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A Review of Cold Metal Transfer Welding's Analysis of Joints

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Abstract: Metal to Cold Transfer Welding is a distinctive method of the welding process that has changed the way we view welding. Because it has a minimal heat input and is stable and spatter-free. It also provides a fast welding speed. Low heat input causes the intermetallic layer and Heat Affected Zone to thin down. High tensile strength and a fair percentage of elongation are the results. In this technique, fine granules are seen. High Hardness results from the observation of fine granules. In this procedure, porosity is kept to a minimum. In this technique, slag production and fumes are decreased. Faster solidification and rapid cooling are both seen. After solution treatment and age treatment, CMT welded joints performed well in terms of tensile strength, hardness, and microstructure. When EMF was used, our tensile strength improved. Rapid prototyping, 3D printing, hard facing, overlay, cladding, turbines, casting die restoration, and stack building in electric vehicles are among areas where CMT has found use. Overall, the procedure is entirely digital.

Keywords: Hardness, Age Treatment, Tensile Strength, Solidification, Welding

I. INTRODUCTION

The filler wire is integrated into the machine during the CMT welding process, which Fronius first developed in 2004. Comez and Durmus investigated the mechanical and microstructural characteristics of aluminium alloy under various heat inputs [1]. By using the CMT technique, Cao et al linked mild steel and aluminium alloys. They investigated the Taguchi approach, which optimises the welding variables, utilising orthogonal experiments. They discovered that the most important factor influencing the welding process was the wire feed rate [3]. The macrostructure and microstructure of AA6061 were studied by Kumar et al. He also looked at AA6061's Techno-Economic Evaluation [6]. Balamurugan et al. used cold metal transfer welding to conduct similar welding on AA6082-T4 alloys [7]. The impact of filler content and process factors on the intermetallic layer of the aluminum-steel joint was researched by Silvayeh et al. [8]. Metals AA6061 and AA7075 were welded differently by Comez and Durmus [10]. In steels with zinc coatings, Ahsan et al. explored the mechanism of porosity creation [11]. Irizalp et al. looked into the mechanical and microstructural characteristics of AA1050 [12]. According to Chen et al's research [13], wire feed rate, wire deposition rate, average droplet size, and boost duration and current are all significant factors. Li et al used a cold metal transfer technique to fuse titanium alloy to stainless steel [14]. Similar welding of S.S. 202 using the Cold Metal Transfer technique was carried out by Gupta and Yuvaraj [15]. Singh et al. evaluated the cold metal transfer process's ability to fuse dissimilar junctions made of dual phase steel and aluminium alloy [16]. Samantha et al. investigated the impact of welding speed on the mechanical characteristics and corrosion behaviour of an aluminium and steel dissimilar junction [17]. Spot welding Al6061 and DP590 was carried out by Du et al using the cold metal transfer technique. [18]. Yang et al [19] conducted welding on steel with zinc coating and aluminium alloy. Cold metal transfer welding was used by Feng et al to join aluminium and copper in a different manner [20]. Cold metal transfer welding of aluminium alloy and galvanised steel was carried out by Niu et al. [21]. Various case studies are conducted to provide insight into the mechanical and microstructural characteristics of various joints created using the CMT technique. These case studies have demonstrated the viability of CMT welding in joining different and comparable metals, demonstrating its strength in comparison to other welding processes.

II. OVERVIEW OF THE PROCESS

(1). The Peak Current phase: At first, constant voltage and high current are supplied. Due to the welding arc's high starting current, the wire electrode is heated and ignited.

(2). Background Current Phase: During this phase, the current is reduced and a little globule of molten material is forming on the wire tip. As a result, the current is reduced to move the molten globule, and it stays there until a short circuit is detected.

(3). Phase of Short Circuit: During this phase, a short circuit is detected, which causes the molten globule that was at the filler wire's tip to transfer to the workpiece. In this manner, the short-circuit transmission occurs without any current.

III. DIFFERENT CASE STUDIES

[1]. Comez and Durmus investigated how AA5754 and AA7075 were welded differently. In order to weld, three different heat inputs were used. In the Weld Zone and Partially Melted Zone, it has been shown that small holes develop at low heat input and huge pores at high heat input. The HAZ of AA5754 Base Metal's grain coarsened as the heat input increased. The AA7075 Base Metal's Partially Melted Zone also saw grain coarsening as a result of the increased heat input. AA5754's HAZ is smaller than AA7075's. Because of this, AA7075's Heat Affected Zone Hardness is higher than AA5754's. As heat input increases, tensile strength declines. There was a fracture in the HAZ of AA5754. As heat input increases, the rate of corrosion reduces.

Maximum corrosion was seen when little heat was applied [1].

[2] Durmus and Comez investigated the cold metal transfer technique for welding AA5754 and galvanised steel. Two samples were examined using various amounts of heat. In the Heat Affected Zone of AA5754, grain coarsening occurred as a result of an increase in heat input. Between AA5754 and the galvanised steel barrier, a thin, black intermetallic layer is created that is primarily composed of the Al-Fe phase. In samples with increasing heat input, there was more material loss seen. After welding, residual stresses develop, leading to corrosion stress cracking, which lowers the joint's strength. Corrosion rate has been impacted by MgZn2 precipitates. The MgZn2 samples' material loss and corrosion resistance are both worsened by the change in MgZn2 size and distribution. Finally, it was found that samples with thinner intermetallic layers had better tensile strengths [2].

[3]. The welding of an aluminium alloy to galvanised steel was researched by Cao et al. By using the Orthogonal Array approach, an experiment design was carried out to optimise the welding variable. To investigate the role of welding variables in the welding process, 27 welding tests were conducted. Wire feed rate was one of the welding variables that was examined. Welding parameters include speed, wire type, deviation distance, coating thickness, and others. The kind of wire used was shown to have the greatest influence on the welding variable, contributing 48.92%, followed by the wire feed rate, contributing 19.35%. Due to its chemical makeup, the type of wire utilised in the welding process was more important than wire feed rate. Additionally, it was shown that by reducing the heat input, the Heat Affected Zone narrows, increasing the joint strength. The thickness of the intermetallic layer has an inverse relationship with the heat input. Finally, it was discovered that joint strength is increased when the thickness of the intermetallic layer is decreased [3].

[4] Comez and Durmus investigated cold metal transfer welding of AA5754 to galvanised steel. Differences between the two applied heat inputs were noted. While the grains of galvanised steel remained same, the grains of aluminium base metal grew coarser. Due to low heat input, the HAZ of both base metals was limited; nevertheless, it was visible with high heat input. At low heat input, the intermetallic layer thickness was thinner; at high heat input, it was thicker. AlFe phase made up the intermetallic layer. Superior hardness and high tensile strength were noted at the intermetallic layer as a consequence of the intermetallic layer's increased thickness as a result of high heat input. Due to the creation of pores, the intermetallic layer fractured [4].

[5]. Cold Metal Transfer welding of AA5754 was examined by Durmus and Comez. Differences between the four applied heat inputs were found. While comparatively big holes were seen at high heat input at the weld surface, small pores were seen at low heat input in the weld root but did not appear at the top surface. The pores at the weld root had time to rise to the surface at the weld joint with higher heat input because solidification is completed there for a longer period of time than it would have in the weld joint with lower heat input. Due to the high heat input, the base metal of AA5754's HAZ experienced grain coarsening. At low heat input, tensile strength was higher, while at high heat input, it was lower. Fine dimples were seen at AA5754 Base Metal, indicating a fracture there. Finally, it was discovered that the samples' bending strength reduced as heat input increased [5].

[6]. Similar welding of AA6061 was done by Kumar et al using cold metal transfer welding. It has been shown that welding speed decreases as heat input increases. At both low and high welding speeds, we achieved impressive penetration depth and excellent weld width. As welding current increases, the reinforcement height lowers. The rate of cooling reduces as the feed rate rises. Low heat input and high welding speed result in low porosity density [6].

Balamurugan et al. carried out [7]. Cold Metal Transfer welding was used to conduct similar welding on AA6082-T4 alloys. There were three distinct heat inputs, and differences were seen. It was discovered that fast welding speed and low heat input resulted in the greatest tensile strength. With little heat input and a high welding speed, the maximum percentage of elongation was achieved. Low welding speed and strong heat input produced the lowest percentage of elongation. Furthermore, it was discovered that high welding speed and moderate heat input resulted in the lowest hardness. High heat input and low welding speed were used to achieve the maximum hardness. The cause is believed to be an increase in heat input, which promoted martensite production in the Heat Affected Zone and increased HAZ hardness. The Weld Zone suffered a fracture [7].

Silvayeh et al. studied cold metal transfer welding of aluminium alloy and galvanised steel in their study [8]. With various contents, six fillers were utilised. Robacto500 and CMT Braze+ were the utilised torches. It was shown that

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increasing the heat input causes the thickness of the intermetallic layer to rise. Additionally, it was discovered that the areas where the filler material's silicon concentration was higher were where thinner IMCs developed. The explanation is that the silicon element affects or inhibits the width of IMCs. In the end, they discovered that the IMCs Width has very little possibility of being influenced by the distance between the torch and the workpiece. Additionally, the CMT Braze +torch is superior to the Robacta 500 torch. When compared to the CMT Braze+ torch, the Robacto500 torch produced longer needle-shaped particles and IMCs that were thicker [8].

[9]. Comez and Durmus explored the same cold metal transfer welding of AA6061. Differences between the three applied heat inputs were found. When welding speed was raised, it was found that weld size reduced. At intermediate heat input, pores were seen. Due to the considerable heat input, grain coarsening happened in the Heat Affected Zone. At modest heat input, fine grains were seen in the Heat Affected Zone. Tensile strength increased with fine grain content whereas it dropped with coarse grain content. High welding speeds and low heat input result in a narrowing of the heat affected zone. As heat input increases, tensile strength falls. Low heat input was used to observe maximum Joint efficiency. Finally, it was discovered that the highest rate of corrosion happened at low heat input and the lowest rate occurred at high heat input [9].

[10]. Comez and Durmus used Cold Metal Transfer Welding to execute different welding on the metals AA6061 and AA7075. Differences between the three applied heat inputs were found. At low heat input, the production of pores was minimal, but at high heat input, the formation of pores was maximal. Grain coarsening occurred in the Heat Affected Zone of the weld metal as a result of increased heat input. Lower heat input led to the observation of fine grains. It has long been understood that increasing heat input both increases porosity and pore size. In the current investigation, elongated dendritic grains were produced by increasing heat input, which also caused the partly melted zone to extend. Fine grains were seen in the partly melted zone with low heat input. Al-Fe phase-containing intermetallic layers of varying thickness were discovered. Due of the small grain structure in the HAZ, maximum hardness was achieved with minimal heat input. Due of grain coarsening, the HAZ achieved minimum hardness at high heat input. Tensile strength decreased as heat input increased. At the base metal AA6061, there was a fracture. Finally, it was discovered that the corrosion rate rose when welding heat was raised. Low heat input led to the observation of pitting corrosion. At high heat input, pitting and intergranular corrosion occurred [10].

[11]. Similar welding of steel plates using the Cold Metal Transfer technique was done by Ahsan et al. They discovered that the composition of the wire's elements affects how much slag forms. Differences between the three different wires' chemical compositions were observed. It was found that the amount of slag was determined by the silicon and manganese content of the wire. When the filler wire's silicon and manganese contents were at their maximum, the most slag was produced during the welding process. When silicon and manganese concentrations were at their maximum, the bead cross-section had the longest legs and the least amount of reinforcing. However, the shortest leg length and most bead reinforcing were noted when silicon and manganese contents were lowest [11].

Irizalp et al. used cold metal transfer welding to weld AA1050 [12]. Due to the extreme suppression of bubble initiation and development, it has been found that materials with rapid cooling rates have low porosities. Additionally, the porosity is low at modest cooling rates because liquid bubbles have time to escape. However, the amount of porosity is significant at moderate cooling rates because the weld pool's bubbles were neither repressed nor given enough time to escape. Fine grains were seen as a result of the quick cooling that was seen due to the minimal heat input. At the modest heat input, the tensile strength reached its maximum. Due to little heat input, the HAZ has the highest hardness. The HAZ of the aluminium base metal experienced failure [12].

[13]. Chen et al. researched welding mild steel Q-235 in a bead-on-plate setup. The two primary variables that have the greatest influence on the entire process are the boost current (Ib) and boost period (tb). The stability of the CMT process was most strongly influenced by the boost time (tb), whilst the boost current had only a minor impact. Boost time and Boost Current have no impact on CMT's transfer frequency. They also discovered that when boost current and boost duration grew, welding power did as well. They discovered that when boost current and duration rose, the rate at which wire melted also increased, which in turn enhanced the rate at which material deposited. The most significant influences on weld size are the boost current and boost period. The depth of penetration and weld width increased with increasing boost current (Ib) or boost period (tb), while reinforcement height varied little [13].

[14]. Li et al. used a cold metal transfer technique to fuse titanium alloy to stainless steel. The differences between the four different heat inputs were noticed. In the fusion zone, spherical precipitate-like particles were seen. With more heat applied, these particles got coarser and more erratic. Fe and Cu particles make up the majority of these particles. At the interface with high input, the Ti-Cu IMCs were produced. Due to strong heat input from IMC production at the Ti-Cu interface, the micro-hardness increased. With more heat input, the joint's shear strength diminishes. It was shown that the wetting angle decreases as heat input increases. At low heat input, the Ti-Cu IMCs experienced fracture; at high heat input, the Fusion Zone experienced fracture [14].

[15]. Similar S.S. 202 cold metal transfer welding was carried out by Gupta and Yuvaraj. There were three distinct heat inputs, and the variations were documented. The Taguchi Method was used to optimise the process using quadratic regression. A numerical metric called the signal to noise ratio may be used to calculate the yield stress, ultimate

strength, and % elongation. The percentage of elongation, ultimate strength, and yield stress are all better when the signal to noise ratio is higher. At 120 A and 3 mm/sec welding speed, the ultimate tensile strength was at its highest. Maximum Yield Stress was achieved at 100 A and 4mm/sec of welding speed. Percentage Elongation was greatest at 100 A and 4 mm/sec welding speed [15].

[16]. Cold metal transfer welding of AA5052 and DP780 was carried out by Singh et al. They investigated the impact of the wire feed rate to welding speed ratio on the stability of the arc and its properties. There were three types of filler wire used: Pure Al, AlSi5, and AlSi12. With varying wire feed rates and welding speeds, the bead profile changed. At the highest wire feed rate to welding speed ratio, the maximum bead width was seen. Lowest wire feed to welding speed ratio resulted in lowest bead width. The porosity in the fusion zone was impacted by the filler wire's Si content. Due to porous oxides that are present on the base metal's surface, pores might form. FeAl3 and Fe2Al5 intermetallic layers were found. The intermetallic layer's ability to develop was hindered by the filler wire's Si content. Low wire feed rate to welding speed was shown to be stable. Due to a thicker intermetallic layer, joints welded with Pure Al filler wire demonstrated lower failure loads. The junction where AlSi12 filler wire was used to weld showed the highest failure load. Due to HAZ softening, micro-hardness was at its lowest near the base metal's HAZ. The joint's microhardness was determined by the Si concentration. The micro-hardness of the joint increases with Si concentration. At the Interface, there was a fracture. Brittle intermetallic layer was the cause of the fracture [16].

[17]. The effects of welding speed on the mechanical behaviour and corrosion resistance of a dissimilar junction made by cold metal transfer welding and 19000 Al alloy and galvanised steel were explored by Sravanthi et al. Two samples were joined together using various welding heat inputs and speeds, and differences were found. Weight loss was seen after the samples were later subjected to a NAOH solution and nitric acid. There were two weld interfaces seen. IMCs of the Al-Si-Fe phase were seen at both interfaces. Al3FeSi2 and Al5FeSi were created. Interaction between welding beads and steel and aluminium. At the weld bead-steel contact, inter-granular corrosion was seen. At the Al-Welding bead contact, there was excessive pitting seen. The examination of weight reduction was then done. According to the results, samples with lower weld speeds and higher heat inputs lost the most weight, whereas samples with higher weld speeds and lower heat inputs lost the least weight, suggesting that the samples with higher heat inputs were more susceptible to corrosion. IMCs width increased and ultimate tensile strength dropped in the sample with high heat input, whereas IMCs width rose and ultimate tensile strength increased in the sample with low heat input [17].

[18]. Spot welding Al6061 and DP590 was carried out by Du et al using the cold metal transfer technique. The Taguchi Method's orthogonal test was used to optimise the process. Wire feed rate, Arc length correction, and welding speed were the factors that worked well. An orthogonal test revealed that the welding process was most significantly influenced by the wire feed rate, followed by arc length correction and welding speed. When welding was carried out at these ideal conditions, it was shown that the droplet was evenly dispersed and covered and that the tensile strength was ideal. The nugget grows bigger and the droplet spreads more uniformly as the heat input increases. The diameter of the plug grows as the wire feed rate rises, but the plug's height gradually lowers. Joint strength falls and intermetallic layer thickness decreases as wire feed rate rises [18].

[19]. Yang et al. performed welding on steel that was coated with zinc and aluminium alloy. It was addressed how pre-setting gap and offset distance affected the welding process. Three distinct offset distances and four different pre-setting gaps were employed. When the pre-setting gap was increased, it was found that the wetting angle reduced and the length of the bonded line increased. Due to enhanced wetting behaviour and a decreased absence of Fusion, the tensile strength rose as the Pre-setting gap widened. Wetting angle and bonded line length reduced when Offset distance was increased. The bonded line length dropped when the offset distance was raised because the deposition time marginally reduced along with the spreading of the molten metal. There were two different failures. The base metal's heat-affected zone experienced the first failure. Heat caused HAZ to soften, which led to a failure in that area. The second breakdown happened where the steel with zinc coating and the aluminium alloy met. The intermetallic layer was similarly impacted by the pre-setting gap [19].

[20]. Cold metal transfer welding was used by Feng et al to join aluminium and copper in a dissimilar way. There were 6 distinct heat inputs used. the impact of heat input on the joint's mechanical characteristics and microstructure. The Cu at the weld-Cu interface melts more as heat input increases, and the Al-Cu intermetallic layer thickens and becomes more fragile. When a result, as the heat input increases, the mechanical qualities weaken. Al-Cu and -Al phases that are equally sized make up the weld zone. Al2Cu makes up the majority of IMCs. Because the intermetallic layer thickened with increased heat input, the tensile strength decreased. Fractures of two different sorts were seen. The Heat Affected zone experienced the first kind of fracture, whereas the Weld/Cu contact experienced the second type [20].

[21]. Cold metal transfer welding was done by Niu et al. on aluminium alloy and galvanised steel. Zinc was applied to galvanised steel. The differences between the seven distinct currents were recorded. Comparisons between the two distinct fillers, ER4043 and ER4047, were made. It was found that the wetting angle reaches its greatest without the zinc coating and as the current increases, which causes the bonded line length to be the shortest and the tensile strength to diminish. Wetting angle reduced as current was increased when a zinc coating was applied. And as welding current grew, so did the length of the bonded line. This happened because as the current grew, the wire's fluidity increased.

When ER4043 was used with the same current, the wetting angle was lower than when ER4047 was utilised. ER4043 produced a shorter bonded line than ER4047. Because of this, ER4047's wet ability when combined with it was lower than ER4047's. IMCs from the Al-Fe-Si phase developed close to the joint contact. The tensile strength decreased with higher welding current whether ER4043 or ER4047 was used. Near the joint's contact, there was a fracture [21].

[22]. Pickin and Young investigated a typical CMT cycle. The CMT cycle comprises two phases: the first is the arching phase, and the second is the short circuit phase. The beginning of the arching phase begins with a strong current pulse during which the stuck molten globule begins to separate. With a decrease in welding current, the short circuit phase begins, and the molten globule separates.

Pickin and Young found out that the duration of Arching Phase and Short Circuit phase plays the major role in CMT process. Degree of penetration is in linear relationship with the current. By controlling the short circuit duration under given heat input, wire feed rate can be controlled which in turns controls the depth of penetration. When short circuit duration is increased degree of penetration is decreased. It is a low thermal Input Process [22].

[23]. Li et al studied the dissimilar welding of Ti alloy and stainless steel by Cold metal transfer welding. When it involves the microstructure the Ti-Cu interface line is uniform, regular and straight. The weld width was increased and wetting angle decreased with increasing heat input. So heat input had impacted weld shape. Under modest heat input, several little spherical particles are seen. The particles get coarser and more erratic as the welding current increases. Fe and Cu are the two primary spherical particles. The Ti-Cu IMCs are further found with high-intensity input. $CuTi_2$, Cu_2Ti_3, and Cu_4Ti_3 are these. At high heat input, the microhardness at the Ti-Cu contact was at its highest. The IMC layer's micro-hardness rises at the Ti-Cu contact. At greatest heat input, the joint's lowest tensile strength was observed. Low heat causes the fracture to develop at the Ti-Cu contact. The fracture near the Ti-Cu contact is caused by the IMCs [23].

IV. SOLUTION TREATMENT AND ARTIFICIAL AGE TREATMENT

The sample was heated to 530°C in a furnace for 45 minutes as part of the solution treatment, and then it was quenched in water. The sample was once again heated in the furnace for 8 hours at 175°C to simulate artificial ageing. The mechanical and microstructural characteristics of the Solution treatment and the Artificial Age treatment were compared. In the Heat Affected Zone (HAZ) of Solution treatment and artificial age treatment samples, it was found that the average grain size was 7.12 m and 5.34 m, respectively. Samples from the Solution treatment had bigger grains on average than samples from the Age treatment. The hardness of HAZ in samples treated with artificial age is 67% higher than in samples treated with solution. For samples that underwent solution treatment, the reduction in hardness was caused by the coarsening of the grains due to the high temperature. Due to the high temperature, the tensile strength, yield strength, and percentage elongation reduced in samples treated with solution as well as those treated with artificial ageing. However, samples that had been artificially aged had greater tensile and yield strengths than those that had undergone solution treatment. This is owing to the refined and fine grains of samples that have undergone artificially aged treatment [23].

V. RECENT TRENDS AND APPLICATION

(1) MIG repair, first. Cold Metal Transfer Process weld junctions

Repairing MIG Welded joints using the Cold Metal Transfer procedure revealed differences. When compared to the heat-affected zone of MIG, the repaired area showed fine grain structure. Due to the low heat input of the cold metal transfer method, the repaired heat affected zone is narrower than the unrepaired heat affected zone. Because of this, the hardness of the heat-affected zone after repair is superior to the heat-affected zone. Due to this, when welded joints were repaired using the cold metal transfer procedure, the fracture propagation resistance also increased. There were torn edges and a few tiny dimples in the heat-affected area. The deeper dimples are greater and more frequent in the corrected heat-affected zone. As a result, the heat-affected zone after repair has heat-affected zone's lower fracture toughness. Overall, the Cold Metal Transfer method performed better than MIG welding to repair the junction [24].

(2). Cladding, Hard-facing, and Overlay Using Cold Metal Transfer

(3). Using the cold metal transfer process to join stacks of electrical steel sheets

(4). Quick Prototyping using Cold Metal Transfer

(5). Cold Metal Transfer Process for Wire Arc Additive Manufacturing

(6). Repairing the Gas Turbine Engine Combustors' Fuel Nozzle using a Cold Metal Transfer Process

VI. APPLICATION OF EXTERNAL MAGNETIC FIELD ON COLD METAL TRANSFER WELD

Through two annular coils that were used to link the work piece and welding torch, EMF was applied. It was discovered that an external magnetic field had an impact on the cold metal transfer joint's microstructure, which in turn affected the joint's tensile strength. The weld surface seems to have wave-like features when EMF is applied.

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Additionally, it was noted that the IMC layer was lowered to 1 m when EMF was applied, increasing the joint's tensile strength [28].

VII. CONCLUSIONS

1. Due to the low heat input technique, fewer emissions and splatter were seen.
2. The thickness of the intermetallic layer was lower than with traditional welding.
3. Fine grains were seen as a result of the low heat input, and a greater tensile strength was discovered.
4. Micro-hardness was increased as a result of a narrower HAZ. This outcome is related to a little heat input.
5. In the CMT process, the porosity density and corrosion rate were the lowest.
6. The mechanical characteristics of the joint were enhanced by Solution Treatment and Age Treatment.
7. CMT has shed light on a number of applications, including weld joint repair, overlay, hard-facing, and cladding.

REFERENCES

[1] Nilay ÇÖMEZ, Hülya DURMUŞ, Corrosion behavior and mechanical properties of cold metal transfer welded dissimilar AA7075-AA5754 alloys, J. Cent. South Univ. (2020) 27: 18−26

[2] Hülya DURMUŞ, Nilay ÇÖMEZ, Investigation of Corrosion Resistance of Cold Metal Transfer Welded AA7075 Aluminum Alloy Galvanized Steel Couples MSU J. of Sci., Volume 7, Issue 1, p 639-644

[3] R.Cao, Gang Yu, J.h Chen, Pei Chung Wang, Cold Metal Transfer joining Aluminum Alloys to Galvanised Mild Steel, Journal of Materials Processing Technology 213 (2013) 1753 – 1763

[4] Nilay Çömeza, Hülya Durmuş, Consideration of cold metal transfer welding Of Aa5754 to Galvanized Steel from Mechanical and Micro structural Aspects, Revista De Metalurgia 54(1), January– March2018, E115, Issn-L: 0034-8570. Https://Doi.Org/10.3989/Revmetalm.115

[5] Hulya Durmuş, And Nilay Çömez, Mechanical Properties Of Aa5754 Sheets Welded By Cold Metal Transfer Method , Technological Applied Sciences (Nwsatas), 2a0124, 2017; 12(4):170 - 177.

[6] N Pavan Kumar, S Arungalai Vendan, N. Siva Shanmugam, Investigations On The Parametric Effects Of Cold Metal Transfer Process On The Micro structural Aspects In Aa6061, Journal Of Alloys And Compounds (2015), Doi: 10.1016/J.Jallcom.2015.10.166.

[7] S. Balamurugan, R. Ramamoorthi, I.K. Kavin Jeysing, S. Kumar, I. Mohammed Sharukhan, G. Muthu Prakash And S. Madhan, Indian Journal Of Science And Technology, Vol 12(42), Doi: 10.17485/Ijst/2019/V12i42/143273, November 2019

[8] Zahra Silvayeh, Rudolf Vallant, Christof Sommitsch, Bruno Gotzinger, Werner Karner, And Matthias Hartmann, Influence Of Filler Alloy Composition And Process Parameters On The Inter metallic Layer Thickness In Single-Sided Cold Metal Transfer Welding Of Aluminum-Steel Blanks, Metallurgical And Materials Transactions A.

[9] Nilay Çömez, Hülya Durmus, Effect Of Heat Input On The Microstructure, Strength And Corrosion Behavior Of Sheets Of Alloy Aa6061 After Cold Metal Transfer Welding, Metal Science And Heat Treatment, Vol. 61, Nos. 7 – 8,November, 2019

[10] Nilay Çömez, Hülya Durmuş, Cold Metal Transfer Welding Of Aa6061 to Aa7075: Mechanical Properties and Corrosion Journal Of Engineering Materials And Technology. Received December 08, 2017.

[11] Md. R.U. Ahsan, Muralimohan Cheepu, Tae-Hoon Kim, Chanyoung Jeong, Yeong -Do Park, Mechanisms of Weld Pool Flow and Slag Formation Location In Cold Metal Transfer (Cmt) Gas Metal Arc Welding (Gmaw), Weld World.

[12] Irizalp, A.O.; Durmus, H.;Yuksel, N.; Turkmen, Cold Metal Transfer Welding Of Aa1050 Aluminum Thin Sheets, I. Revista Matéria, V. 21, N. 3, Pp. 615 – 622, 2016.

[13] Maoai Chen, Dong Zhang, Chuansong Wu, Current Waveform Effects On Cmt Welding Of Mild Steel, Journal Of Materials Processing Technology 243 (2017) 395–404

[14] Gang Li, Shengyu Xu, Xiaofeng Lu, Xiaolei Zhu, Jufeng Song, And Yupeng Guo, Microstructural Evolution And Mechanical Properties Of Ti Alloy/Stainless Steel Lap Joints During Cold Metal Transfer Technique With Cusi3 Filler Wire Journal Of Materials Engineering And Performance.

[15] Prasanna Gupta & N. Yuvaraj, Parametric Optimization Of Cold Metal Transfer Welding Process On Aisi 202 Austenitic Stainless Steel, International Journal Of Mechanical And Production Engineering Research And Development (Impart) Vol. 10, Issue 3, Jun 2020, 12713–12724.

[16] Jaivindra Singh & Kanwer Singh Arora, Nikhil Shajan, Mahadev Shome, Dinesh Kumar Shukla1influence Of Wire Feed Rate To Speed Ratio On Arc Stability And Characteristics Of Cold Metal Transfer Weld–Brazed Dissimilar Joints, The International Journal Of Advanced Manufacturing Technology (2020).

[17] S. S. Sravanthi, Swati Ghosh Acharyya, K.V. Phani Prabhakar & Joydip Joardar (2019): Effect Of Varying Weld Speed On Corrosion Resistance And Mechanical Behavior Of Aluminium - Steel Welds Fabricated By Cold Metal Transfer Technique, Materials And Manufacturing Processes, Doi: 10.1080/10426914.2019.1605180

[18] Guodong Du, Yanfeng Xing, Chuanya Yin Process Optimization Of Cold Metal Transfer Plug Welding Of Aluminum Aa6061-T6-To- Galvanized Dp590 Steel Based On Orthogonal Experiment Method, Materials Science (Medžiagotyra). Vol. 25, No. 2. (2019) Pg (207- 213).

[19] Shanglu Yang, Jing Zhang, Jin Lian, Yongpin Lie, Welding Of Aluminum Alloy To Zinc Coated Steel, Materials And Design 49 (2013) 602–612

[20] Jicai Feng, Yibo Liu, Qingjie Sun, Jinping Liu, Laijun Wu, Microstructures And Properties Of Aluminum–Copper Lap-Welded Joints, Advanced Engineering Materials 2015

[21] Song Niu, Su Chen, Honggang Dong, Dongsheng Zhao, Xiaosheng Zhang, Xin Guo, And Guoqiang Wang, Microstructure And Properties Of Lap Joint Between Aluminum Alloy And Galvanized Steel By Cmt, Journal Of Materials Engineering And Performance ,
Volume 25(5) May 2016 Pg 1839–1847

[22] R. Ahmad, M.A Bakar, Effect Of Post Weld Heat Treatment On The Microstructure And Mechanical Properties Of Aa6061 By Cold Metal Transfer, Materials And Design 32 (2011) Pg 5120–5126

[23] S. Prakash, R. John Felix Kumar, S.Jerome, Effect Of Heat Treatment On Microstructure And Mechanical Properties Of Cmt Welded Aluminium Alloy 2024, Materials Today: Proceedings 5 (2018) 26997–27003

[24] Bangjian Yang, Zhenghong Fu, Ting Li, Meile Shan, Kang Guo, Bing Chen, Wei Lu, Guoqing Gou And Wei Gao, Microstructure And Fracture Toughness Properties Of Cmt Repairing Welded 7075-
T651 Mig Welding Joint, Mater.Res.Express6(2019)1265d6

[25] G.P. Rajeev, M. Kamaraj, Srinivasa R. Bakshi , Hardfacing Of Aisi H13 Tool Steel With Stellite 21 Alloy Using Cold Metal Transfer Welding Process, Surface & Coatings Technology(2017),
Doi:10.1016/J.Surfcoat.2017.07.050

[26] C. G. Pickin And K. Young, Evaluation Of Cold Metal Transfer (Cmt) Process For Welding Aluminium Alloy, Science And Technology Of Welding And Joining 2006 Vol 11 No 5 Pg 583 - 585.

[27] Gang Li, Shengyu Xu, Xiaofeng Lu, Xiaolei Zhu, Jufeng Song, And Yupeng Guo, Microstructural Evolution And Mechanical Properties Of Ti Alloy/Stainless Steel Lap Joints During Cold Metal Transfer Technique With Cusi3 Filler Wire, Journal Of Materials Engineering And Performance.

[28] Yibo Liu, Qingjie Sun, Jinping Liu, Shijie Wang, Jicai Feng, Effect Of Axial External Magnetic field On Cold Metal Transfer Welds Of Aluminum Alloy And Stainless Steel, Materials Letters 152 (2015) Pg 29-31

[29] Akshay Rokade,[1]* Sachin Ambade[2], and Chetan Tembhurkar [3] Intl. J. Engg. Sci. Adv. Research 2021 December; 7(4): 10-15