a good nano Ag coating process.
5. The corrosion rate was decreased by increasing the (Al_2O_3-GNS) rates. APPENDIX

Appendixes, if needed, appear before the acknowledgment.

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