International Journal of Manufacturing, Materials, and Mechanical Engineering
Volume 7 • Issue 4 • October-December 2017

Surface Micro Patterning of Aluminium Reinforced Composite through Laser Peening

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ABSTRACT

Aluminium Composites have universal engineering applications because of their higher strength to weight ratio, ductility, and formability. However, in diverse applications, mechanical properties are the prerequisite at closer surface regions. Such localized changes without impacting various surface treatment approaches can attempt the bulk phase. Laser peening is an advanced surface engineering technique, which has been successfully applied to improve the surface morphology of the material. In this work, the authors focus on improving the surface properties of Al7075 composite through laser peening technique. The hardened layer was evaluated using surface integrity with optical microscopy, EDS, SEM and analysis of microhardness. Process parameters and resulting microstructures of Aluminium composite are summarized, along with the impact of laser peening on surface properties. Research results indicated that laser peening shows a significant influence on the final condition of the surface layer of Aluminium composite.

KEYWORDS

Laser Peening, Mechanical Properties, Metal Matrix Composites, Microstructure Analysis, Stir Casting

INTRODUCTION

Current engineering applications require materials with the broad spectrum of properties like lighter, stronger and less expensive which are rather difficult to congregate using monolithic material systems. Metal matrix composites (MMCs) have been noted to offer such tailored property combinations required in a wide range of engineering applications. The particular benefits exhibited by metal-matrix composites, such as increased specific strength, lower density, increased high-temperature performance limits, stiffness and improved wear-abrasion resistance (Sarkar, Modak, & Sahoo, 2015), are dependent on the properties of the matrix alloy and the reinforcing phase. The applications of MMCs in aerospace, automotive and defense industries can be attributed to its improved thermo-mechanical properties and high strength to weight ratio (Shivanna & Ramamurthy, 2015). Metal Matrix Composites (MMC)(Rajesh, Krishna, Raju, & Duraiselvam, 2014) is sophisticated materials formed by mixing a ductile metal/metallic alloy with hard phases, called reinforcements, to develop the

DOI: 10.4018/IJMMME.2017100102

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advantages of both. Alumina, Boron, Silicon Carbide, etc. are the most commonly used nonmetallic reinforcements, combined with Aluminum, Magnesium, etc., to obtain a unique combination of properties. Discontinuous reinforced aluminium metal matrix composites (DRAMMCs) are a class of composite materials having desirable properties increased fatigue resistance (Zhou et al., 2012), controlled coefficient of thermal expansion, and superior dimensional stability at elevated temperatures, etc.(Rino, Chandramohan, & Sucitharan, 2012) (Seetharaman, 2016). The advantages in some of the physical attributes of MMCs such as non-inflammability, low electrical, no significant moisture absorption properties, resistance to most radiations and thermal conductivities (Yellappa, Puneet, G V Krishnareddy, Giriswamy B, 2014).

The critical shortcomings of MMCs are their cost of manufacturing, which has placed limitations on their actual applications and distressed surface-related properties of aluminium have severely limited its further or direct use. The cost=efficient process for manufacturing composites is essential for growing their use. Particulate-reinforced aluminium metal matrix composites (AMCs) (Malhotra, Narayan, & Gupta, 2013) because of their isotropic properties and relatively low cost are attracting researchers. In recent years, several processing techniques have been designed to prepare particulate reinforced aluminium matrix composites (AMCs). Among the various processing techniques existing for discontinuous or particulate reinforced metal matrix composites, stir casting is one of the best processing methods accepted for the production of large quantity composites. In this study, these disadvantages are overcoming by stir casting technique for fabrication and a laser-based technique is explored to enhance the surface-related properties like microstructure and hardness of aluminium matrix composites. This investigation is to examine the effect of reinforcements (Zirconia plus Silicon Carbide) (Mahamani, Muthukrishnan, & Anandakrishnan, 2012) on mechanical properties of Al 7075 composite samples, processed by stir casting method. Three sets of composites are prepared with fixed percentage of Silicon Carbide (2%) & varying rate of Zirconia (2%, 4% and 6%) by weight fraction. The properties of the samples such as Tensile strength, Impact Strength, Hardness and percentage elongation will be evaluated. From experimental studies, the best combination of matrix and reinforcement sample is further assisted with Laser peening technique for enhancing surface related properties like microstructure and hardness which plays a crucial role in preventing surface crack initiation. Microstructure and SEM analysis were also done to see the distribution and presence of ZrO2 and SiC particles in aluminium alloy (Kumar, Lal, & Kumar, 2013). The hardness test for both laser peened and unpeened the best sample, and the comparison of results are carried out.

FABRICATION OF ZIRCONIA, SIC REINFORCED AMCS

Selection of Fabrication Method

Until date, various processing techniques (Surendran, Kumaravel, & Vignesh, 2014) have been in use for the fabrication of Zirconia plus SiC reinforced AMCs. Among the variety of manufacturing processes available for discontinuous metal matrix composites, stir casting is accepted and currently practiced commercially its advantages in its simplicity, flexibility and applicability to large scale production and, its principle to allow a conventional metal processing route (Mathur & Barnawal, 2013) to be used and its cheap cost. This liquid metallurgy processing method is the most economical of all the existing routes for metal matrix composite production (Bonollo, Guerriero, Sentimenti, Tangerini, & Yang, 1991), allows large sized components fabrication, and can sustain high productivity rates (see Table 1).

MATERIAL ACQUISITION

AL7075: Aluminium 7075 (Al7075) is chosen as the matrix material since, it is low cost and has better properties like excellent thermal conductivity, high shear strength, abrasion resistance, high-

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