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Characterisation of Aluminum over Mild Steel by Friction Surface Processing

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Abstract: Friction surfacing is an advanced manufacturing process, which has been successfully developed over the past decade. The process is used for corrosion and wear resistant coatings and for reclamation of worn engineering components. The major requirement is for flexibility to enable rapid changes of process parameters in order to develop new applications, with variations of materials and geometries in term of cost and reliable manner. So, the Present work deals with the solid state coating by friction surfacing process where aluminum is coated over mild steel substrate. The effects of traverse speed on the geometry, interfacial bond characteristics and mechanical properties of coatings are studied. Metallurgical studies were made using optical microscopy; mechanical tests included bend tests and micro hardness tests.

Keywords: Friction surfacing, steel, Al, Tool profile, Bend test, Microstructure, Micro hardness, Shear test.

INTRODUCTION

The material surfaces are engineered to impart specific properties, which could be different from those of the core material. These surface modifications are generally carried out to impart wear and corrosion resistance of the substrate materials. Various surface engineering process techniques are adopted for surface modifications which include chemical deposition process, high temperature diffusion related process involving chemical reactions, deposition by fusion routes such as weld overlay, flame spray techniques etc., which are widely employed. Friction surfacing, which is related to friction welding, utilizes the frictional energy dissipated during operation and generates a layer of plasticized metal without the need for external heat source. The friction surfacing of aluminium presents an inherent problem due to the high thermal conductivity of the metal. However with aluminium heat quickly escapes upwards through the rod material. Effectively the cooling rate of the substrate is increased, thus achieving thermal balance between the rod and the substrate to retain more heat in the metal transfer zone.

EXPERIMENTAL PROCEDURE

Material Specification

A mild steel plate of 250mm length, 120mm width and 10mm thickness plate was taken and for obtaining good friction between two metals i.e., This process is done on conventional vertical milling machine and it can also be done on CNC machines also but it should be of spring loaded control machine, because in this CNC machines the Z-axis will remain fixed according to the programmed made by the operator. Material chemical composition-AL, Mild steel

CHEMICAL COMPOSITION OF AL 6082

Table 1: Chemical composition of Aluminium 6082

ELEMENT	%Present
Si	0.7-1.3
Fe	0.0-0.5
Cu	0.0-0.1
Mn	0.4-1.0
Mg	0.6-1.2
Zn	0.0-0.2
Ti	0.0-0.1
Cr	0.0-0.25
Al	Balance

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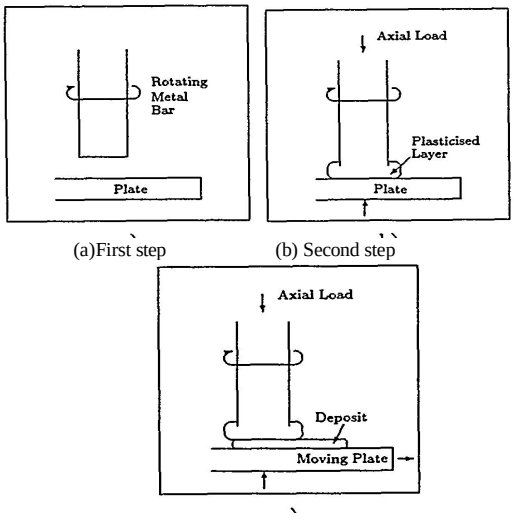
CHEMICAL COMPOSITION OF MILD/LOW CARBON STEEL

Table 2: Chemical composition of Mild/Low Carbon Steel

Element	Content
Carbon, C	0.14 - 0.20 %
Iron, Fe	98.81 - 99.26 % (as remainder)
Manganese, Mn	0.60 - 0.90 %
Phosphorous, P	≤ 0.040 %
Sulfur, S	≤ 0.050 %

Principle Mechanism of Friction Surfacing Process

Friction surfacing is a solid phase cladding technique; it uses a combination of heat and deformation to clean surfaces and metallurgically bond metals together. In its simplest arrangement a rotating consumable bar is brought into contact, under low load, with stationary substrate. At initial contact, the rotating bar is preferentially heated to form plasticized layer by the frictional motion.



(a)First step (b) Second step

(c)Final step

Fig 1: Principle Mechanism of Friction Surfacing Process

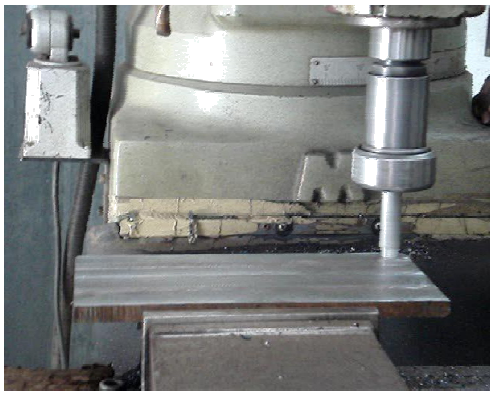


Fig 2: Frictional Surfacing Setup on Conventional Milling Machining

Fig 3: Coating of Aluminium over Mild Steel

Fig 4: After coating of aluminium over mild steel the formation of layers along the plate

RESULTS & DISCUSSION

Bending Test

This test was conducted on the universal testing machine as the specimen standard is fixed between two supporting blocks and the load is applied on the specimen by gradually increasing the load over the work piece until the breakage occurs in the specimen.

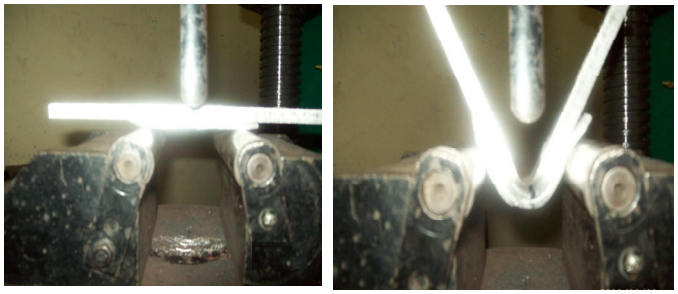


Fig 5: Before & After Testing the Specimen

Graph between Load (N) Vs Displacement(mm)

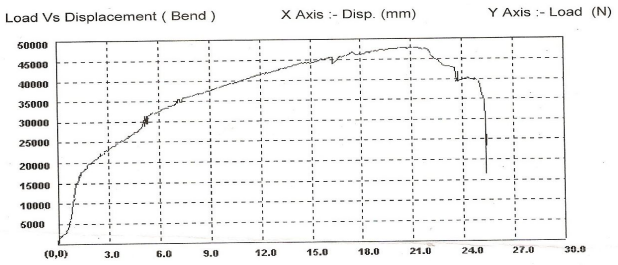


Fig 6: Graph of Load Vs Displacment

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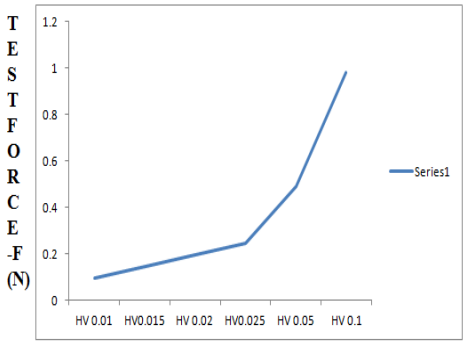
VICKERS'S HARDNESS TEST

The test is conducted on machines with an indentor of a square based diamond pyramid having an angle of 136 degrees between opposite faces the specimen is carefully prepared and placed on the stage. It is raised upwards to make contact with indentor. The applied load is (5-120 kg in increment of 5 kg) selected according to the thickness and hardness of the specimen.

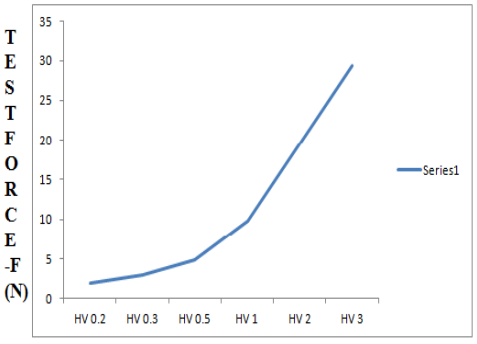
Table -3 Standard Vickers Scales

Micro-hardness scales	Test force *F* (N)	Low-force hardness scales	Test force *F* (N)	Macro-hardness scales	Test force *F* (N)
HV 0.01	0.09807	HV 0.2	1.961	HV 5	49.03
HV0.015	0.1471	HV 0.3	2.942	HV 10	98.07
HV 0.02	0.1961	HV 0.5	4.903	HV 20	196.1
HV0.025	0.2452	HV 1	9.807	HV 30	294.2
HV 0.05	0.4903	HV 2	19.61	HV 50	490.3
HV 0.1	0.9807	HV 3	29.42	HV 100	980.7



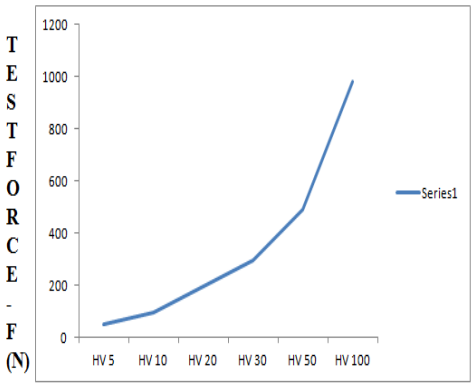
MICRO HARDNESS SCALE

(A)



LOW HARDNESS SCALE

(B)



MACRO HARDNESS SCALES

(C)

Fig 7**:** Graphs of Micro hardness scales Vs Test forces (F), Low force hardness scales Vs Test Forces (F) and Macro hardness scales Vs Test forces (F)

CONCLUSION

It is observed from Friction surfacing, excellent bonding is obtained with no defects such as porosity, oxidation. The material properties like bond integrity, Bending strength, hardness distribution will not change and there is an increase as compared with before the F.S process. No cracking's occurred in the Heat Affected Zone. Melting of material will not take place as the coat forms at Recrystallization temperature only. More advisable process among the existing process used in wide range of applications. From the tests concluding that these Friction Surfacing products can be used efficiently.

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