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A Study on Effect of Mechanical Properties Of Al-Zro2 Composite by Liquid Routing

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Abstract: In this paper, Al-ZrO2 composites are formed by Vortex method using ZrO2 powder with 1 micron regular diameter as reinforce particles and LM24 as the matrix metal. The melt composites are blended for 13 minutes, then threw into a metallic mold. Distinctive specimens of 1, 2 and 3 volume percent of ZrO2 in throwing temperatures of 7500C are framed. Impact of volume percent of ZrO2 particles and throwing temperature on elasticity, microstructure, and Hardness of Al-ZrO2 composites have been researched. The most extreme elasticity is accomplish in the example containing 2 vol. % ZrO2 delivered at 750°C which demonstrates an expansion of 35% in contrast with the LM24 non-strengthened amalgam and Maximum Hardness was acquired in the example containing both 3 Vol % ZrO2 created at 7500C which demonstrates an increment of 12% in comparision to the LM24 non-fortified compound. Microstructures were seen by SEM to examine the uniform conveyances .

1. INTRODUCTION

Metal Matrix Composites (MMC's) are measured a group of advanced materials which represent lowdensity, good tensile strength, high modulus of elasticity, low coefficient of thermal expansion, and goodwear resistance. These characteristics could not be achieved together in the monolithic materials [1-3].Vortex or stir casting is the most commonly used method to produce composite particulates. This is mostly due to its simplicity, low production cost and flexibility to produce a wide range of MMC's.Addition of hard ceramic particles into a ductile metallic matrix results in the production of composites that possess the properties of both phases [2-4].

Many research have been complete to study the effects of such second phases as SiC [5, 6], TiB2 [7],Al2O3 [8], and B4C [9] on reinforcing the aluminum matrix.

2. EXPERIMENTAL PROCEDURES

The principle crude materials utilized as a part of this study were aluminum compound and zirconia powder. LM24 aluminumalloy was utilized as the network of the composites. The compound structure of this amalgam isshown in Table 1. zirconia powder (ZrO2) was additionally utilized as fortifying stage (Fig. 1)

Fig 1. Zirconium Oxide

The heater utilized as a part of this exploration as appeared in Fig. 2 and 3, incorporated an impeller which was made ofgraphite. Keeping in mind the end goal to create the composites, the aluminum combination was softened at 7500C. The melt was blended at a consistent velocity of 300 rpm for 13 min. The required measure of zirconia powder was weighed by weight of the treated melt (1, 2, and 3 vol. %) and afterward capsulated inside a couple aluminum foil wrappings and additional into the liquid combination. Mixing was acknowledged out for 2 more minutes and the resultant slurry was then thrown into the metallic mold to set and frame the composite examples.

Table 1: Chemical Composition of LM24 by Wt%

Element	Al	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Trace
% Min	-	7.5	-	3.00	-	-	-	-	-	-	-
% Max	-	9.5	1.00	4.00	0.50	0.30	-	0.50	2.90	-	0.50
% Normal	-	8.5	-	3.50	-	-	-	-	-	-	-

In order to inspect the tensile strength of the specimens, Universal Testing Machine (INSTRON) was used. The tensile specimens were ground according to ASTM [15]. For each testing condition, 3 specimens were subjected to tensile test and the average of the 3 results was reported.

Figure 2. Electric Furnace with Mechanical Stirrer

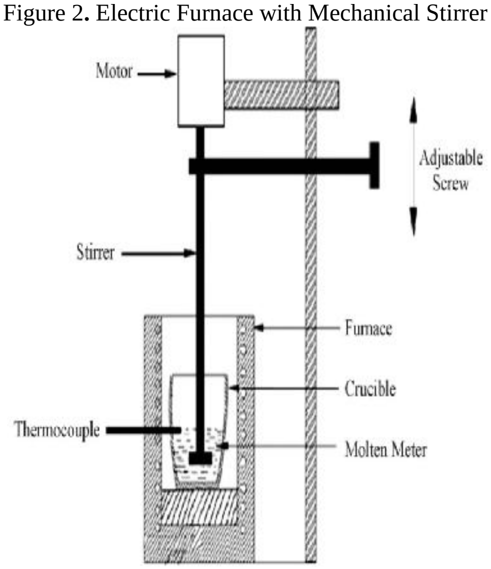


Fig. 3. The schematic of the Vortex method

The prepared composites were subjected to micro structural characterization using Scanning Electron Microscopy prepared with EDX analysis (Hitachi Su-1500 model) to identify morphology and distribution of ZrO2 particles in LM24 matrix. XRD analysis of the ready composite was done using XRD Machine-7000; M/s Shimadzu Analytical India Pvt. Ltd. The investigational density of the ready composite was determined using Archimedes's principle and compared with the theoretical densities of LM24 (2.7 g/cm3) and ZrO2 particles (5.68 g/cm3).Micro hardness measurements were conducted on prepared composite at 30 different locations on the same specimen using Brinells hardness tester. The automatic properties of the equipped composites were measured under tension using a Computerized Universal Testing Machine (INSTRON) as per ASTM E08-8 standards. Tensile tests were conducted on three specimens for each composition and average value is reported.

3. RESULTS AND DISCUSSIONS

a) Tensile test results

The mechanical properties of matrix alloy LM24 has improved on ZrO2 incorporation. Figure 4. and Figure.5 shows the relation among tensile strength of the fabricated composites and ZrO2 of different particle size and varying wt% respectively. Fig. 4. As it can be seen, at 750oC and 2 vol. % ZrO2, the strength has increased to 197 MPa, which shows an increase of about 60% over the pure LM24 alloy. The effects of the casting temperature and ZrO2 content on the mechanical properties of the Al-ZrO2 composites are shown in Fig:6.

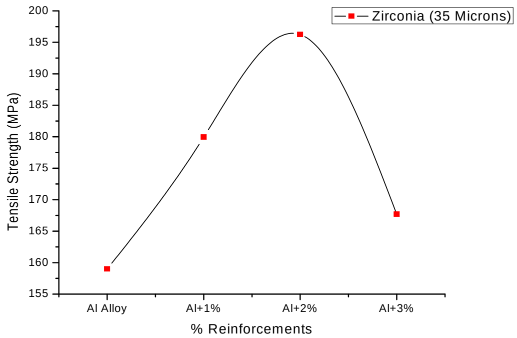
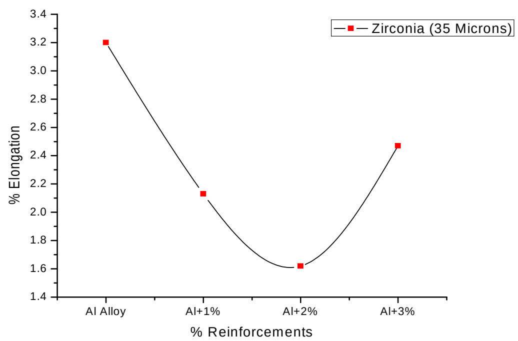


Fig 4. Tensile Strength of Al+ZrO_2 Composites material



\Fig 5. % Elongation of Al+ZrO_2 Composites

The reason for rising the yield strength at 750°C for the samples of 0-2 vol. % ZrO2 could be rising the dislocation density and their pile-ups behind the ZrO2 particles which act as obstacles in the movement of dislocations. The greater the amount of ZrO2, the larger the number of dislocations formed and thus, a higher yield strength is achieved. This is optional by the uniform distribution of ZrO2 particles within the matrix observed in [16]. It is observed from the Fig.6 that ZrO_2 particles are dispersed equally in the aluminium matrix for particle size and for all wt%. This can be attributed to the effective stirring action and the use of appropriate process parameters.XRD analysis confirms the presence of ZrO_2 reinforcement within the matrix in Fig.7.

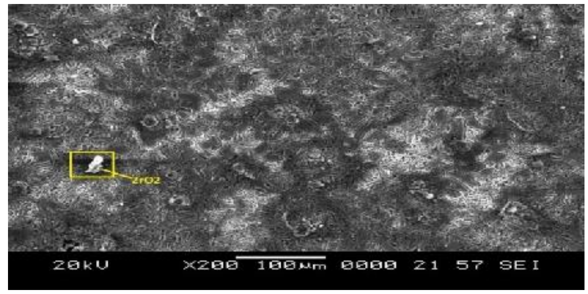


Fig 6. Micro structure of LM24 alloy reinforced with 2% ZrO_2

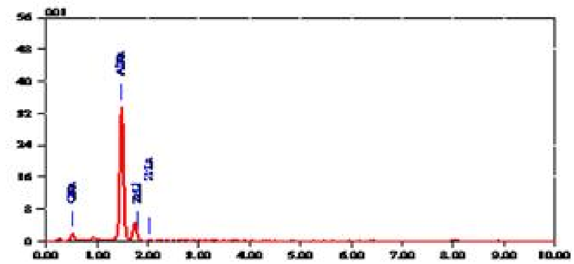


Fig 7. XRD Peaks of LM24 alloy reinforced with 2% ZrO_2

b) HARDNESS TEST RESULTS

It was experiential from Figure.8 that, the hardness of AMCs has increased with raise in particle size and wt% of reinforcement. Addition of reinforcement particles in the melt provides additional substrate for the solidification to trigger there by increasing the nucleation rate and decreasing the grain size. The brinell's hardness of AMCs was found to be maximum (88 BHN) for the particle size of 10µm of 3 wt%. There is decrease and then increased in hardness compared to the base alloy. The presence of such hard surface area of particles offers more resistance to plastic deformation which leads to increase in the hardness of composites**.**

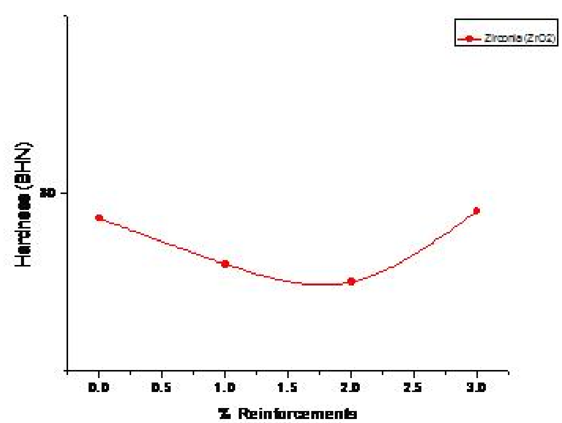


Figure 8. Hardness of the as Cast LM24-B_4C with different wt%

CONCLUSION

1) Al- ZrO2 composites were successfully produced by stir casting in this study.

2) By rising the ZrO2 content in the specimens formed at 750°C, the tensile strength also increase. This is due to the addition of dislocation behind ZrO2 particles which act as barriers on the movement of dislocations.

3) The Optical micrographic study and XRD analysis revealed the presence of ZrO_2 particles in the composite with homogeneous dispersion effect on the tensile strength.

4) The Tensile Strength of AMCs was found to be maximum for 2 wt% in case of varying wt% of the reinforcement.

5) The optimum production conditions of Al- ZrO2 composites are 750°C and 2 vol. % ZrO2.

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