REVIEW ARTICLE

SAMRIDDHI Volume 14, Issue 3, 2022 Print ISSN: 2229-7111 Online ISSN: 2454-5767

Examination of Weld Cladding methods for C.S. and S.S. and their Impacts - Review

Altafhussain G. Momin[1], Bharatlal C. Khatri[2], Mrunal K. Chaudhari[1], U.V. Shah[2], Janak Valaki[3]

[1]Department of Mechanical Engineering, Gujarat technological University, Ahmadabad, Gujarat, India

[2]Department of Mechanical Engineering Government Engineering College, Modasa, Gujarat, India

[3]Department of Mechanical Engineering, Lalbhai Dalpatbhai College of Engineering, Ahmadabad, Gujarat, India

Abstract

The center is about the various properties of C.S. and also S.S. Materials and how it performs under the warmth and learn about its wear, and erosion obstruction. Cladding measure is the holding together of divergent metals so cladding makes another surface layer with unexpected creation in comparison to the base metal. It is additionally used to fix an exhausted segment to reestablish its unique working condition like turbine edge. The outcomes showed that this material has the daringness to adjust the various properties of the warming cycles like welding.

Keywords: Cladding, C.S., Microstructure, S.S, Welding.

SAMRIDDHI : A Journal of Physical Sciences, Engineering and Technology (2022); DOI: 10.18090/samriddhi.v14i03.18

Introduction

C.S and S.S have a wide scope of utilization in the industry. Serious issues with C.S are wear, consumption, scraped spot and disintegration of parts. It usually happens to the key mechanical components, for example, valve seat, collars, stem, pipes, valve surface, and so on, along these lines diminishing the assistance life of segments. To improve the working existence of such parts, different surface alteration strategies are utilized where the surface presenting to such cruel conditions is ensured by saving shallow composites on a superficial level with the advantage of welding procedures. Tempered steel clad plate is utilized broadly in view of its amazing consumption opposition, strength, and ease.

Cladding

Cladding is a type of heated surface treatment in which a layer of hard or consumption-safe mixture is applied to a less costly substrate to improve erosion resistance, wear resistance, and hardness with the purpose of extending the equivalent's assistance life. Unlike solidifying, which modifies the characteristics of the substrate's surface layer to a certain depth, It is the process of covering an existing surface with a new layer of material that is different from the underlying material.

Cladding offers a one-of-a-kind mix of desirable characteristics nowhere to be found in other alloys. It is possible to use a base metal for value or primary characteristics, with a secondary metal added for surface security or unique properties like erosion resistance or wear resistance, for example. The thickness of the cladding may be greatly increased, making it heavier and more robust.

Advancements regularly utilized for cladding are:

- Thermal showering
- Laser-based techniques
- Arc welding

Investigation of weld cladding Strategies for Carbon Steel and Stainless Steel

Mushtaq Khan, Syed HusainImranJaffery, Liaqat li, MohmmadMujhid, and Shahid I Butt (2015) investigated thermal plasma welding processing parameters for 304 L and low carbon steel (-36). According to the findings, welding dissimilar metals is extremely challenging, and high-quality welds need precise process parameter adjustments.

Corresponding Author: Altafhussain G. Momin, Department of Mechanical Engineering, Gujarat technological University, Ahmadabad, Gujarat, India, e-mail: altafhussain@ldce.ac.in.

How to cite this article: Momin AG, Khatri BC, Chaudhari MK, Shah UV, Valaki J. (2022). Examination of Weld Cladding methods for C.S. and S.S. and their Impacts - Review. SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology, 14(3), 363-369.

Source of support: Nil

Conflict of interest: None

The sample broke from the S side in a tractable test, suggesting that the weld junction is more powerful than the base metal.[1]

That process on grey C.I substrate overseen by Hussein, S. Kamarul, and M. N. Ayof. Grey cast iron is difficult to weld due to its inherent fragility and susceptibility for cracking when subjected to temperature decreases during the arc welding process. By employing nickel-based alloy as the filler material, weld cladding using gasmetalarc weld joining technique and method may be done successfully and except cracking. The nickelbasedalloymaterialcanpreventcarbonmigration into the fusionzone, thus preventingcarbidephasetoform in the fusionzone. Nickel may also trap carbon as graphite, preventing the production of martensite.[2] Figure 1 shows that Martensite development in the warmth-influenced zone of the dark iron substrate.

In 2002, Cheng Zhao, Feng Tian, Hong-Rui Peng, and Jun-Ying Hou succeeded in cladding Stellite Ni60 amalgam on steel with a non-moved curve plasma cladding. The plasma bend cladding test used low-carbon steel as the substrate (AISI 1020). The coating was a self-fluxing satellite Ni60 composite powder. The table shows the interaction boundaries.

The non-transferred arc plasma process parameters, especially the surface temperature of the substrate steel, are crucial for preparing clad. You may achieve uniformity, good adhesion, and non-weakened coatings. [3]

Table 1: shows a Process Parameters for the non-diluted clad coating used for the present investigation.

Plasma Arc Current (A)	150
Plasma Arc Voltage (V)	22
Plasma gas (Ar) Flow rate (m3 /h)	0.3
Orifice diameter (mm)	5
Distance between nozzle and layer (mm)	5
Plasma torch velocity (mm/min)	300

Table 2: Lists the chemical components of cladding materials and base metal. (Percentage)

Material	*C*	*Si*	*Mn*	*P*	*S*	*Ni*	*Cr*	*Mo*	*Fe*
PFB-132	0.065	0.59	1.39	0.022	0.006	2.02	13.47	0.038	Bal.
PFB-131 S	0.140	0.68	0.99	0.021	0.011	0.98	12.42	0.37	Bal.
Base Metal	0.190	0.13	0.84	0.01	0.007	0.32	0.019	----	Bal.

Limin Zhang, Dongbi Sun, and Hongying Yu (2008) that the effects of niobium on the microstructure and wear resistance of plastified iron-based alloy coatings have been studied. The substrate is composed of plain steel and is 80 mm × 100 mm in size with an 8 mm thickness. 13 wt.% r, 5% wt. Ni 4.5% by weight 3.2 wt.% Mo Si In the balancear, blended as clad alloy powders (without nb) and 1.5 wt.% are utilized. To assess coating thickness, use a plasma scanning seed and a powder feed rate. When compared to 0.45% carbon steel, and Nb-contained clad coatings both show high excellent wear obstruction in a dry sliding wear test. [4]

Shufeng Wang, Huiqi Li, Xiang hen, Jing hi, Min Li, Lu Hai, and Hui Xu (2010) used a mechanical vibration technique during coating to increase the microstructure and wear resistance of plastified Fe-based alloy coatings. The low carbon steel substrate was 300 mm x 200 mm x 10 mm in size, and the steel specimen was 300 mm x 200 mm x 10 mm in size. It was then spot welded into position on a rectangularplate measuring 1800 mm x 600 mm x 10 mm. The coating substance was Fe-based self-fluxing alloy powder. **Figure-2** shows that Nab-free and Nab-contained microstructure of the coating and substrate's bonding region.

They arrived at this conclusion as a consequence of the experiment. With mechanical vibration, the microstructure of plasma clad coatings is enhanced, the coatings' mainphases are unchanged, and the coatings' averagemicrohardness and wear resistence are both enhanced. In this case, the best frequency is 100 Hz. The technique of mechanical vibration has been shown to be an effective method for improving plasma clad coating microstructure and wear resistance. [5]

MiCroplasmaArc Welded austenitic Welding quality characteristics kondapalliSivarasada, HalamalasettiSrinivasa performed stainless welding on ISI 304L, ISI 316L, ISI 316Ti, and ISI 321 sheets. A graph depicting the difference in mechanical characteristics for various diets is shown in Figure 3.

Figure-4 shows that Mechanical property variations for various steels. They construe that beat current MPAW was adequately done on a combination of austenitic solidified prepares. As demonstrated by the examination of weld quality attributes, AISI 304L has a good weld quality touch math, most significant flexible power, and hardness for comparable thickness and welding limits. Regardless, AISI 316L has the least flexibility, while AISI 321 has the smallest granule size and hardness.[6]

IEffect of Post-Weld Heat Treatment on Thermal Fatigue Resistance in Submerged Arc Stainless Steel Strip Cladding was investigated by I.C. Kuo et al. (2008). Utilizing a lowered bend cladding procedure, PFB-132 and PFB-131S martensitic tempered steel strips were preserved on an SS41 carbon steel substrate. The materials' substance production is visible in Table 2.

They discovered that raising the PWHT temperature decreased hardness. In terms of toughness, the PFB-131S cases were more serious than the PFB-132 examples. The increased Ni concentration in PFB-132 lowered the substance's AC1 temperature and helped with temper relaxation. Carbides formed at granule boundaries in a machine-molded structure, weakening grain boundaries and reducing warm exhaustion resistance. [7]

Wichan Chuaiphan, and Loeshpahn Srijaroenpramong (2010) carried out an experiment on GTAW is more effective process on filler alloy on rust behavious mechanical property and microstructure of different weldment metal between LCS sheets and AISI 201. The ER309L and ER316L fillers, according to the findings, are strong prospects for enhancing weld metal pitting coefficient resistance to values equivalent to ISI

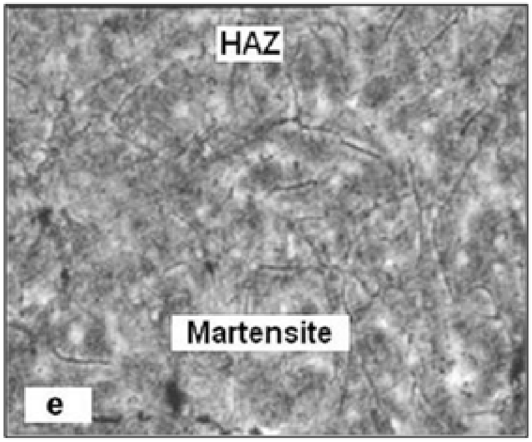

Figure 1: Marten site development in the warmth-influenced zone of the dark iron substrate

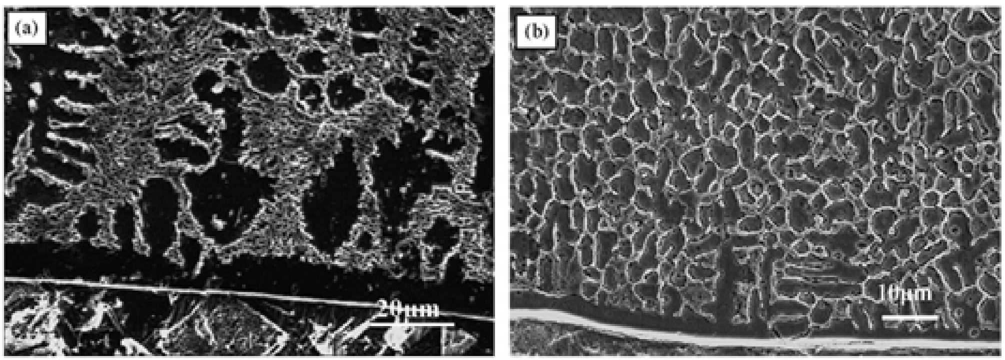

Figure 2 : (a) Nab-free and (b) Nab-contained microstructure of the coating and substrate's bonding region.

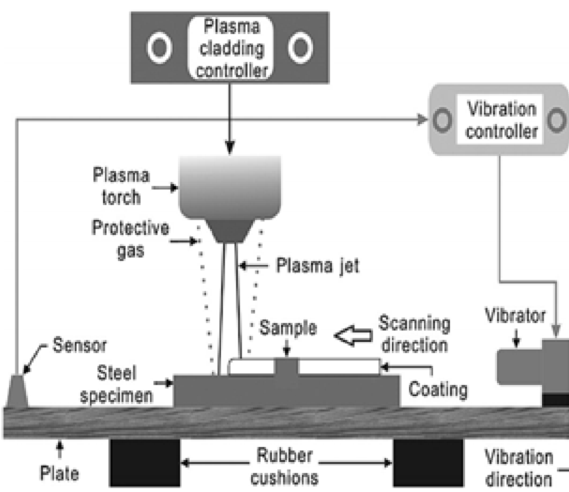

Figure 3: The plasma cladding measurement as a function of mechanical vibration is shown in a schematic graph.

201 base metal. This is due to the fact that ISI 309L filler has a high Chromime content (24.791 wt%), whereas ER316L filler has a low Mo content (2 wt%) but a high R content (24.791 wt%) (21.347 wt%). The weldments were generally similar in hardness; however, a small region of increased hardness was observed on the S side between the weldment border and the base metal fusion barrier, which was attributed to carbon migration from S and the associated transitions. [8]

S. Shahi and S. Andey conducted an using response surface methods, Reduce dilution in G.M. and UGM stainless steel single-layer cladding experiments. The substrate for this experiment was structural steel that had been chopped up to acceptable sizes of 2506150612 mm plates apiece, and the filler wire utilised was 316L with a diameter of 1.14 mm. They investigated the effects of wire feed rate, occv, electrode extension, and welding speed on dilution in this experiment. According to the data, wire feed rate was shown to be the most important variable influencing dilution throughout the range of input parameters tested, followed by electrode extension, V, and welding speed. Lower wire feed rate, V, and welding speed, as well as increased electrode extension, were revealed to be the base dilution conditions. Aside from the minor changes of the UGMW technique, Due to a considerable drop in the main welding current, supplementary preheating of the filler wire reduces base metal pention. [9]

Monika Solecka, aweetrzak, and GnieszkaRadziszewska employed the CMT technique to examine Ni-base alloy deposition on carbon steel microstructure (2015). Schaeffler presented a diagram for selectingelectrodes for weldingplaincarbon and stainlessplants. Degard et al. studied the fusion zone mechanical characteristics of welded duplex lloy SF 2507 to carbon prepares in the 1990s. They think that welding factors such as heat input lowered the characteristics and stability of the fusion zone. They're considering joining mild steel plates to austenitic stainless steel plates (304). Thickness: 3 mm. Arc welding was employed for all of the welding procedures, with a welding current of 100 ampere. We used both mild steel welding electrodes and stainless steel welding electrodes (W.S.: E308l-16). This experiment discovered that any of the stainless steel welding electrodes may be used to weld stainless steel 304 to mild steel: WS/SME: SF-5.4 E308l-16 mild steel welding electrode or W.S.: E6013 mild steel welding electrode.[10]

The Trama Center is a place where you can go to learn about Sharma, Rahul Hastelloy C-276 was chosen by Er. Manoj Kumar and Dr. Abhishek Kamboj. which is Family Part Of Nickel as a cladding Material And Shielded metal bend welding (SMAW), otherwise called manual metal circular

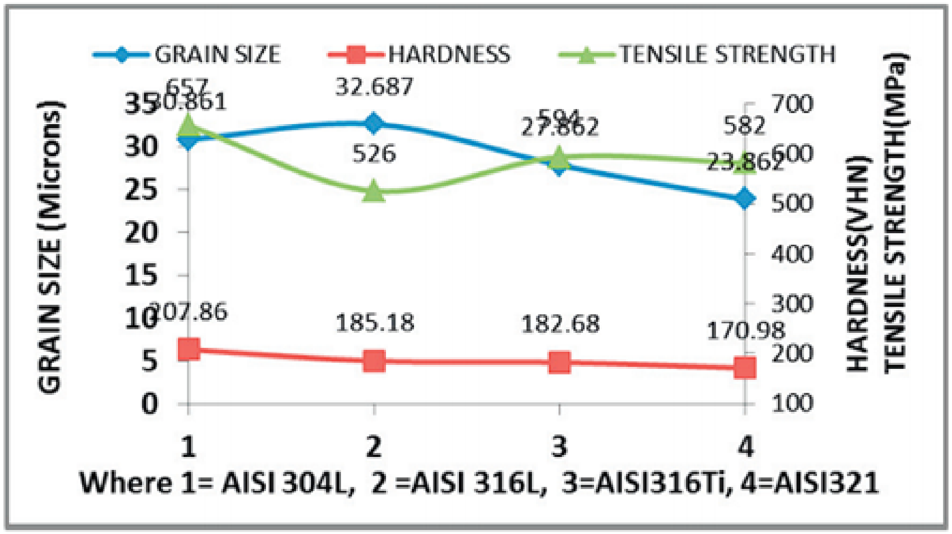

Figure 4: Mechanical property variations for various steels.

segment welding (MMA or MMAW)As A welding cycle And The SA 516 Grade 70 base plate is made of low carbon steel.

Parameter	Span
Ampere (I)	70-130 Amp
Voltage (V)	20-28V
Speed	220-250mm/min
Pre warmth	75
Interpass Max	200
Extremity DCEP	

The Results Are as below

Dab Finish	:	Good
Weld Fusion	:	Good
Including Slags	:	No
Undercut	:	No

No Typical Porosity and Crack in the Welding Cavity HastelloyC-276 was successfully welded, matching ASME Sec IX and Sec IIC specifications.[11]

Kaushik Sharma, Shailendradeva, Ravindrakumar, concluded on Their work it is believed that numerous methods for producing a clad layer on low grade preparations have been devised. Distinctive welding processes, such as GMW, GTW, SMW, LBW, and so on as well asseveral cross breed welding processes, suchas Co2-laser-GMAW, LMDT, etc. were utilized for the yield ofquality welding, to be applied in various enterprises in broad spectrum for improving me chanical properties such as hardness, cold hardness, etc. By having proper heating input, the mechanical properties of a clad component can be enhanced. By regulatingsolder, solderingvoltageandsolderingtravelspeed, heatinput is set. When the necessary microstructure of the clad component is achieved, both mechanical and anti-corrosion features can be enhanced under various reactiveenvironments.[12]

P.K. Miniappan, V.V. Arun Shankar, and A. Saiyath Ibrahim demonstrated flux cored arc welding with stainless steel cladding over mild steel. This investigation led them to the conclusion that a change in weld current impacts the pace of weld deposition. Mechanical qualities like as tensile strength, toughness, and hardness are improved by increasing the rate of weld deposition. The rate of corrosion on the weld bead is minimal due to the presence of austenitic phase on their grain area. Furthermore, Corrosion avoidance is aided by the presence of increased chromium and nickel from the electrode to the weld metal.[28]

S.M. Specialty Handbook: Stainless Steels, 06398G The precise influence of welding boundaries on weakening is reported by J.R. Davis, Davis and Associates.

Amperage: As amperage (current thickness) increases, so does dilution. The arcgetshotter penetrates deeper, morebasemetal liquefying makes.

Polarity: Direct current electrodenegative (DEN) has a lesser penetration and dilution than direct current electrode positive (DCEP) (DEP). When you change UITent, you get a dilution that's halfway between what's offered and what's provided.

- Size of the electrode: A smaller electrode has a lower amperage, resulting in less dilution.
- Travel speed: The quantity of base metal dissolved is reduced while the amount of filler metal liquefied rises, resulting in a reduction in dilution.
- Dilution is reduced by a broader electrode oscillation and dilution is also affected by the oscillation's frequency.
- Gravity forces the weld pool to run ahead of, beneath, or behind the arc, depending on the welding location or job inclination. If the weld pool stays above or below the arc, there will be less base metal penetration and consequent dilution.
- Dilution is also influenced by the protective medium, such as gas or movement. The following safeguarding media are given in decreasing dilution order: helium, carbon dioxide, argon, self-protected

motion cored arc welding, and granular motion with alloy addition (low).[38]

Conclusion

From the current audit paper following focuses have been obtained.

- The mechanical vibration approach has proven to be an efficient strategy to enhance the microstructure and abrasion resistance of plasma clading.
- Mechanical properties of the surface component might be improved by supplying valid thermal input. The welding Amphere, voltage, and weld travel motion are all utilized to manage the amount of heat input.
- Using optimal conditions, uniform, strong attachment, and non-weakened clad coatings may be obtained. In conjunction with other cladding methods, the non-moved curve plasma cladding strategy is efficient and harmless to the ecosystem interaction.
- The welding boundaries, for example, heat input, confined the combination zone characteristics and stage strength.
- Hardness can be reduced by increasing the PWHT temperature.
- Welding of metals that are dissimilar is very troublesome and sound welds must acquired through precise improvement of cycle boundaries.
- By using a nickel-based compound as the filler material, the weld cladding may be refined without breaking using a gas metal bend welding approach and technology.
- For the weld with hardened steel and carbon steel, various layers display distinctive microstructures. A microstructure related with martensite is found in the main layer of weld loaded up with carbon steel attributable to the combination of nearby tempered steel weld and the intricacy of amalgam components.
- In customary PTAW compounds, high hardness/wear opposition is generally gotten from consolidating artistic particles into an appropriate cover to a sum important to wet and hold the clay stages adequately.

Future work

Weld cladding serves vital job in the industry. Weld cladding can be by numerous methods like PTAW, GMAW, GTAW, etc. S.S 347 as a cladding material has excellent consumption and wear obstruction.

- Dilution control of base metal and cladding metal by changing its interaction boundaries.
- Microstructure and surface hardness investigation of the weld cladding done by GTAW.
- Research on C.S as a base metal and S.S 347 as cladding.

References

[1] Shane Fatima , Mushtaq Khan , Syed Husain Imran Jaffery , Liaqat Ali , Mohammad Mujahid and Shahid I Butt, Optimization of cycle boundaries for plasma circular segment welding of austenitic treated steel (304 L) with low carbon steel (A-36),2015

[2] Hussein, N. I. S ,Kamarul S. R. , Ayof, M. N, PRELIMINARY STUDY OF ON CLADDING PROCESS ON GRAY CAST IRON SUBSTRATE

[3] Cheng Zhao, Feng Tian, Hong-Rui Peng, Jun-Ying Hou.,Non-moved curve plasma cladding of Stellite Ni60 composite on steel, 2002

[4] LiminZhang ,Dongbai Sun, HongyingYu.,Effect of niobium on the microstructure and wear obstruction of iron-based composite covering delivered by plasma cladding,2008.

[5] Shufeng Wang, Huiqi Li , Xiang Chen, Jing Chi , Min Li , Lu Chai , Hui Xu, Improving microstructure and wear obstruction of plasma clad Fe-based composite covering by a mechanical vibration method during cladding, 2010

[6] Kondapalli Siva Prasada , ChalamalasettiSrinivasa Rao , DameraNageswara Rao, Study on Weld Quality Characteristics of Micro Plasma Arc Welded Austenitic Stainless Steels, 2014

[7] I.C. Kuo, C.P. Chou, C.F. Tseng, and I.K. Lee, on Submerged Arc Stainless Steel Strip Cladding—Effect of Post-Weld Heat Treatment on Thermal Fatigue Resistance,2008

[8] WichanChuaiphan, and LoeshpahnSrijaroenpramong, EFFECT OF FILLER ALLOY ON MICROSTRUCTURE, MECHANICAL AND CORROSION Behavior OF DISSIMILAR WELDMENT BETWEEN AISI 201 STAINLESS STEEL AND LOW CARBON STEEL SHEETS PRODUCED BY A GAS TUNGSTEN ARC WELDING,2010

[9] A. S. Shahi and S. Pandey, Prediction of weakening in GMA and UGMA treated steel single layer cladding utilizing reaction surface philosophy

[10] Monika Solecka ,PawełPetrzak and Agnieszka Radziszewska, microstructure of weld overlay Ni-base composite kept on carbon steel by CMT technique, 2015

[11] [Er. Rahul Sharma, Er. ManojKumar , Dr. Abhishek, Kamboj, Hastelloy C-276Weld Overlay by SMAW Process, ISSN : 2248-9622, Vol. 7, Issue 5, (Part - 3) May 2017, pp.86-91

[12] Kushiksharma, Shailendra deva, Ravindrakumar, A Review on Cladding Process to Improve Metal Properties, ISSN: 2321-9653; I.C. Value: 45.98; S.J. Impact Factor: 6.887 Volume 6 Issue IV, April 2018

[13] H. E. Pattee, R. M. Evans, R. E. Monroe, The joining of different metals. Protection Metals Information Center, Battelle Memorial Institute, Columbus, Ohio, 1968

[14] A. L. Schaeffler, Constitution graph for tempered steel weld metal. Metal Progress, (1949) 680 - 680.

[15] L. Odegard, C. O. Pettersson, S. A. Fager, The determination of welding consumables and properties of different welded joints in the superduplex tempered steel Sandvik 2507 to carbon steel and exceptionally alloyed austenitic and duplex hardened steels. Procedures of the fourth International Conference of Duplex Stainless Steels, Glasgow, Scotland, (1994) Paper No. 94

[16] R. Kaçar, O. Baylan, An examination of microstructure/property connections in unique welds somewhere in the range of martensitic and austenitic tempered steels, Materials and Design, (2004) 317 – 329

[17] [17] A. Gural, B. Bostan, A. T. Ozdemir, Heat treatment in two stage locale and its impact on microstructure and mechanical strength subsequent to welding of a low carbon steel, Material and Design, (2007) 897 – 903

[18] Z. Boumerzoug, C. Derfouf, T. Baudin, Effect of welding on microstructure and mechanical properties of a modern low carbon steel. Designing, (2010) 502 – 506

[19] Bhanu Kiran, V.T., Krishna, M., Praveen, M. what's more, Pattar, N., Numerical Simulation of Multilayer Hardfacing on Low Carbon Steel, International Journal of Engineering and Technology, Vol.3, No.1, pp.53-63, 2011

[20] Khanna, O.P., A Textbook of Welding Technology, Dhanpat Rai and Sons Publications, New Delhi, 1994

[21] Gualco, A., Svoboda, H.G., Surian, E.S. also, de Vedia, L.A., Effect of Welding Procedure on Wear Behavior of a Modified Martensitic Tool Steel Hardfacing Deposit, Materials and Design, Vol.31, No.9, pp.4165–4173, 2010

[22] Dupont, J.N. also, Kusko, C.S., Martensite Formation in Austenitic/Ferritic Dissimilar Alloy Welds, Welding Journal, Vol.1, pp.51-54, 2007

[23] Bhanu Kiran, V.T., Krishna, M., Natraj, J.R. also, Kumar, S., Development and Characterization of an Electrode Deposition Procedure for Crack-Free Hardfacing of Low Carbon Steel, International Journal of Engineering and Technology, Vol.4, No.1, pp.95-106, 2012

[24] Krishnaprasad, K. also, Prakash, R.V., Fatigue Crack Growth Behavior in Dissimilar Metal Weldment of Stainless Steel and Carbon Steel, International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering, Vol.3, No.8, 1016-1022, 2009.

[25] Pawlowski, L., Thick Laser Coatings: A Review, Journal of Thermal Spray Technology, Vol.8, No.2, pp.279-295, 1999

[26] Vilar, R., Laser Alloying and Laser Cladding, Material Science Forum, Vol.301, pp.229-252, 1999.

[27] Lee, J.W., Nishio, K., Katoh, M., Yamaguchi, T. also, Mishima, K., The Performance of Wear Resistance Cladding Layer on a Mild Steel Plate by Electric Resistance Welding, Welding in the World, Vol.49, No.9/10, pp.94-101, 2005.

[28] P.K. Miniappan, V.V. Arun Shankar, A. Saiyath Ibrahim, CLADDING OF STAINLESS STEEL OVER MILD STEEL BY USING FLUX CORED ARC WELDING, 17.05.2020

[29] S. Thiyagarajan, N. Lalithkumar, S. Jeyakumar, Experimental Investigation of Process Parameters of Stainless Steel Cladding on Mild Steel Plate, IJIRSET, Vol.6, Issue 3, March 2017

[30] T. Kannan and J. Yoganandh, Effect of Process Parameters on Clad globule Geometry and Its Shape Relationship of Stainless Steel Claddings stored by GMAW, International Journal Of Advanced Manufacturing Technology (2010) 47:1083–1095,20 August 2009

[31] T. Ishida, Formation of Stainless Steel Layer on Mild Steel by Welding Arc Cladding, Journal Of Materials Science 26 (1991) 6431 6435.

[32] P.K. Palani and N. Murugan, Sensitivity Analysis For Process Parameters In Cladding Of Stainless Steel By Flux Cored Arc Welding, Journal Of Manufacturing Process, Vol. 8/No.2,2006

[33] S.X. Lv*, Z.W. Xu, H.T. Wang and S.Q. Yang, Investigation on TIG cladding of copper amalgam on steel plate Maney in the interest of the Institute 10 February 2007

[34] [34] Sivakumar, S., S. Senthil Kumaran, M. Uthayakumar, and A. Daniel Das. "Garnet and Al-flyash composite under dry sliding conditions." Journal of Composite Materials 52, no. 17 (2018): 2281-2288.

[35] Kumaran, S. Senthil, and A. Daniel Das. "An Examination of consistent ferritic tube and austenitic compound cylinder plate joining by grinding welding measure." Materials Today: Proceedings 5, no. 2 (2018): 8539-8546.

[36] Das, A. Daniel, and S. Senthil Kumaran. "FWTPET Investigation on SA213 Tube to SA387 Tube Plate." In Applied Mechanics and Materials, vol. 852, pp. 355-361. Trans Tech Publications, 2016

[37] Sellappa, S., Prathyumnan, S., Keyan, K. S., Joseph, S., Vasudevan, B.S.G., and Sasikala, K. (2010). Assessment of DNA harm acceptance and fix restraint in welders presented to hexavalent chromium. Asian Pac J Cancer Prev, 11(1), 95-100.

[38] ASM Specialty Handbook: Stainless Steels, 06398G J.R. Davis, Davis and Associates, Stainless Steel cladding and Weld overlays.

[39] L.M. Smith, "Designing with Clad Steel," NiDI Technical Series No. 10,064, Nickel Development Institute, 1992

[40] R.G. Delati, "Planning with Clad Metals," Metallurgical Materials Division of Texas Instruments, Inc.

[41] "Stainless Clad Steels," The Intemational Nickel Company, Inc., 1963

[42] H. Enockl, U. Malina-Altzinger, and H. Omig, Advantages of Duplex Clad Plates, Duplex Stainless Steels'91, Volume 1, J. Charles and S. Bemhardsson, Ed., les versions de body, 1992, p 649-655

[43] Selvan, M.C.P., Raju, N.M.S., and Sachidananda, H.K. (2012). Impacts of cycle boundaries on surface harshness in grating waterjet cutting of aluminum. Outskirts of Mechanical Engineering, 7(4), 439-444.

[44] Shanmughasundaram, P., Subramanian, R., and Prabhu, G. (2011). A few investigations on aluminum–fly debris composites created by two stage mix projecting technique. European diary of logical exploration, 63(2), 204-218.

[45] Sivanantham, A., Manivannan, S., and Shanmughasundaram, P. Impact of ATIG Welding Process Factors on the Wear Behavior of AISI 316L. Signal, 3(145), 115.

[46] Daniel Das A. "Impact of GTAW welding boundaries on mechanical properties of aluminum six-arrangement welded tests" in Journal of Advanced Research in Dynamical and Control Systems 2019, 11 (12) pp 1112-1118

[47] Daniel Das A. "Impact of TIG welding boundaries on mechanical properties of Al6063 welded tests " in Journal of Advanced Research in Dynamical and Control Systems 2019, 11 (12) pp 1119-1125

[48] D.W. Gandy, S.J. Findlan, and R. Viswanathan, Weld Repair of Steam Turbine Casings and Piping—An Industry Survey, ASME J. Press. Vess. Technol., 2001, 123(2), p 157–160

[49] A. Minister, Weld Repairs to High-Pressure Feed/Effluent Heat Exchangers, Int. J. Press. Vess. Pip., 2000, 77(2–3), p 139–145

[50] J.R. Davis, Davis and Associates, Hardfacing, Weld Cladding and Dissimilar Metal Joining. ASM Handbook-Welding, Brazing and Soldering, vol. 6, tenth edn., ASM Metals Park, OH, 1993, p 699–828

[51] K.G. Budinski, Hardfacing: An Overview of the Processes, Weld. Des. Fabr., 1986, July, p 51–57

[52] S. Chatterjee and T.K. Buddy, Weld Procedural Effect on the Performance of Iron Based Hardfacing Deposits on Cast Iron Substrate, J. Mater. Cycle. Technol., 2006, 173(1), p 61–69

[53] P. Corengia, F. Walther, G. Ybarra, S. Sommadossi, R. Corbari, and E. Broitman, Friction and Rolling-Sliding Wear of DC-Pulsed Plasma Nitrided AISI 410 Martensitic Stainless Steel, Wear, 2006, 260(4–5), p 479–485

[54] C.X. Li and T. Chime, Corrosion Properties of Plasma Nitrided AISI 410 Martensitic Stainless Steel in 3.5% NaCl and 1% HCl Aqueous Solutions, Corros. Sci., 2006, 48(8), p 2036–2049

[55] B. Gulenc and N. Kahraman, Wear Behavior of Bulldozer Rollers Welded Using a Submerged Arc Welding Process, Mater. Des., 2003, 24(7), p 537–542

[56] A.K. Bhaduri, T.P.S. Gill, S.K. Albert, K. Shanmugam, and D.R. Iyer, Repair Welding of Cracked Steam Turbine Blades Using

Austenitic and Martensitic Stainless-Steel Consumables, Nucl. Eng. Des., 2001, 206(2–3), p 249–259

[57] A.G. Olabi and M.S.J. Hashmi, Effects of the Stress-Relief Conditions on Martensite Stainless-Steel Welded Component, J. Mater. Cycle. Technol., 1998, 77(1), p 216–225

[58] Y.C. Lin and S.C. Chen, Effect of Residual Stress on Thermal Fatigue in a Type 420 Martensitic Stainless Steel Weldment, J. Mater. Interaction. Technol., 2003, 138(1), p 22–27

[59] C. Demian, A. Denoirjean, L. Pawłowski, P. Denoirjean, R.E. Ouardi, Microstructural examinations of NiCrAlY þ Y2O3 balanced out ZrO2 cermet coatings stored by plasma moved circular segment (PTA), Surf. Covering. Technol. 300 (2016) 104e109.

[60] S. Huang, D. Sun, D. Xu, W. Wang, H. Xu, Microstructures and properties of NiCrBSi/W.C. biomimetic coatings arranged by plasma splash welding, J. Bionic Eng. 12 (2015) 592e603.

[61] Y.F. Liu, Y.L. Zhou, Q. Zhang, F. Pu, R.H. Li, S.Z. Yang, microstructure and dry sliding wear conduct of plasma moved bend clad Ti5Si3 built up intermetallic composite coatings, J. Compounds Compd. 591 (2014) 251e258.

[62] J. Lin, D. Guo, Y. Lv, Y. Liu, X. Wu, B. Xu, G. Xu, B. Xu, Heterogeneous microstructure advancement in Ti-6Al-4V amalgam slim divider parts stored by plasma curve added substance producing, Mater. Des. 157 (2018) 200e210.

[63] S. Huang, D. Sun, W. Wang, H. Xu, Microstructures and properties of in-situ TiC particles built up Ni-based composite coatings arranged by plasma splash welding, Ceram. Int. 41 (2015) 12202e12210.

[64] H.T. Cao, X.P. Dong, Z. Dish, X.W. Wu, Q.W. Huang, Y.T. Pei, Surface alloying of high-vanadium high velocity steel on flexible iron utilizing plasma moved curve method: microstructure and wear properties, Mater. Des. 100 (2016) 223e234.

[65] B.S. Sidhu, D. Puri, S. Prakash, Mechanical and metallurgical properties of plasma splashed and laser remelted Nie20Cr and Stellite-6 coatings, J. Mater. Interaction. Technol. 159 (2005) 347e355.

[66] A. Mama, D. Liu, C. Tang, X. Zhang, C. Liu, Influence of gleam plasma Co-put together alloying layer with respect to sliding wear and worrying wear opposition of titanium composite, Tribol. Int. 125 (2018) 85e94.

[67] Q.Y. Hou, J.S. Gao, F. Zhou, Microstructure and wear qualities of cobaltbased compound kept by plasma moved circular segment weld surfacing, Surf. Covering. Technol. 194 (2005) 238e243.

[68] J. Shin, J. Doh, J. Yoon, D. Lee, J. Kim, Effect of molybdenum on the microstructure and wear opposition of cobalt-baseStellitehardfacing compounds, Surf. Covering. Technol. 166 (2003) 117e126.

[69] M.S. Sawant, N.K. Jain, Investigations on wear qualities of Stellite covering by miniature plasma moved curve powder testimony measure, Wear 378e379 (2017) 155e164.

[70] G.P. Rajeev, M. Kamaraj, S.R. Bakshi, Hardfacing of AISI H13 device steel with Stellite 21 composite utilizing cold metal exchange welding measure, Surf. Covering. Technol. 326 (2017) 63e71.

[71] Z. Chang, J. Gong, C. Sun, Co-based nebulous/nanocrystalline composite coatings saved by bend particle plating, J. Mater. Sci. Technol. 29 (2013) 806e812.

[72] F.Y. Shu, L. Wu, H.Y. Zhao, S.H. Sui, L. Zhou, J. Zhang, W.X. He, P. He, B.S. Xu, Microstructure and high-temperature wear component of laser cladded CoCrBFeNiSi high-entropy combination shapeless covering, Mater. Lett. 211 (2018) 235e238.

[73] W. Li, P. Xu, Y. Wang, Y. Zou, H. Gong, F. Lu, Laser combination and microstructure of miniature and nano-organized W.C. built up Co-put together cladding layers with respect to titanium composite, J. Amalgams Compd. 749 (2018) 10e22.

[74] A. Arvanitaki, B.J. Briscoe, M.J. Adams, S.A. Johnson, The rubbing and grease of elastomers, Tribol. Ser. 30 (1995) 503e511.

[75] X. Hong, Y.F. Tan, C.H. Zhou, T. Xu, Z.W. Zhang, Microstructure and tribological properties of Zr-put together nebulous nanocrystalline coatings stored with respect to the outside of titanium composites by electrospark testimony, Appl. Surf. Sci. 356 (2015) 1244e1251.