UNIVERSITI TEKNOLOGI MARA

THE BEHAVIOUR OF ALUMINA REINFORCE METAL MATRIX COMPOSITE WITH NANOSIZED PARTICLE ADDITION

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ABSTRACT

Development of lightweight metal matrix composites (MMCs) has been studied with different weight composition of reinforcement materials. Alumina (Al_2O_3) in micron and nanosized powders were used to develop high strength and light-weight aluminum matrix composites material. The samples were produced via powder metallurgy (PM) method. The powder mixtures were ball milled before uniaxially pressed and sintered in nitrogen gas environment. This research was done to develop a powder metallurgy (PM) processes that enable the dispersion of nanosized powders. The dispersion technique was added in powder metallurgy (PM) process to disperse the micron and nano- Al_2O_3 powders. The effect of alumina (Al_2O_3) content and size on the mechanical properties of the composites was also investigated. The relationship between morphological characteristics and mechanical properties of new developed material was examined. The results showed that the homogeneous distribution of powders mixture had improved the mechanical properties with the addition of micro and nano-Al_2O_3. The optimum for hardness is 53.32 HV, strength of 74.66 MPa as well as toughness of 25 kJ/m^2 in composition containing 90 wt% pure aluminum + 7.5 wt% alumina (Al_2O_3)(μm) + 2.5 wt% alumina (Al_2O_3)(nm). However, the mechanical properties of the composite became poor when the composition of nano-Al_2O_3 is more than 7.5 wt%. From the morphological study showed that the nanosized alumina (Al_2O_3) powders tend to agglomerate with the increasing of nano- Al_2O_3 powders. The potential application for this new developed composite material is likely to be in automotive and aircraft industries where improvement in hardness, density, and strength as well as toughness is demanded.

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CHAPTER 1

INTRODUCTION

1.1 Background

Metal matrix composites (MMCs) represent a new generation of engineering material which is strong and hard, but also very brittle ceramic reinforcement incorporated into a metal which is aluminum is used as a matrix material. It has properties of high ductility, a desirable property that permits them to undergo relatively severe impact loading without fracture, whereas ceramic material such as alumina (Al_2O_3) and other ceramic does not. This combination of aluminum and alumina (Al_2O_3) known as a composite material and aluminum based particles reinforced composites exhibit many attractive which it can improve the properties including specific strength, specific stiffness, wear resistance, excellent corrosion resistance, high elastic modulus and decreased coefficient of thermal expansion compared to the conventional aluminum alloys. Metal matrix composites (MMCs) combine the metallic properties of matrix alloys (ductility and toughness) with the ceramic properties of reinforcement (high strength and high modulus), leading it to a greater strength in shear and compression with higher service-temperature capabilities. Composite materials' technologies offer a unique opportunity to tailor the properties of aluminum including the increased in strength, the decreased in weight, higher service temperature, improved wear resistance, higher elastic modulus, control coefficient of thermal expansion, and improved in fatigue properties. In fact, according to the UK Advisory Council on Science and Technology, aluminum matrix