Review of: "The Influence of Hot Extrusion on The Mechanical and Wear Properties of an Al6063 Metal Matrix Composite Reinforced With Silicon Carbide Particulates"

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Potential competing interests: No potential competing interests to declare.

“The Influence of Hot Extrusion on The Mechanical and Wear Properties of an Al6063 Metal Matrix Composite Reinforced With Silicon Carbide Particulates”

Comments

Abstract

The abstract is written in a generalized manner, lacking specific details about experimental results and mechanisms. The authors need to completely rewrite the abstract, avoiding the use of general statements such as 'Lightweight composite materials.' Ensure the inclusion of specific experimental findings and mechanisms in the revised version.

Introduction

Page-2: What does "solid metallurgy" mean? Does such a term exist?

Page-2: “The most popular are the Al 6000 and Al 7000 series due---”. It should be AA6XXX and AA7XXX.

Page-1: “the most popular are the Al 6000 and Al 7000 series due to their ease of fabrication, low cost, and machinability”. In general, all aluminum alloys have ease of fabrication, low cost, and machinability. Mention the specific characteristics of 6XXX and 7XXX alloys.

Page-2: No continuity between one sentence and another. For example, “A.M. Xavior et. al [5] developed composites considering aluminium alloys from the 2xxx series as the matrix and SiC and Al2O3 as reinforcements by the powder metallurgy route. The composite had 1.5 times the compressive strength of the peak-aged aluminium alloy 6061. The molten metal and ceramic foam only slightly reacted. Microwave sintering was used to process the aluminium reinforced with silicon carbide at 5 vol% at a sintering temperature of 770 °C and a pressure of 250 MPa [6]. Many researchers have attempted to develop metal matrix composites with widely available reinforcements such as graphite, silicon carbide, titanium carbide, tungsten, boron, Al_2O_3, Al-Mg, ZA27, and TiB2[7][8][9][10].”

Page-2: Use subscripts for TiB2.

Page-2: Do tungsten, boron, Al-Mg, and ZA27 have been used as reinforcements? If so, explain.

Page-2: What does "wear coefficient" mean? Does such a term exist?

Page-2: What does "wear life" mean? Does such a term exist?

Page-2: What do the authors want to communicate from the statements “When a composite is composed of a base aluminium matrix alloy in a dry lubricated condition, the coefficient of friction was significantly reduced. In dry sliding wear conditions, titanium di-boride (TiB2) demonstrated improved wear performance and a decrease in the coefficient of friction.”?

Page-3: Is it “post-cast” or “post-casting”?

The following are general comments about the Introduction section:

- The literature review is very brief.
- There is no detailed discussion regarding the exploration of the literature gap.
- What is the motivation behind addressing this problem?
- How does the present investigation contribute to addressing the existing literature gap?
- The novelty of the work needs to be highlighted.
- What was the rationale for selecting AA6063 alloy and SiC reinforcement in the present study?
- What are the advantages of the hot extrusion route over other secondary processing routes?
- Authors should exercise caution while using technical terms and ensure that the use of their own technical terms is justified.

Experimental work

Page-3: The term “Fabrication” is used for construction of part through mechanical actions. Does it correct to use fabrication of composite for liquid metallurgy route?

Page-3: It was mentioned as “The aluminium ingots were procured----”. The aim was to prepare AA6063 composite. No information was provided regarding addition of alloying elements to achieve the AA6063.

Page-3: “The pre-heated silicon carbide was introduced into the molten aluminium at a predefined weight percentage.” What is the weight percentages considered? How does SiC introduced in the melt?

Page-3: “A continuous stirring process was carried out using a mechanical stirrer to ensure the reinforcement and matrix alloy are assorted.” What type of string rod material used? What is the design of string plate?

Page-3: “The developed molten melt was then poured into permanent moulds that were pre-heated to 200°C to drive out moisture”. What is the mold material? What is the size of mold?

Page-3: “The hot extrusion operation was carried out on a 500-ton extrusion press at an extrusion temperature of 550°C, an extrusion ratio of 9.0, and a ram speed of 2 millimeters per second.” What is extrusion ratio? What is the extrusion die design and material? Is it direct extrusion or indirect extrusion method? Does the reduction obtained in single step or

multiple steps?

Page-3: “Tensile and compression tests were conducted as per ASTM B557M and ASTM E-9……. samples as per ISO 6507”. Mentioned the year/revision of the standards.

Page-3: “ The specimens were prepared as per the IS1757 standard for the charpy impact test”. Mentioned the year/revision of the standard.

Page-3: “Wear test samples for various loads ranging from 10 N to 60 N in steps of 10 N at a constant speed of 100 rpm and a constant track radius of 0.2 m were used…” What is the total wear track distance or duration of test conducted?

Page-3: “An adhesive wear test was performed on a standard pin on a disc wear test rig as per the ASTM G99 standard”. Mention the year/revision of the standard.

The following are general comments about the Experimental Work section:

- No information is provided about the vendors from whom aluminum and SiC were procured.
- The chemical composition of the aluminum alloy and SiC is not given. How can the authors confirm that they used the correct composition of the alloy and SiC?
- What is the particle size, shape, and distribution of the SiC used?
- No information is provided about the equipment or instruments used for the experimental work.
- There is no mention of the protective atmosphere during processing. The authors only state that SiC was introduced into the molten liquid and stirred. Liquid aluminum alloys can easily undergo oxidation when exposed to the atmosphere, leading to oxide film formation, bi-film defects, and decreased mechanical properties.
- How much quantity of aluminum alloy was melted in each casting?
- The stirring speed of 300-400 rpm creates a vortex. How was this vortex problem addressed?
- The authors have only mentioned the standards followed for tensile, compression, impact, and wear tests. What is the size of the samples used in these tests? What type of notch was used for the impact study? What were the test conditions, such as temperature, atmosphere, and lubrication?

Results and Discussion

Page-3: “The density test was conducted on all prepared composite systems,” How were the densities of the samples determined? No information is provided in the experimental work.

Page-4: Mention the X-axis and Y-axis labels along with units.

Page-4: “How were the porosities of the samples determined? No information is provided in the experimental work.

Page-5: “The results reveal that the density continued to increase with increasing weight fractions of reinforcement in composites”. Use the term weight percentage instead of weight fraction and maintain the same throughout the article.

Page-5: “Due to differences in the density and mechanical structure of crystals and the atomic arrangement in ceramic

reinforcements, density exhibits a relative enhancement with the increasing weight fraction of reinforcement". What does the term "mechanical structure of crystals" mean? How does the atomic arrangement in ceramic reinforcements affect density while using the same type of SiC?

Page-5: "Density improves further in postcast processing by 1.2%. This is due to strain hardening and the atomic compacting of composites,…". The hot extraction was carried out at 550 deg C, which is well above the recrystallization temperature. How does the author expect strain hardening to take place? Justify.

Page-5: "It was noticed that the porosity of the composite is mainly influenced by the particle size of ceramic reinforcements; thus, as the volume fraction of reinforcement is increased, porosity is also increased due to the inhomogeneity of the alloy and the reinforcing element at the atomic level and the particulate nature of reinforcements". What is the relationship between particle size and volume fraction? No experimental evidence was presented to show the influence of particle size on porosity. Similarly, how was the inhomogeneity of the alloy confirmed?

Page-5: "Tensile tests were performed under controlled conditions….". What are the controlled conditions?

Page-5: Figure-1 shows just two photographs. No labeling is provided to indicate the conditions and wt% of reinforcement. The first photograph consists of five samples, while the second photograph consists of only four samples.

Page-5: "The ASTM E-8 standard was followed…..". A different standard was mentioned in the Experimental Work. Which standard was followed?

Page-6: "The elongation of the material is observed to decrease with the incorporation of ceramic reinforcements". No results on elongation were presented.

Page-6: "Graph 3. Tensile strength effect on the progressive integration of SiC reinforcement from 0% to 8% in as-cast and hot extruded conditions". Is it the effect of tensile strength on reinforcement or the effect of reinforcement on tensile strength?

Page-7: "Graph 4. Young's modulus effect on the progressive integration of SiC reinforcement from 0% to 8% in as-cast and hot extruded conditions". Is it the effect of Young's modulus on reinforcement or the effect of reinforcement on Young's modulus?

Page-8: Why were only four samples presented in Fig. 2?

Page-9: "Graph 5. Compression strength for the effect of the progressive integration of reinforcement under cast and hot extruded conditions". Check the sentence.

Page-9: "The crushing of SiC-reinforced composites was observed to be steady due to the optimal mixture of SiC into the aluminium alloy". What does "steady" mean? What is the optimal mixture of SiC?

Page-9: "……it demonstrated linear improvement with systematic doping of particulate reinforcement". What does "systematic doping" mean?. The term "doping" is generally used for the atomic diffusion of an atom/element.

Page-9: “……the pressurized and hot work of the material has evidently resulted in the compacting of crystals under mechanical and thermal loads, resulting in a greater atomic packing factor in the material and thus increased atomic density,…". The atomic packing factor and atomic density are structure-sensitive parameters. Do the authors try to communicate a change in the crystal structure of composites with hot extrusion? If so, where is the proof?

Page-11: “Graph 7 shows that the impact strength of the material has an adverse effect on composition…". Check the statement.

Page-11: “Graph 7 shows that the impact strength of the material has an adverse effect on composition and showed depleting ----- allowing it to withstand impact loads, in agreement with similar findings from other researchers”. The paragraph gives contradicting statements. If the increased hardness lowers the impact strength, why do hot extruded composites show higher impact strength? If hot extrusion resulted in recrystallization, why do hot extruded composites show higher hardness?

Page-13: Graph-8. Use different color lines for different loads. The color lines for 10N& 40N and 20N&50N look similar. Why is the wear rate unit mentioned in µm? How is the wear rate measured?

Page-13: Graph 9. Is it wear or wear rate?

Page-14: How is the coefficient of friction measured?

Page-14: Graph-11. Use different color lines for different loads. The color lines for 10N& 40N and 20N&50N look similar.

Page-15: Graph 9. Is it wear or wear rate?

Pages 15&16: “Graphs 11-13 show the wear rate and coefficient of friction for various loads for a composite reinforced with SiC with various weight fractions under 'as-cast' conditions.” Check the conditions mentioned.

Page 16: “The wear rate is linearly reduced with an increase in reinforcement percentage;” Graphs show no linear trends.

Page 16: “The hot extruded composite shows a significant impact on improving the wear rate of the developed composite.” Graphs show decreasing wear rates with hot extrusion composites.

Page 16: “It is observed that material transfer between the composite and the counterpart material in the as-cast condition is reduced in the hot extruded condition.” The sentence is not complete.

The following are general comments about the Results and Discussion section:

- Use the term 'Figure' instead of 'Graph' throughout the manuscript and adjust the figure numbers accordingly.
- It appears that all the plots were created using Excel. Please use dedicated graph plotting software to present the plots.
- Avoid using terms such as 'strain hardening,' 'interstitialcy and atomic substitutions,' 'doping,' 'atomic packing factor,' and 'atomic density' without experimental proof. Refrain from incorporating terminology from the literature without understanding the specific conditions used.

- Young's modulus of a material is a structure-insensitive property. It is intriguing to note that extruded composites show higher E values than as-cast ones. Provide justification for this observation.
- Present the stress-strain diagrams of the tensile test for all samples.
- Clarify the significance of Figures 1 to 4 and how these figures support the results and discussion.
- Use the International System of Units (SI units).
- Graphs 1-9 and 11 lack X-axis and Y-axis labels. Refer to the literature for guidance on how to properly plot and present graphs.
- Graphs 14-17: Include a scale bar for SEM images. Specify if the images were observed under SE or BSE mode. It seems the micrographs may have been cropped from another report; provide original, high-quality micrographs.
- The microstructural study of prepared composites is missing to confirm SiC particle dispersion in the castings.
- The results were simply presented and indicated coherence with the literature study. Elaborate on the utility or uniqueness of this study.
- No mechanism with experimental evidence was discussed in this study.
- The main aim of the article is to discuss the influence of hot extrusion as a secondary process after casting on mechanical and wear behavior. The authors have failed to address this aspect.

Conclusions

Page 19: It should be 'conclusions,' not 'conclusion' (plural, not singular).

Page 19: The statement, "In the hot extruded composite, the grains were noticeably refined, and the reinforcement layers were considerably dissolved, reflecting the effective diffusion and doping of reinforcement atoms into the Al 6063 matrix," lacks supporting results in the articles. Avoid using such vague statements.

Page 19: The statement, "The wear rate of the composites decreased as the reinforcement quantity increased, as the form and quantity of reinforcement demonstrated the tribological advantage of materials," raises a question about the term 'form.' Please clarify the meaning of 'form.'

Page 19: The statement, "Topographic analysis of the worn surfaces of sliding wear observed under SEM and the optical specimen under sliding wear revealed less wear and tear," is unclear about what is meant by 'optical specimen.' Additionally, no tear study was conducted.

Overall, the literature gap and motivation for undertaking this study were not adequately explained. The English writing needs improvement. The authors have solely presented the experimental results without attempting to explain the obtained results and the underlying mechanisms. There was a lack of effort to explain the plots and connect the findings with existing literature. The technical terminology was used vaguely without experimental proof. The authors should be more aware when employing technical terms and avoid their use without proper justification.

Suggested to go for a major revision of this article with inclusion of comments