Wear on Thermal &Plasma Spray Coated Al-2014 Alloy under Dry Sliding Conditions

A.Arun, K.Ramya Sree, Ram Subbiah, J.Saranya, N.Sateesh

***Abstract:** In this paper, wear are common problems encountered in the piston. Thermal spray coatings re one of numerous methods for alteration of part's surface properties. The innovation relies upon the standard of dissolving and speeding of fine particles and their quick cementing delayed consequence on the substrate. Among every one of the strategies of thermal spray coatings, High-Velocity Oxy-Fuel and Plasma spray procedure is broadly utilized in different applications. In this research, chemical powder with explicit properties against wear was chosen, and it was showered with high velocity oxygen fuel (HVOF) and plasma spray strategies onto Aluminium 2014 alloy substrates. Both the coatings have same binder with equivalent rate. The coatings were portrayals were done with the help of Scanning Electron Microscope, X-ray Diffractometer, and Pin-on-disc wear testing machine. A pin on disc machine was used to analyse the wear behaviour by applying 10N and 20N loads.*

***Keywords:** Thermal Spray Coatings, HVOF ceramic Coating, Plasma ceramic coating, Wear resistance, Pin-On-Disc apparatus.*

I. INTRODUCTION

It surpassed that of some other metal with the exception of iron. Aluminium is quite often alloyed, which notably improves its mechanical properties, particularly when tempered. For instance, the regular aluminium foils and refreshment jars are amalgams of 92% to 99% aluminium. The properties of the different aluminium composites has brought about aluminium being utilized in businesses as assorted as vehicle, sustenance arrangement, vitality age, bundling, design, and electrical transmission applications. Aluminium compounds have been utilized in numerous applications where basic daintiness and consumption obstruction are
significant. They are additionally amazingly great channels of power (third best after silver and copper, separately), yet have a high coefficient of warm development that makes them inadmissible for high temperature applications (e.g., external skin of rapid airplane, some motor segments). On the other hand it takes just 5% of this to remelt and reuse one ton of aluminium. There is no distinction in quality among virgin and reused aluminium composites. Unadulterated aluminium is delicate, bendable, and consumption safe and has a high electrical conductivity.

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Many forms of thermal spray coating are currently available to improve various surface properties of the metal part. HVOF thermal spraying and plasma spraying are widely used to produce wear-resistant coatings and the coating is an electrochemical process that changes the metal surface in a decorative, durable way, which increases corrosion and wear.

II. MATERIALS AND PROCESSES

2.1 COATING MATERIALS

The substrate was made of Aluminium 2014 grade alloy with the following proportions: Si 0.50-0.90, Fe (max%) 0.50, Cu (max%) 0.50, Mn 3.9-5.0, Cr 0.4-1.2, Mg (max%)0.10, Ni 0.2 – 0.8, Zn (max%)0.1, Ti+Zr (max%)0.25, Ti (max%)0.20, other each (max%)0.15, other Total(max%)0.05, Al (%) as the remaining balance. The examples were cleaned ultrasonically in alcohol first and then acetone. The Aluminium specimens were prepared in 8 diameter x 50 mm length of pieces. Surface blasting was finished with Aluminium Oxide to upgrade the substrate-coating adhesion strength [11].

Tungsten carbide is concoction carbide containing equivalent pieces of tungsten and carbon. It is around twice as solid as steel with twofold the thickness and is twofold the thickness of steel—almost halfway between that of lead and gold. Tungsten Carbide's hardness level is practically identical with corundum and must be cleaned and completed with abrasives of predominant hardness, for example, cubic boron nitride and precious stone powder, wheels, and mixes. In its fundamental structure, tungsten carbide is a fine dim powder, yet it very well may be squeezed and framed into shapes for use in mechanical apparatus, cutting devices, abrasives, protective layer penetrating rounds, different devices and instrument

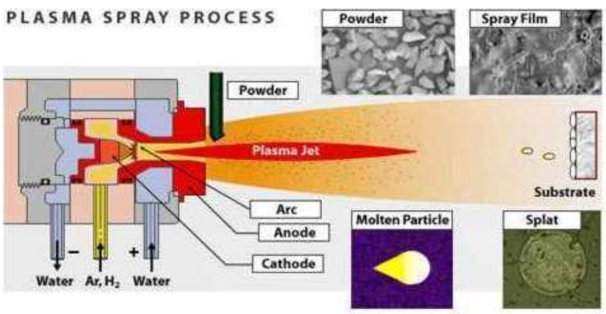
The HVOF tungsten carbide warm splash procedure produces huge measures of motor vitality into the powder particles. At the point when these exceptionally enthusiastic particles strike the substrate, their speed drops to zero and they assimilate their dynamic vitality, which makes them security in a flash to the work piece. Resulting particles arrive all the while, quickly working up the covering.

Tungsten carbide warm shower coatings are the most every now and again connected wear safe surface medicines. With a variety of HVOF warm splash gear and guarantee reliable generation. The HVOF warm shower rooms are intended to suit a wide scope of segments, using enormous diverting capacities and hardware going from robots and X-Y firearm controllers to overhead cranes. Forte constructed installations are utilized to deal with tedious creation; complex concealing apparatuses ensure uncoated territories.

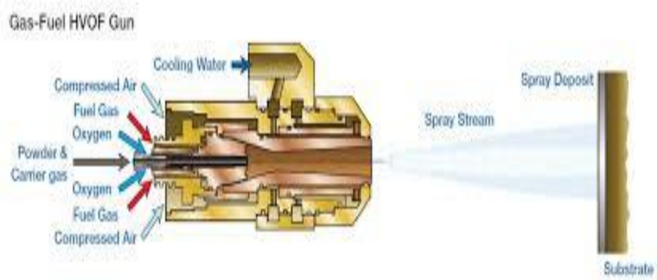
In this examination, two warm shower covering methods, to be specific plasma and HVOF (utilizing propylene gas as fuel), were utilized to coat earthenware WC onto Aluminium 2014 composite.

The covering thickness with the two strategies was around 100µm, 200µm, 300µm. Preheating somewhere in the range of 75 and 85°C was connected before covering to decrease oxidation. The covering quality was explored as far as bond quality, microstructure, thickness and hardness.

2.2 THERMAL SPRAY COATING METHODS



(a)



(b)

Fig. 2.2:- Coating (a) Plasma spray (b) HVOF spray.

In this examination, plasma spray coating was accomplished utilizing a gun (F4) made by Sulzer Metco. As shown in Fig. 2.2 (a) plasma parameters wre used to spray chromium oxide in form of fine powder with a current rate of 250 Amp , voltage of 63 V. The flow rates for Argon (Ar) and hydrogen (H2) were given as 123.5 and 32 L/min.

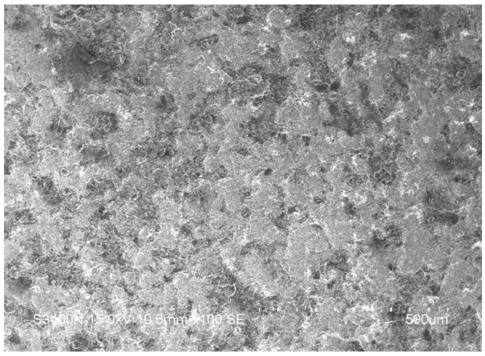
2.3WEAR TEST

In this segment, different sorts of physical testing were conducted including porosity, thickness, harshness, miniaturized scale hardness, and bond quality, trailed by wear testing under different burdens. At last, wear testing was finished with a stick on-plate analyzer model TR-20 LE. The wear tests were performed between the uncoated and coated samples. The load were alternatively varied with 10N and 20 N.

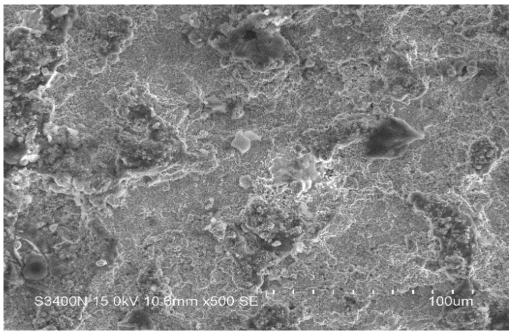
III. RESULT ANALYSIS AND DISCUSSION

3.1 MORPHOLOGICAL CHARACTERIZATION

The covered examples demonstrate that the stored layer verified the substrate reliably and pursued well. Here, the samples showered by plasma contained various surface defects which impacted the wear. Dissimilar to the HVOF splash covering as splat limits are not clear. The HVOF-covered example had an extremely thick surface as in Fig.3.1.1 represents the top SEM surfaces of tests covered by HVOF at different amplifications. Fig.3.1.2 delineates the top SEM surfaces of tests covered by plasma at different amplifications. It may, during splashing, the temperature of the powder was not satisfactory, so a to some degree softened area shaped at the top. Fig. 3.1.2 (a) shows a couple of permeable territories in both covering types.

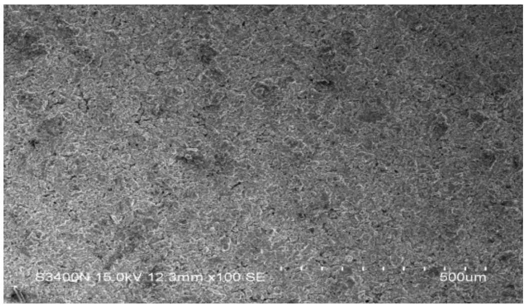


(a) HVOF

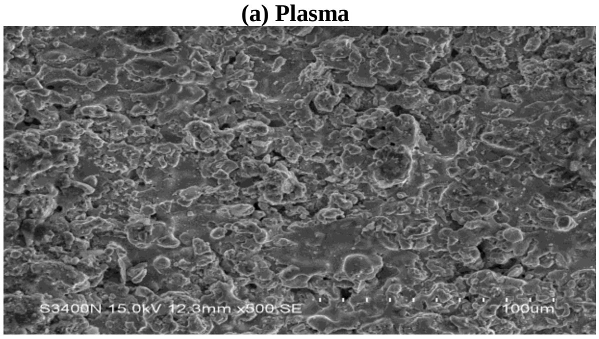


(b) HVOF

Fig. 3.1.1 SEM of HVOF coated samples at different magnifications: (a) 300X (b)2000X



(a) Plasma

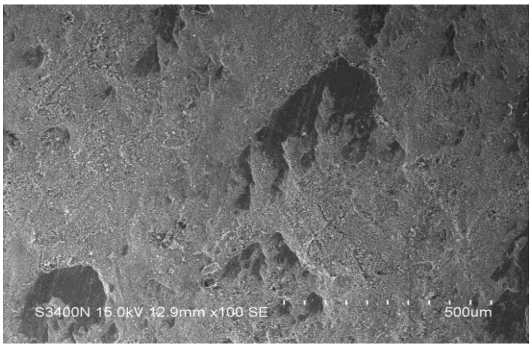


(b) Plasma

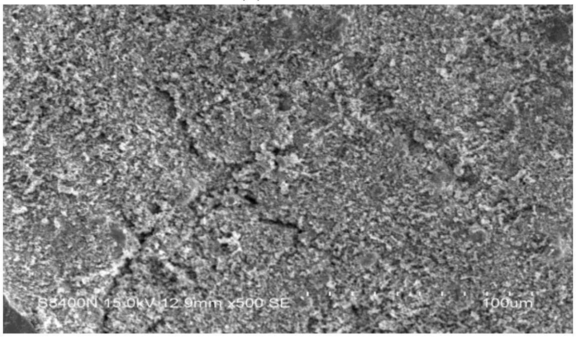
Fig. 3.1.2 SEM of HVOF coated samples at different magnifications: (a) 300X (b) 2000X

3.2 WEAR BEHAVIOUR

Covering thickness straightforwardly influenced covering hardness, which is the reason the HVOF test hardness was higher than that of the plasma-covered example. As shown by Bobzin et al. [13], As far as application, it is significant for the bond quality between the covered layer and As far as application covering's administration life [29].

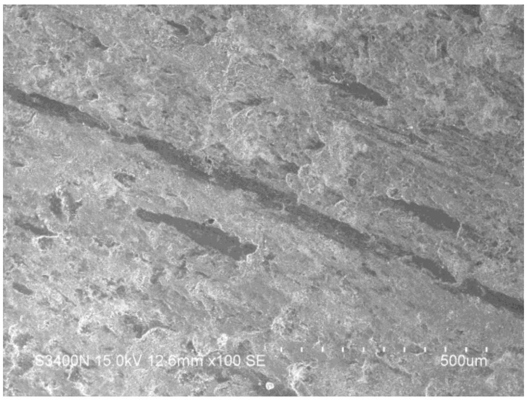


(a) Plasma

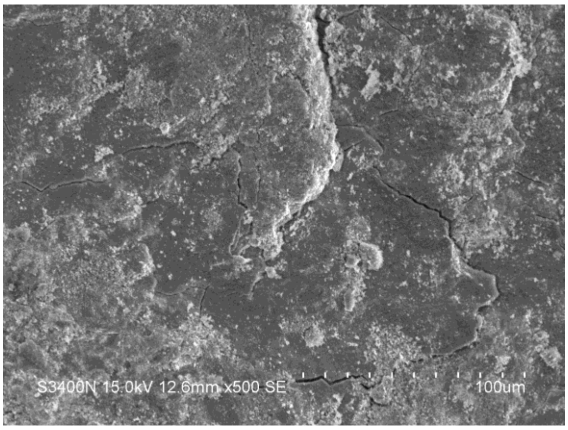


(b) Plasma

Fig. 3.2.1 SEM images for Plasma coated samples at maximum load (20 N) at different magnifications: (a) 100X (b) 500X.



(a) HVOF



(b) HVOF

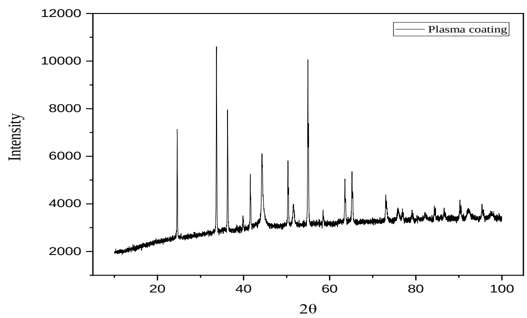
Fig. 3.2.2 SEM images for Plasma coated samples at maximum load (20 N) at different magnifications: (a) 100X (b) 500X.

Fig. 3.2.1 speaks to a surprising break that finished in twisting after burden exertion at the edge of the substrate surface for Plasma covered. Profound and wide scores shaped superficially toward the part of the bargain and the wear tracks ended up perceptible in general surface. These tracks obtained by the wear were made during the wear test. Complying with Fig. 3.2.1 (b), the higher amplification obviously shows the ragged plasma covered example surface and the wear flotsam and jetsam.

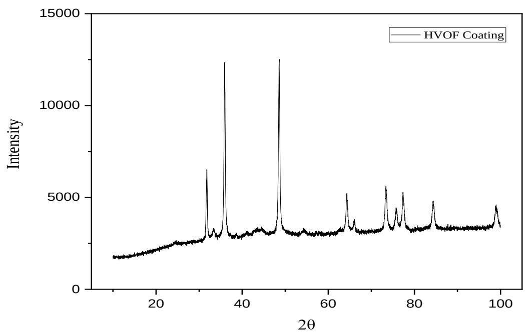
Table. 3.2 Weight losses and volume of wear loss of coated samples under different loads

Loads	Rate of weight loss in gms			Volume Wear loss in kg/m³		
	Al-2014	Plasma Treated sample	HVOF treated sample	Al-2014	Plasma sample	HVOF sample
10 N	10.4	10.6	10.6	5.88	5.99	5.77
20 N	10.3	10.55	10.54	5.82	5.96	5.94

In Fig 3.2.3 shows XRD chart of plasma covered and HVOF Coated examples at 20N burden .X-beam powder diffraction (XRD) is a fast diagnostic method fundamentally utilized for stage recognizable proof of a crystalline material and can give data on unit cell measurements XRD investigation of the WC and Cr2O3 covered examples was performed. Since XRD was performed on the whole example its example demonstrated number of pinnacles comparing to the components present in both the HVOF and Plasma covering.



(a) Plasma coating



(b) HVOF coating

Fig 3.2.3:- XRD graph of plasma coated and HVOF Coated samples at 20N load.

IV. CONCLUSION

From microstructural investigation the HVOF treated samples performed superior properties compared to to the plasma coated samples. The wear properties of HVOF treated samples under various loads proved high durability and weight reduction were restricted, particularly under variableloads. The wear resistance of HVOF method has better than the plasma technique improving the life of material.

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