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A REVIEW ON WEAR RESISTANCE COATINGS ON MAGNESIUM ALLOYS

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Abstract

In this article, various methods have been proposed to improve the wear resistance of composite coatings on Magnesium and its alloys are being studied. A preliminary analysis was carried out by several authors on a magnesium-coated preforms, depending on the reinforcement content (wt.%), Sliding speed (m / s), applied load (n) and sliding distance (m).Excellent properties were obtained on the coated preforms of magnesium alloys compare to the reinforcements preforms and base metal to provide good bonding strength between them. Highlights that different manufacturing methods have the optimum control standards needed to enhance mechanisms for obtaining aggravating properties. The volumetric ware loss, test parameters are discussed and the critical point of each specific strengthening procedure is compared. Relevant evidence to justify an increase in Archad's stiffness reduces the wear rate. The increase in wear resistance and its effects on mechanical properties is discussed in this paper. The effect of sliding distance, applied load simulation results were discussed.

KEYWORDS: *Magnesium Alloy, Coated Preforms, Methods of Coatings, ANSYS ACT, Sliding Distance.*

INTRODUCTION

Recent research on magnesium and its alloys, which were applicable for commercial purposes, such as power tools, aviation, vehicle maintenance, and energy conservation, increased due to the lower density of about two-thirds of the aluminum density and specific strength, compared to other structural minerals. A hybrid nanoparticle is made of magnesium alloy that contains

TiC nanoparticle reinforcements using solidification treatment followed by hot extrusion. The beneficial effects of adding TiC nanoparticles on improving the tensile and pressure properties of hybrid magnesium alloys were discussed in this paper. Magnesium is 35% lighter than aluminum [1]. Mg or Mg alloys have very weak wear resistance, due to their smoothness. From a practical point of view, increasing the resistance of magnesium alloys to abrasive wear is important in systems where they operate in sliding motion, for example brake systems and actuators (pistons and cylinders) and during processing of rolling or forging. The wear condition occurs when there is a relative movement between two solids under the influence of the load, the movement can be sliding or rolling, i.e. one-way or there are opportunities to combine both rolling and sliding, as well as oscillating movement at a small capacity. Corrosion cannot be said to be the quality of the material, but it's still a replica of the system. The term wear and tear is invented as a loss of materials from the surface of a solid substrate through frictional movement against the measuring body for certain mechanical reasons. Material loss or wear rate can range from 10^{-3} to 10^{-20}, depending on specific condition, such as sliding speed, loading, type of material used and also the condition of the environment in which it is worn. Unreinforced magnesium beads (AZ31) and reinforced Nano compound (AZ31 / 1.5 vol.% Al2O3 / 1.5 vol.% Ni) were synthesized by sclerosis hardening followed by hot extrusion. In the field and exposed microscopic features that remind us of the mechanisms of local ductile failure at the microscopic level. Magnesium alloy compounds (AZ91D) reinforced with silicon carbide particles of different size ratios are manufactured by a two-stage pressure casting process. The results showed that the mechanical properties of the compounds increased with increasing SiC particles and decreased with increasing particle size [2-5]. Magnesium-based metal matrix compounds, fortified with a different boron carbide (B4C) content, were prepared using the casting method. The mechanical properties of casting compounds, such as tensile strength and total hardness, have been studied. The incorporation of fly ash traction features such as tensile strength and efficiency have been improved. [6-8].

Carbon nanotubes (CNTs) are obtained from a compressed method of AZ91 metal matrix compounds (MMC). Corrosion properties were determined and the possibility of applying automatic transmission and engine parts was investigated [9]. This paper examines various factors such as (a) the effect of different reinforcements, (b) The tribology properties such as volume loss and wear loss (c) treatment technology and its effects. (D) A comparison of the parameters of composite coatings to various magnesium alloy techniques was discussed.

ANSYS ARCHARD Simulation

Archard, Rhee (1980) in his wear theory, has proposed the wear volume as a function of normal load, sliding velocity and hardness of the material. A famous wear Archard law obtained by modelling the problem is given in below

$$Q=KWL/H \tag{1}$$

Where: Q is the total volume of the wear debris produced

K is the dimensionless constant

W is the total normal load (N)

L is the sliding distance (mm)

H is the hardness of the softest contacting surfaces

ANSYS ARCHARD Simulation is an innovative technique to finding Volume loss and wear on pin using ANSYS ACT software. In actual practice considerable error was found for this analysis.

In ANSYS, the volume of wear was calculated according to the formula

$$\acute{\omega}=dh/dt=K/H\ p^m\ v^n \tag{2}$$

Wear thickness $dh= (K/H\ p^m\ V^n)\ dt$

Where: H is material hardness P is the contact pressure V is the sliding velocity m is Pressure exponent, and n is Velocity exponent.

Wear on pin and Volume loss of pin were found with the help of ANSYS software under different loading and sliding conditions of different materials (Reinforced Hybrid composites and coating preforms shown in Fig).

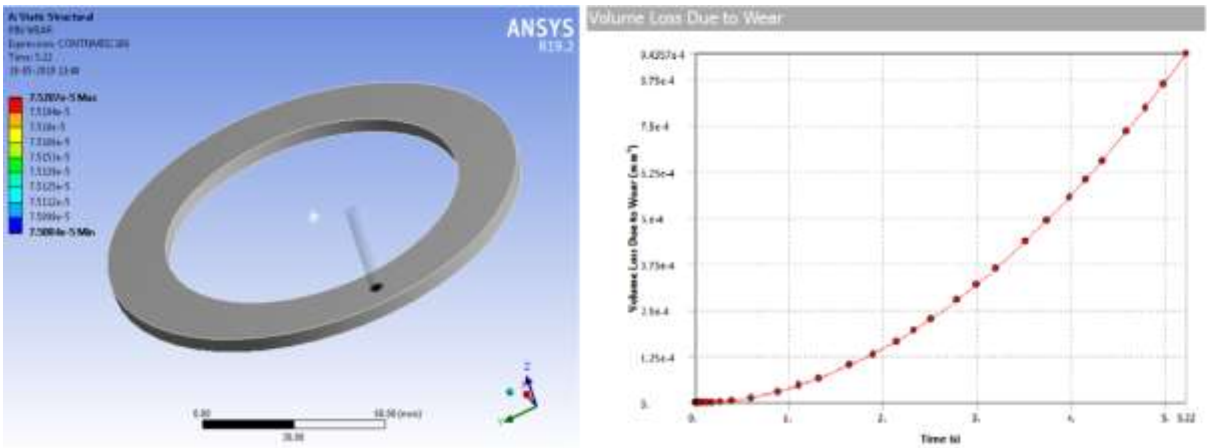

Fig 1.5 ANSYS Archard Wear Model for finding Volume loss and wear on Pin

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LASER MELTING PROCESS

The surface of the mechanical components must have good corrosion resistance, high strength and other surface properties to extend their life. There are many ways to improve the component's surface property, such as plasma techniques, fire mitigation, chemical vapor deposition, physical vapor deposition, etc. Selective laser fusion (SLF) is an advanced additive manufacturing technology, with characteristics of a high degree of freedom of manufacture, low costs and high efficiency. The process parameters for SLF are laser type, transverse laser power, scanning speed, laser spot size, overlapping area, and melting depth.

Yueling Lyu et al investigated the selective laser fusion (SLF) is an important and advanced additive manufacturing technology. The multi-layer TiAlN / TiN coating can improve the surface property of SLF products. This paper aims to explore the effects of different SLF process parameters on the property of the TiAlN / TiN multilayer coating on a 361L sample and the mechanism of these effects [10].

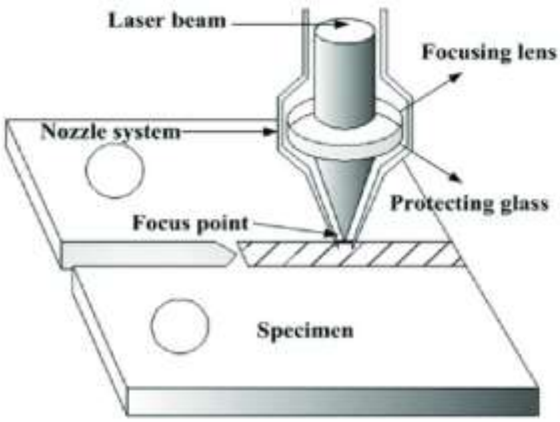

Fig 1.1 Schematic Illustration of LSR Process [11]

Xingchen Yan et al reports the, a promising method (Micro-arc Oxidation, MAO) is proposed to improve wear resistance by forming a dense oxidizing coating on the surface of SLF Ti6Al4V alloy. Sliding wear test and hardness tester were used to distinguish mechanical performance. It was found that as the duration of treatment increased, the growth of the coating slowed down, gradually accompanying the deteriorating aspect. The oxidizing layer consists of γ-alumina and TiAl2O5. Meanwhile, a significant improvement in Tribology performance on Ti6Al4V alloys was found using MAO treatment. It is believed that the MAO treatment can improve the reliability of load-bearing surfaces on SLM Ti6Al4V parts [12].

F. Bartolomeu et al Presents the, five Ti6Al4V cellular structures are designed and produced with different sizes of open cells (100-500 µm) by SLF. These structures were experimentally tested against alumina using an alternative sliding ballon-plate tribometer. Samples were immersed in a phosphate buffered saline (PBS) at 37 ° C to simulate the environment to some extent. The results showed that the friction and wear performance of Ti6Al4V cellular structures is influenced by the size of the open cell of the structure. Greater corrosion resistance was obtained for 100 µm open cell structures designed, apparently due to the greater contact area to support pre-load [13].

F. Bartolomeu et al Studied three different treatment methods have been studied: conventional casting, hot pressing, and selective laser melting. Comprehensive metallurgical, mechanical and metaphysical characterization was performed by X-ray diffraction analysis, Vickers hardness tests and cross-plate ball-wear tests for the Ti6Al4V / Al_2O_3 sliding pairs. The results showed a significant effect of the treatment pathway on the components of the microstructure and the resulting differences in hardness and wear performance. The highest hardness and corrosion resistance of Ti6Al4V alloys due to laser selective smelting was obtained, due to a significantly different cooling rate that causes a significant difference in the microscopic structure compared to hot pressure and casting. This study evaluates and confirms that selective laser smelting can produce customized Ti6Al4V implants with improved wear performance [14].

THERMAL SPRAY COATING TECHNIQUE

Thermal spray is a general term for a group of processes in which metal, ceramic, and content materials and some polymeric materials are fed in the form of powder, wire, or rod with a lamp or pistol that is heated near it or slightly above the melting point. Drops of magma or molten matter are almost accelerated in a gas stream and dropped onto the surface to be covered (i.e. the substrate). Upon impact, the droplets flow into thin film particles that stick to the surface and overlap and overlap as they solidify. The total thickness of the coating is usually created in several sections of the coating device. Applications of thermal spray paint varied greatly, but the biggest use category is to improve the wear and or surface wear resistance. Other applications include their use to restore dimensions, such as thermal barriers, as thermal conductors, as conductors or electrical resistors, for the electromagnetic shield, and to improve or block radiation. They are used in almost every industry, including aerospace, agricultural equipment, automobiles, primary metals, mining, paper, oil and gas production, chemicals, plastics, and biomedical materials. The following are the different types of process. (1) Flame spray, (2) The electric-arc (wire-arc) spray process, (3) Flame spray and fuse, Plasma Spray, (4) The transferred plasma-arc process and (5) High-Velocity Oxyfuel [15].

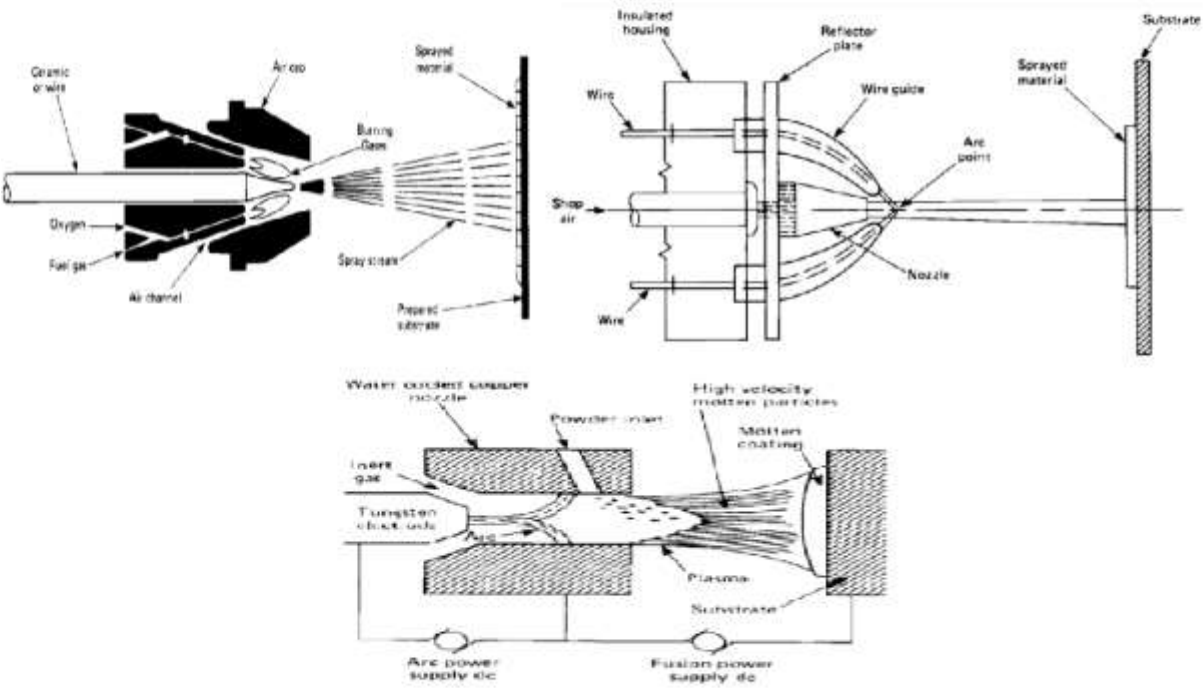

Fig 1.2 Different types of Thermal coating process [15]

R. Anandkumar et al Found the **c**omposite material coatings consisting of Al-Si matrix reinforced with SiC particles by laser coating on Al Cast UNS A03560 alloy substrates from Al-12% weight mixtures and SiC alloy powders. The effect of processing parameters on the microstructure and abrasive wear resistance of coatings is studied. Results show that Al4SiC4 and Si increase the hardness of the material by dispersion hardening but do not contribute to its abrasive wear resistance, because they are softer than the abrasive particles, and confirm that the parameters used to prepare Al-Si-SiC composite coatings by laser cladding must be selected so that only minimal reactions occur between SiC and molten Al [16].

A.J. López et al investigate the high-speed oxygen fuel (HVOF) was used as a manufacturing technology to deposit silicon carbide coated aluminum coating on Mg-Zn substrates. The purpose of this research is to improve the ceremonial performance of the ZE41A magnesium alloy. The parameters of the thermal spray system are optimized to maximize the incorporation of SiC particles into the aluminum matrix for coating and reduce the mechanical damage to the light alloy substrate. Pin-on-disc tests were developed to characterize the tribal behavior of different samples. Compound coatings of 120 lbs thick, 10% weight by weight and high adhesion on the substrate. The wear resistance of the substrates was increased and the wear rate decreased in two orders of volume compared to the hollow Mg alloy after improving the spray parameters [17].

FRICTION STIR PROCESSING TECHNIQUE

Friction stir processing (FSP uses the same process principles as FSW (Friction Stir Welding) [18]; However, instead of combining the samples together, the process modifies the local microscopic structure of homogeneous samples to obtain specific and desired properties by modifying the surface of the microscopic structure (Figure 1). As in the FSW, the device stimulates plastic flow during the process, but depending on the choice of process parameters, i.e. applied force, travel speed, and rotational speed, the material flow can produce a modified microstructure that benefits the material performance / requirements. The modified process was developed by Mishra in 2000, which is a relatively new and interesting technique for developing and modifying the microstructure, as well as improving ownership [19].

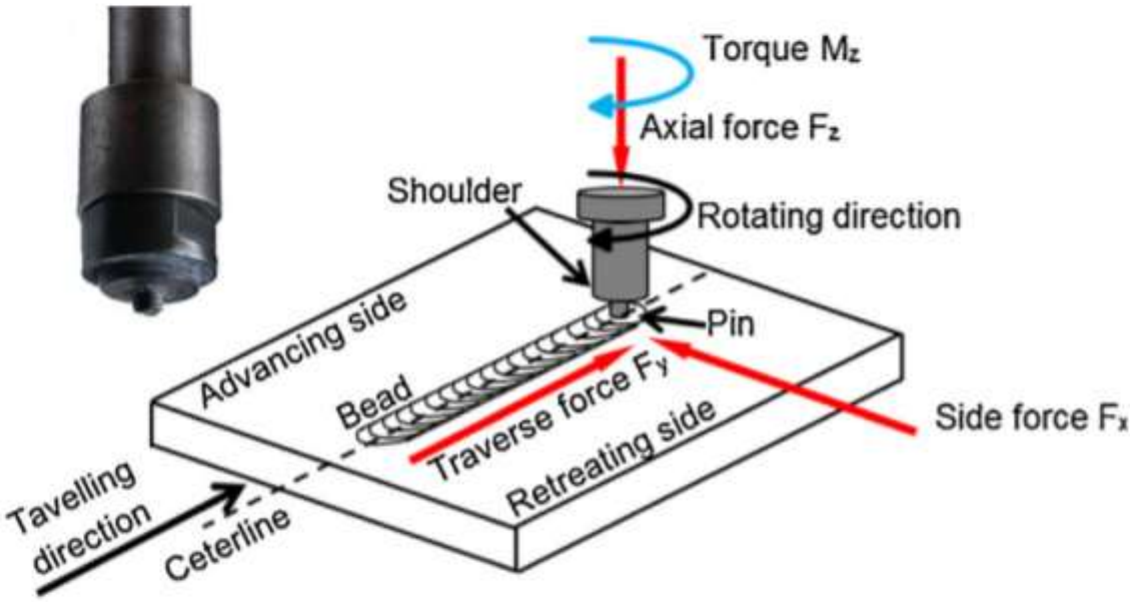

Fig. 1.3 – Schematic drawing of friction stir processing process and a tool [18].

Marek Stanisław Węglowski found the methods commonly used to produce surface layers, such as the surface spraying, or melting with a laser beam, have been known for years. A new method is to treat Friction stir processing (FSP) surfaces. The FSP process is mainly used to modify the microscopic structure in the surface layers close to the working metal components.

In particular, the process can produce: fine grain structure, surface compound, microscopic adjustment of cast alloys, alloys with specific elements, and improved quality of welded joints. The class consists of several main parts. In Part 1, based on the literature review, the main applications and achievements for FSP operations are presented. In the second part: process analysis. The third part focuses on improving the microscopic structure, and the last part provides information about alloys by friction induction, as well as treatment of friction induction with ultrasound vibration [20].

Ahmadkhaniha et al, Composite coating layers containing 0.8% nanoparticles (50 nm) Al2O3 were produced on the AZ91 magnesium alloy by friction treatment (FSP). The spin speed of 800 rpm and the travel speed of 40 mm / min were the optimum parameters for the FSP to obtain a suitable composite layer, with the highest rigidity and wear resistance among the treated layers. Treated layers increased fine hardness by more than 30% and lost mass to less than half. The high hardness and uniform dispersion of Al2O3 molecules reduce direct load in the case of wear and tear. Changing the instrument's rotation direction leads to a greater uniform molecular distribution [21].

H. S. Arora and colleagues designed a surface nanoparticle based on AZ31 and TiC on magnesium AZ31 by stirring. The size of the TiC particles was about 40 تر ومm taken as a strengthening powder. The FSP is manufactured with a vertical milling cutter (5 hp) (CNC) with the help of an FSP tool's rotational speed of 800 rpm, a linear velocity of 40 mm / min and a depth of 0.3 mm immersion to create a uniform distribution of nanoparticles above the surface material. Slip wear abrasion tests using pin-to-disk configuration at normal loads of 5KN and 20KN, slipping speed 1 m / s, sliding distance of 1.5 km. Compared to other FSP conditions, single-pass FSP passes with TiC reinforcement and below the cooler surface using a coolant with a temperature of -20 ° C, have remarkable hardness and wear resistance that have a faster rotation of the tool with the greatest impact on the variation of material hardness [22].

Asaad et al. Studied the rigidity and fine corrosion of AZ91 who produce a composite layer using 5 µm SiC molecules through a stirring friction process step, at rotational speeds and transverse velocities of 900 rev / min and 63 mm / min, respectively. The precision of the fine layer is inversely proportional to the rotational speed, and the grain size is directly proportional to the rotational speed. Increasing the transverse speed and number of passes reduces the grain size, which improves the stiffness value [23].

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ELECTROLESS PLATING AS SURFACE COATING PROCESS

Electroplating is an automatic catalytic chemical technique, used to deposit a layer of hybrid material on a solid part in the presence of a reducing agent. The reducing agent interacts with the metal ions in the electrolyte to precipitate the substrate metal.

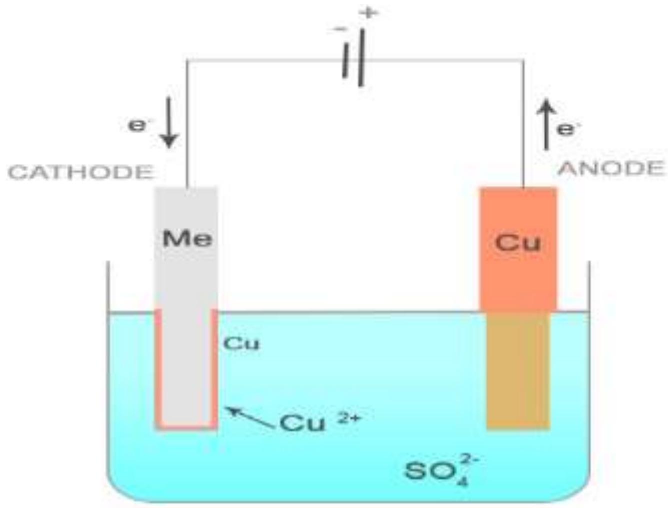

Fig 1.15 Schematic Illustration Electroless Plating Process [24]

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