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Surface Modification of AISI 1020 Steel with TiC Coating by TIG Cladding Process

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ABSTRACT

TiC coating was produced by preplacing a powder of TiC on AISI 1020 low carbon steel substrate. TIG cladding technique has been carried out on the substrate. The cladding process will help to improve the wear resistance, corrosion resistance and hardness value. The effect of coating on mechanical properties of substrate material was studied. Process parameters such as current, scan speed and coating thickness significantly influence the quality of the coating. The hardness value of pure AISI 1020 was observed to be 250 HV. The hardness of cladded plates was greater than that of substrate material.

Keywords—AISI1020 Steel, TiC composite, TIG cladding, hardness

I. INTRODUCTION

Metal components lose their functionality because of wear by combination of corrosion abrasion and impact. This reduces the service life of component. To increase the service life surface modification techniques have been adopted. Many surface engineering techniques have been used to battle with surface failures, but every technique has its own drawback.

Reinforcement with a hard phase may be a good alternative for improving the wear resistance of a softer material without significantly changing other properties such as density. The overall improvement depends on material parameters such as properties of the reinforcing phase (size, geometry and hardness), properties of the substrate (hardness and ductility) and properties of the bond between reinforcing phase and substrate. Recent studies have attempted to enhance the wear and corrosion resistance of different substrate materials by depositing various alloys and ceramic powders making metal matrix composites (MMC)[1].

Reinforcement of metal matrix with ceramic particles can increase the hardness, wear resistance, strength and stiffness when compared with its base metal. However, fabrication of complete component of metal matrix composite is uneconomical due to high cost of ceramic particles and manufacturing complexities. High energy density deposition methods such as laser cladding, thermal spraying and TIG cladding considerably improve the surface properties. Among the most commonly used ceramic materials used, TiC is prominent reinforcement

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material. TiC has high hardness, good wettability, high thermal solubility, high melting temperature and high thermal conductivity [3].

High power laser and electron beam melting have been used extensively. These techniques are expensive, technologically complex and require precise control of the system, Whereas TIG cladding is an economical and easy method for surface modification [2]. It produces high quality coating across a wide range of materials. As compared to other methods thick deposits (in range of few mm) can be obtained by this process. In recent years, many researchers have taken place on TIG cladding by using TiC as reinforcement on various substrate materials. The surface layer obtained by this technique on different substrate materials has fine microstructures with high hardness and wear resistance different from the starting metal.

TIG surface alloying offers many advantages in the deposition of hard and wear-resistant coatings on different substrates by simultaneous melting of both the coating material and a fine layer of the substrate [4]. It produces high quality coating across a wide range of materials. As compared to other methods thick deposits (in range of few mm) can be obtained by this process.

Variety of substrate materials such as AISI 1045, AISI 4340, AISI 304 has been reinforced with TiC ceramic composite coating. AISI 1020 is a low carbon steel with carbon percentage of about 0.22% by weight. Very few surface modification methods can be applied to this steel because of its low carbon content value. Hence surface coating method can be applied to improve the properties of AISI 1020 material. Form the literature it is observed that very few studies on TiC coating On low carbon steel produced by TIG cladding has been encountered.

Thus with the objective to produce hard, wear resistant coating on low carbon steel to enhance mechanical properties, in the present work, TiC coating is produced on AISI1020 steel substrate with the use of TIG arc heat source. This work particularly focuses on forming coating of TiC ceramic particles on AISI 1020 low carbon steel. Processing parameters such as current, scan speed, coating thickness etc. are taken into consideration to get a good quality coating. The effect of processing parameters on mechanical properties will be studied in this work.

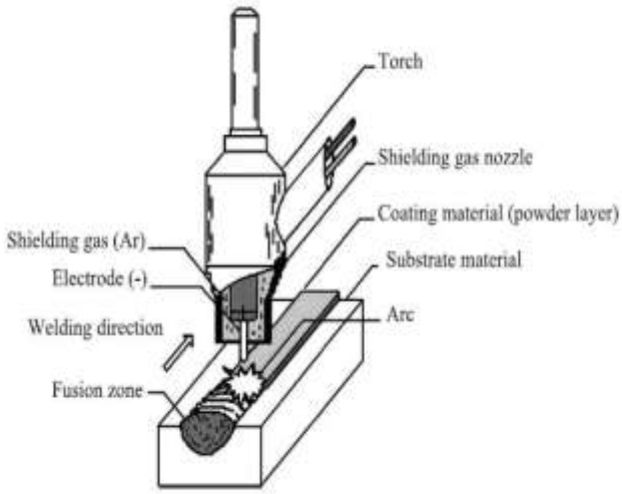

Fig. 1. Scematic diagram of TIG coating

Fig. 2. Powder Preplacement

II. EXPERIMENTAL WORK

Titanium carbide(TiC) powder of 99% purity of size 20 µm grain size was used as reinforcement material on AISI1020 low carbon steel of composition given in table 1. At first the surface of AISI1020 low carbon steel plates of 150 x 50x 8 mm^3 was polished with emery paper to degrease and cleaned with acetone before pre placing TiC powder for alloying. The physical properties of coating material used are listed in Table 2.

TiC powder was mixed with specific amount of acetone and polyvinyl alcohol organic binder to prepare a semi solid paste. Polyvinyl alcohol was heated to make it semisolid as it is in granular powder form. TiC powder was then mixed with the semisolid Polyvinyl Alcohol. This paste was then preplaced on the substrate surface uniformly. To form a predefined thickness the volume of powder required to cover the area was calculated Doctor blade method was used to spread the semi solid solution uniformly over the substrate. The plate was then placed on the table and fixed with industrial tape. The semi solid solution was the spread over the plate with the help of thin blade. It was then kept in open atmosphere for some time. Hence, preplaced layer of approximately 0.5mm thickness was obtained on the substrate.

Table 1 Composition of AISI 1020 low carbon steel wt %

Element	C	Si	Mn	P	S	Cr	Fe
Wt%	0.22	0.22	0.55	0.01	0.009	0.15	98.84

Table 2 Physical properties of TiC powder

Powder	Density (kg/mm^3)	Melting temperature (^oC)	Hardness (HV)
TiC	4.93	3067	2800

The substrates were then dried in an oven at 100 ^0C to remove any moisture content.

Thickness of the layer was calculated from the thickness difference of the substrate before and after the pre placement. Fig. 1 shows the powder pre placement.

A TIG equipment was used to generate a torch with a 2.4 mm diameter tungsten electrode was used to create an arc for the process. TIG welding torch was attached to a speed controlled linear guide-ways so that different scan speeds can be obtained. Welding current, scan speed are varied to obtain optimum process parameters to get a feasible coating. Details of processing conditions are listed in Table 2. The schematic diagram of TIG cladding is shown in Fig. 2 a dummy plate is kept before the substrates to establish the arc.

The heat input H for melting the track under the torch the torch generated at voltage V and current I at scan speed S was calculated using equation (1), where where is the efficiency of heat absorption, which is considered to be 48% for TiG torch melting.

- Heat input (H) = $\eta \times \frac{VI}{S}$ (1)

Process parameters are to selected according to their effect on machining. For preliminary experiments parameters selected are current, scan speed, voltage, heat input and coating thickness. The literature review states that current, heat input, scan speed and coating thickness have major effect on response variables such as hardness, wear resistance and surface roughness. Hence, the three input parameters are varied to get a novel TiC coating.

III. RESULTS AND DISCUSSION

The TIG torch melting track with different variables exhibited smoother surface with some ripple marks. This ripple phenomenon is associated with rapid solidification of the liquid melt and this behaviour also observed by researcher in previous works.

Fig.3.a. Surface topography at 62A current

Fig. 3.b. Surface topography at 76A current

Table 3. Hardness value (HRB)

Current (A)	Hardness Value (Rockwell)
62A	120
76A	130

The hardness test was carried on Rockwell Hardness tester. Ball indenter was used to check the hardness value. Hardness value of Low carbon steel was observed to be 99-100. The cladding was carried at different currents. Corresponding hardness values are mentioned in Table. 4

The surfaces were been seen to b free from any defects but pores were seen in the melt cross sections of some tracks. The pores are mostly in the low temperature regions of the melt pool.

IV. CONCLUSION

A hard and wear resistance TiC coating has been successfully developed on AISI 1020 steel substrate by TIG cladding process. TiC metal matrix composite layer made an interfacial bond between the coating and substrate surface.

The surface hardness value of pure AISI 1020 low carbon steel was observed to be 100 . After coating, the hardness value was increased significantly. In general, the hardness value of samples after cladding was observed to be 1.5 times more than the substrate material.

The experiments revealed that the input parameters i. e. current, scan speed and coating thickness effect the mechanical properties of the coating.

REFERENCES

[1] Saroj, S. el at.(2017) ‘Microstructure and mechanical performance of TiC-Inconel825 composite coating deposited on AISI 304 steel by TIG cladding process’, Journal of Materials Processing Technology, (Online) http://dx.doi.org/10.1016/j.jmatprotec.2017.06.042

[2] Mridha, S and Baker, T.(2015) ‘Overlapping tracks processed by TIG melting TiC preplaced powder on low alloy steel surfaces’, Materials Science and Technology, Vol. 31 No. 3, pp. 337-343.

[3] Wenbo, T. et al.(2014) ‘Investigation on TiCP/Al Composite Coating by TIG Cladding’, Applied Mechanics and Materials ,490 , pp 29-33.

[4] Yan, H. et al.(2013) ‘Laser cladding of Co-based alloy/TiC/CaF2 self-lubricating composite coatings on copper for continuous casting mold’, Surface and Coatings Technology, Vol 232, pp. 362-369.

[5] Mridha, S. et al.(2012) 'Incorporation of TiC particulates on AISI 4340 low alloy steel surfaces via tungsten inert gas arc melting', Advanced Materials Research, Vol 445, pp.655-660.
[6] Madadi, F. et al.(2012) 'Optimization of pulsed TIG cladding process of stellite alloy on carbon steel using RSM', Journal of Alloys and Compounds, 510, pp. 71-77.
[7] Sahoo, C. Et al. (2017) 'Microstructure and mechanical properties of TiC-Ni coating on AISI304 steel produced by TIG cladding Process', Journal of Materials Processing Technology, 240, pp.126–137.