DEVELOPMENT OF Al-Cu-SiC$_p$ METAL MATRIX COMPOSITE FOR AUTOMOTIVE APPLICATIONS

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ABSTRACT

In recent years, the demand for reduced weight and high performance materials for automotive applications such as brake disc have increased. The newly developed, aluminium metal matrix composite (Al-MMC) reinforced with silicon carbide (SiC) particulate seem suitable to be an alternative material for this application. In this experimental study, Al-Cu-SiC_p MMC was developed through stir casting method with sand mould. A constant 4.5% of weight percentage of 5 μm pure copper powder was added to the mixtures to enhance the properties of Al-MMC. The effects of particle sizes of SiC as well as the weight percentage of SiC, pouring temperature and stirring time on the hardness. wear, compressive properties, flexure behavior and density of Al-Cu-SiC_p MMC were investigated. Taguchi's Robust Parametric Design was used with inner array L_9 3^4 and outer array with 2 replications to plan the experimental runs. A statistical Pareto Analysis of Variance (Pareto ANOVA) was employed to determine the significant factors of these properties and optimum combinations of process variables for targeted functions. From the analysis, it was found that particle sizes of SiC is the most significant factor for density characteristic and compressive properties while weight percentage of SiC is the most significant factor for hardness and wear resistance characteristics. Optimum combinations were determined and conformity test were conducted to verify the optimum properties of newly developed material, Al-Cu-SiC_p MMC. Optimum combination of hardness was $A_1B_2C_0D_0$ (*59 μm particle size of SiC, 15% of weight percentage of SiC, 675 ^0C pouring temperature and 5 minutes stirring time*) with 82.5 HV; wear rate $A_2B_2C_2D_0$ (*106 μm particle size of SiC, 15% of weight percentage of SiC, 725 ^0C pouring temperature and 5 minutes stirring time*) with 1.585 x 10^{-5} g/sec; compressive strength $A_1B_2C_2D_1$ (*59 μm particle size of SiC, 15% of weight percentage of SiC, 725 ^0C pouring temperature and 10 minutes stirring time*) with 9410.06 MPa and density $A_0B_1C_1D_1$ (*40 μm particle size of SiC, 10% of weight percentage of SiC, 700 ^0C pouring temperature and 10 minutes stirring time*) with 2.6592 g/cm^3.

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LIST OF SYMBOLS

Al-Cu-Mg	-	Aluminium-Copper-Magnesium
Al-Cu-SiC_p MMC	-	Aluminium-Copper-Silicon Carbide particulate metal matrix composite
Al-Li	-	Aluminium-Lithium
Al-MMCs	-	Aluminium metal matrix composites
Al_2O_3	-	Alumina
Al-Zn-Mg-Cu	-	Aluminium-Zinc-Magnesium-Copper
ASTM	-	American Society for Testing and Materials
BS	-	British Standard
DPS	-	Dual particle sizes
SiC	-	Silicon Carbide
SPS	-	Single particle sizes
Wt%	-	Weight percentage
B	-	Constant (Dimensionless wear coefficient)
F	-	Exerted force (N)
H	-	Hardness of the body
k	-	Spring stiffness (3.27kN/m)
n	-	Quantity of data taken
N	-	Rotational per minutes of rotating disc
Q	-	Volume removed per unit sliding
S	-	Sum of squares of differences
SN	-	Signal to noise ratio
V	-	Linear velocity of the disc (m/s)
W	-	Applied load (N)
Wa	-	Weight of specimen after experiment
W_b	-	Weight of specimen before experiment
W_l	-	Weight loss
x	-	Displacement of spring
y	-	Value of data from experiment (for instance, value og hardness

LIST OF APPENDICES