DESIGN AND ANALYSIS OF WING ROOT FITTING MADE BY B₄C REINFORCED AEROSPACE ALLOY AA2014

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Abstract:
Aluminum is the most abundantly found metal in earth crest. Here aluminum reinforced with B₄C is studied. It is found that less work has been carried on aluminum reinforced with B₄C because of higher raw material cost and poor wetting. In the present work, preparation, characterization and evaluation of the hardness, tensile and tribological properties of Al2014 alloy reinforced with B₄C composites. Al2014 alloy composites reinforced with B₄C will be successfully prepared by stir casting process. By reinforcing aluminum with B₄C the improvement in Ultimate tensile strength, yield strength, Hardness and ability to resist higher Wear rate has been observed. The increase in the properties is due to increase in the interfacial bonding of the base metal and the reinforcement. Presently available maximum Wing Root Fittings are made by steel and Al Alloys, in the present work an attempt has been made to prepare design and analyse Al –B₄C Composites by using commercially available softwares by utilizing the mechanical properties obtained from tests. The applications of prepared composites are not only limited to above design further these composites may be used for Aerospace applications like cooling ducts and also ribs of wing structure.

Introduction:
The unique combinations of properties provided by aluminum and its alloys make aluminum one of the most versatile, economical, and attractive metallic material for a broad range of uses-from soft, highly ductile wrapping foil to the most demanding engineering applications. Now a day, aluminum metal matrix composites (MMCs) have gained importance in various industries because of their good mechanical properties such as wear resistance, low density, high strength and good structural rigidity. Aluminum MMCs are preferred in the fields of aerospace, military, automotive, marine and in many other domestic applications.

Objectives:
1. Processing of Al2014 – Boron Carbide particulate reinforced composites by vortex method.
2. Characterization of the prepared MMC’s using scanning electron Microscopy and EDS.
3. Preparation of hardness, tensile, compression and wear specimens as per ASTM standards.
4. Evaluation of mechanical properties as per ASTM standards.
5. Evaluation of wear properties by varying parameters like load and speed.
6. Design and analysis of wing root fitting made by prepared composites.
7. Obtaining the correlation between the microstructural features and the extent of improvement in mechanical and wear properties.

**Methodology:**

1. The stir casting technique will be adopted to prepare the cast composites. The known quantity of Al2014 will be melted at 750 °C in a graphite crucible using resistance furnace. The melted liquid will be agitated with the help of stirrer to form a fine vortex. 3g of degassing tablet (C₆Cl₆-solid hexachloroethane) will be added to the vortex and the slag will be removed from the molten metal. B₄C particles will be preheated at around 300 °C for 3 hrs to make their surfaces oxidized.

2. The preheated B₄C particles will then be added into the vortex and stirred mechanically at 300 rpm for 5 minutes. Before pouring the molten metal to mould, 2g of cover flux (NaCl 45 % + KCl 45 % + NaF 10 %) will be added to the molten metal to reduce the atmospheric contamination.

3. The molten metal at a temperature of 730 °C will then be poured into the mould preheated at 300 °C and will be allowed to solidify to obtain cast rods. The test specimens will be prepared from these cast rods.

4. The composites having 3, 6 & 9 wt. % of B₄C separately and in combination will be made by the same procedure. Prepared samples will be machined as per ASTM standards to conduct the tensile, fatigue and wear tests to know the effect of B₄C particulates on properties of Al2014 alloy.

5. Further Wing Root Fitting will designed and analyzed by using commercially available software’s.

**Results:**

The present work entitled, “Mechanical characterization of boron carbide reinforced AA2014 metal matrix composites” has led to following conclusions

- Al2014-B₄C particulate composites were successfully produced by liquid stir casting route with different weight percentage (viz 3, 6 and 9) of reinforcement.
- The densities of Al2014-3, 6 and 9 wt. % B₄C composites decreased with the addition of B₄C particulates in Al2014 base alloy.
- Al2014-B₄C composites have higher values of hardness when compared with that ofAl2014 base alloy. Also hardness of composites increases with increasing wt. % of reinforcement.
- There is increase in Ultimate tensile strength with addition of 3, 6 and 9 wt. % B₄C particulates to base Al2014 alloy, the extent of which they are increased are 15%, 19.7% and 24.8% respectively.
• Improvements in yield strength of the Al2014 alloy matrix were obtained with the addition of B₄C particulates. The extent of improvement obtained in Al2014 alloy after addition of 3, 6 and 9 wt. % B₄C particulates were 17%, 19% and 23.5% respectively.
• Maximum wear was observed in as cast Al2014 alloy and minimum wear was observed in Al2014-9 wt. % B₄C composites.
• Applied load and sliding speed have more impact on wear loss of both Al2014 alloy and its composites. As load and sliding speed increases there was increment in wear.

Scope for Future work:

Aluminum matrix composites (AMC’s) reinforced with discontinues reinforcements are finding increased use in several industrial applications like automotive sector, defense, and electricity industries because of their improved thermal and mechanical properties. In this study Boron Carbide particles used for the experiment are of 90 microns. This can further be extended to different size particles especially for nano size to study the effect of particle size on mechanical and wear behavior of the composite. Since the samples were not subjected to heat treatment process, the work can be further extended to ageing condition. In the present study wear behavior was analyzed only at room temperature, further this can be extended to wear testing at elevated temperature and also to find these composites in high temperature applications.