ANALYZING CLADDING PARAMETERS OF STAINLESS STEEL WELD USING TIG WELDING

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ABSTRACT: *When two bodies are in sliding contact with each other, dry sliding wear develops. During the process of sliding, pieces may be pushed away from one surface and adhere to the other surface, creating a sticky mess. Later on, they may be transported back to the original location or they may become loose wear particles. It is shown in this article that various experimental circumstances have an impact on the dry sliding wear behavior of surfaces generated by the plasma transferred arc hard facing method on stainless steel, stellite, and colmonoy. Taguchi orthogonal array L9 was used in order to improve the TIG welding settings. The testing findings revealed that the welding current and scanning speed had the greatest impact on the overall performance of the TIG cladding system. The anticipated results of the micro hardness test were obtained, with a rising trend from the substrate to the overlay. When comparing hard faced samples to substrate samples, the results of the wear tests showed that the hard faced samples had outstanding wear resistance.*

Keywords*: Stainless Steel, Molybdenum alloy, Cladding, TIG welding*

1. INTRODUCTION

Recently, a significant deal of effort has been focused on selectively altering the mechanical characteristics of metal surfaces (especially wear qualities) using methods such as laser or arc cladding , surface alloying, and glazing technique, and surface alloying. Over the years, the performance requirements for surface hardening and cladding metal have been significantly increased. Cobalt-based hard facing alloys, nickel-based alloys, and composite alloys are utilized in machinable instruments that need high heat, wear, and corrosion resistance, and where the cladding must be done in a cost-effective and high-quality manner. In recent years, the cladding method on composite alloys, including carbide, has been developed, allowing for the production of fine-grain structure and minute microstructure in a high-quality joint. [1-3]

High-intensity lasers and electron beam melting have been utilized extensively in this procedure. In contrast, TIG cladding is a cost-effective and simple approach for surface modification, while other methods are costly, technologically difficult, and require careful system control. It is capable of producing high-quality coatings on a broad variety of materials. Compared to other techniques, this process can produce thick deposits (in the range of a few millimeters). In recent years, many studies have been conducted on TIG cladding, with TiC serving as reinforcement on a variety of different substrate materials. In contrast to the beginning metal, the surface layer produced by this method on various substrate materials exhibits fine microstructures and great hardness and wear resistance, indicating that it was created using a distinct technique [4-5].

In the deposition of hard and wear-resistant coatings on a variety of substrates, TIG surface alloying provides many benefits over other methods since it involves the simultaneous melting of the coating material and a thin layer of the substrate. It is capable of producing high-quality coatings on a wide variety of materials. Compared to other techniques, this process can produce thick deposits (in the range of a few millimeters). Toughened TiC ceramic composite coating has been applied to a variety of substrate materials, including AISI 1045, AISI 4340, and AISI 304, among others. AISI 1020 is low-carbon steel with a carbon content of about 0.22 percent by weight, considered low [6-8].

Because of the low carbon content of this steel, only a limited number of surface modification techniques may be used on it. It is thus possible to enhance the characteristics of AISI 1020 material using the surface coating technique. As can be seen from the literature, relatively few research has been conducted on TiC coating applied to low carbon steel generated by TIG cladding.[9]

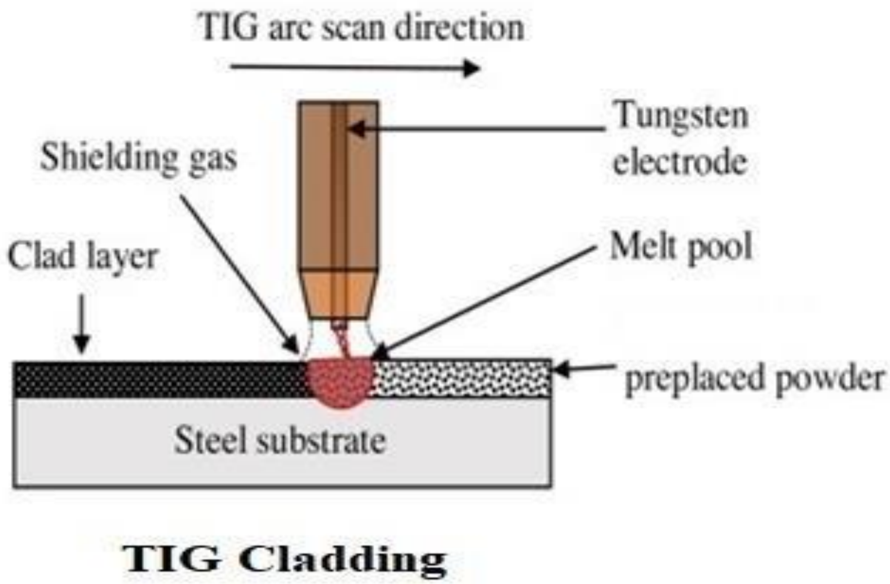

Figure 1 TIG Cladding Process

2. METHODOLOGY

To begin, the MS plates were sliced and samples with dimensions of 40 mm x 25 mm x 10 mm were produced. These samples were rough sanded with 220-grade sandpaper and then washed clean with acetone to remove any dust or oil before being used. Later, the powdered stainless steel was combined with a polyvinyl alcohol and distilled water slurry in the proportions specified by the manufacturer. This semi-solid slurry paste was uniformly applied to the steel surface in the shape of a thick coating, and it was then allowed to dry at room temperature to allow the water content to evaporate.[10]

Later, the TIG welding technique was used to create the cladding layer on top of the MS substrate, which was then painted. When the arc produced by the electrode tip was moved all over the surface of a pre-placed layer, it fused and melted the powder particles. The picture of a TIG welding setup is shown in Fig. 1, with various components of the machine highlighted in different colors. Trials were carried out in order to determine the ranges of welding current, torch scanning speed, and standoff distance that could be used (electrode to work piece distance) [11]. A wide variety of welding currents, scanning speeds, and stand-off distances were tested, ranging from 60 to 100 A, 150 to 350 mm/min, and 1.5 to 3.5 mm, respectively. Observations revealed that the claddings were effectively produced with appropriate bonding, completed weld bead, no surface fracture, and no surface porosity when specific process parameters were used in the development [12]. According to the results of the trial runs, the welding current, scanning speed, and SOD ranges were determined to be 80-100 A, 200-300 mm/min, and 2-3 mm, respectively, for welding current, scanning speed, and SOD. Final TIG cladding tests were carried out in accordance with the Taguchi L9 design matrix on the basis of these parametric setting ranges. A total of three replications were carried out in order to reduce the amount of experimental error.[13-14]

Table 1 TIG welding Parameters

Parameter	**Value**
Voltage (V)	16 V
Argon flow rate (l/min)	9
Polarity	DCEN
Electrode Dia.	mm

2.1. HARDNESS TESTING

The micro hardness testing was carried out with the help of an automated digital micro hardness tester (ADM). The hardness testing was carried out with a standard load of 200 g and a dwell duration of 10 s on the specimen. Prior to the hardness testing, the cross-sections of the samples cut from the center of the clad layers of each specimen (as per the L9 matrix) were polished using emery sheets to remove any imperfections (220-1200 grit size). At the cross-section of claddings, a total of 10 indentations were produced, and the average value was calculated.

Sliding wear testing was carried out in order to determine the wear resistance of the cladding specimens that were produced under various parametric circumstances. The wear behavior of the cladding specimens was investigated using a pin-on-disc tribometer (TR-20, Ducom Instruments Pvt. Ltd., India) to which the cladding specimens were subjected. 30 mm long square cross-section specimens of 10 mm x 10 mm cross-section were slided to a distance of 2000 m across an EN32 spinning disc that had been hardened and polished to a mirror finish (60-62 HRC). The sliding speed was adjusted to 1 m/s, and a normal test force of 30 N was applied to the cladding specimens in order to determine their wear and coefficient of friction. It was determined how wear resistant the cladding specimens were by observing how much weight was lost throughout the testing process. Before and after the wear testing, the weight loss of the specimens was measured in order to get this result. The weight was measured using a semi-analytical weighing scale with a precision of 0.1 mg, which was used for the experiment.

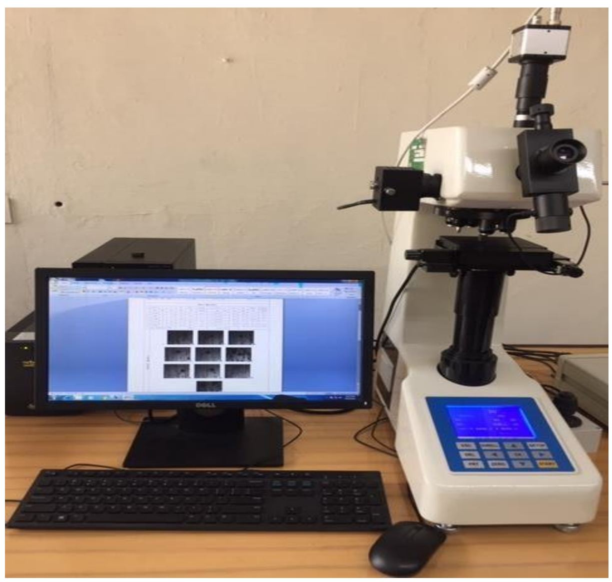

Figure 2 Hardness Testing Equipment

The surface of the TIG torch melting track was smoother with some ripple marks when the variables were varied from one another. When there is fast solidification of the liquid melt, there is a ripple phenomena that occurs, as has been noticed by the researcher in earlier studies.

3. RESULTS AND DISCUSSIONS

The scanning electron microscopy (SEM) pictures of stainless steel feedstock powder utilized in the current study are shown in Figure 3. It can be seen in the pictures that the powder is made up of a combination of irregular and spherical shaped particles that were created as a result of the atomization process used to create it. Each powder particle has a size in the range of 5-40 microns. Figure 4 depicts the energy dispersive spectroscopy (EDS) report of the feedstock powder, which demonstrates the presence of all main elements contained in the stainless steel material, as determined by the EDS method.

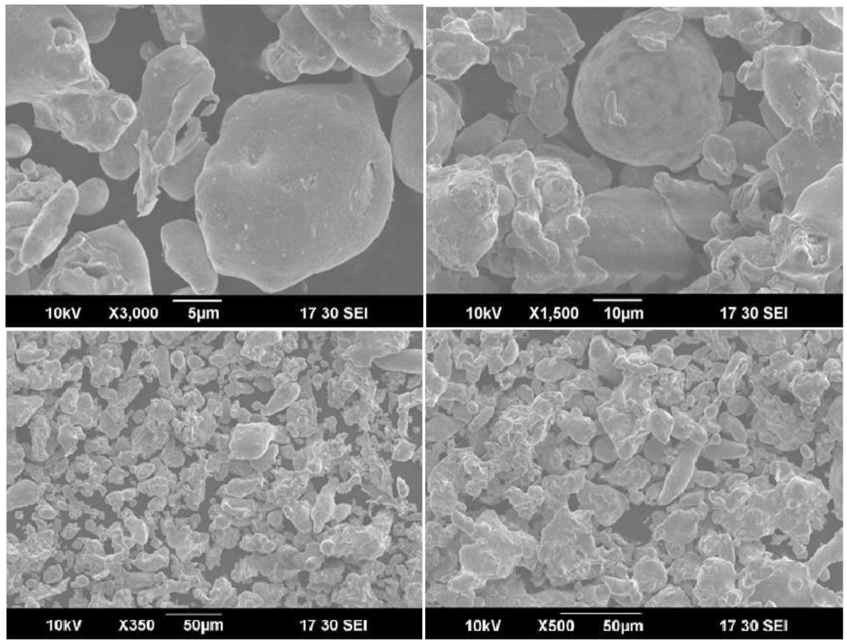

Figure 3 . SEM image of powder

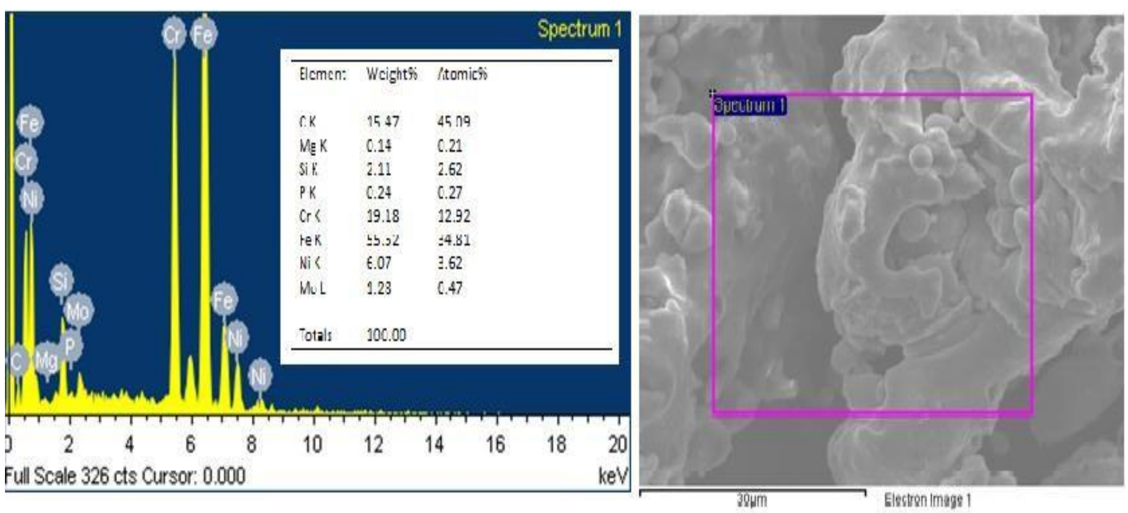

Figure 4 EDS Analysis of Powder

Figure 5 depicts an image of a Vickers micro hardness indent taken over cladding deposited using parametric setting 1 and shows the Vickers micro hardness indent taken over cladding. However, none of the claddings had a lower microhardness value than the mild steel base metal, indicating that they were all equivalent.

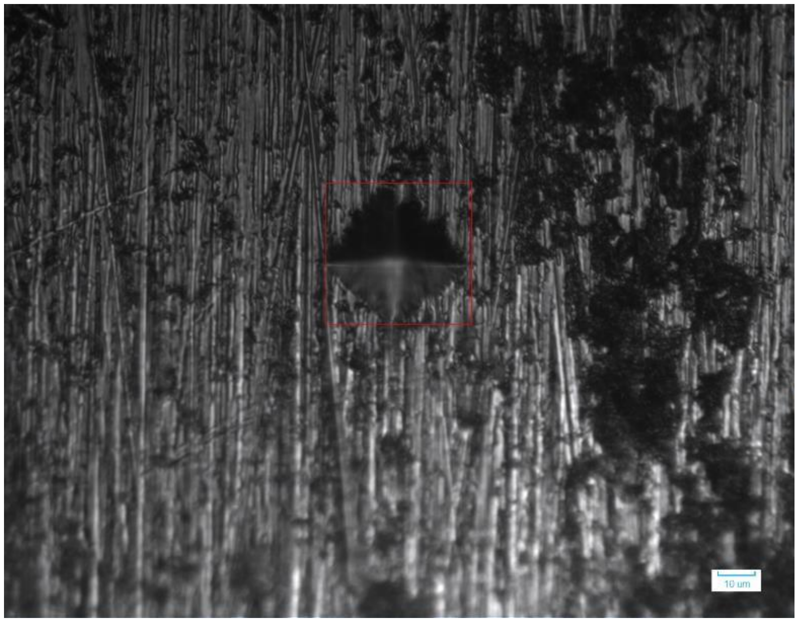

Figure 5 Vickers Hardness Test

CONCLUSION

When it comes to experiment design and process parameter optimization, the Taguchi method is a very successful approach that requires the least amount of trials. After scanning speed and standoff distance, the welding current was shown to be the most important element influencing the wear resistance of claddings. The following parameters were used in the development of the most wear resistant cladding: welding current of 80 A, scanning speed of 200 mm/s, and SOD of 2 mm, in that order. Wear on cladding rises with increasing current because of the greater degree of dilution, which results in the degradation of the chemical composition and mechanical characteristics of the cladding as current increases. Increases in speed cause wear resistance to rise initially, but then declines owing to incorrect melting of pre-placed clad layer powder particles and the presence of anticipated porosity in the formed cladding, which causes the wear resistance to drop.

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