International Journal of Computational and Experimental Science and Engineering
(IJCESEN)
Vol.3-No.2 (2017) pp. 26-28
http:/iakkurt.dergipark.gov.tr/ijcesen

***ISSN:* 2149-9144**

Research Article

Investigation of Mechanical Properties of Aluminum 5754-7075 Alloys Joined by Cold Metal Transfer by Using Different Gas Pressures#

Ugur ÖZSARAÇ[1]*, M. Emin UNAT[1], Faruk VAROL[2], Şafak IŞIK[1], Cengiz ÖZDEMİR[1], Salim ASLANLAR[1]

[1]Sakarya University, Department of Metallurgical and Materials Engineering, 54187, Sakarya-Turkey
[2]Sakarya University, Vocational School of Karasu, 54030, Sakarya-Turkey

* Corresponding Author : ozsarac@sakarya.edu.tr

(First received 25 November 2016 and in final form 20 May 2017)

Presented in "3rd International Conference on Computational and Experimental Science and Engineering (ICCESEN-2016)"

Keywords
Cold metal transfer
Aluminum 7075-5754
Tensile strength

Abstract: In this study, Aluminium 5754-7075 plates in 2.0 mm thickness were joined by magnesium-based (AlMg5) wire in cold metal transfer (CMT) technique. The specimens were prepared in butt joint form. Argon was used as shielding gas and joining operations were done with 20o working angle. Joining operations were done with four different gas pressures as 10, 12 14, 16 l/min. After that, tensile properties of joints were determined and macro-structures of joints were investigated in order to see the joinability of aluminium 5754-7075 alloy by CMT (cold metal transfer) technique. Finally, the micro-hardness values of specimens were measured.

1. Introduction

Demands for the special goods are increased in various industrial areas such as automotive, aerospace and space technology, marine and other sectors [1]. For their good mechanical properties Al and its alloys are being used today [2]. They have a wide range of usage in ship building, automotive sector, chassis, axle and inner panel applications [3]. As a result of various studies, CMT (cold metal transfer) joining method was developed by Fronius company in 2004 in order to join the aluminium/steel dissimilar materials. The joining of them requires precise knowledge of the properties of each material. Aluminium is highly regarded due to its low specific weight and its excellent usability and processing characteristics. On the other hand, its strength and low cost make steel indispensable in many areas of industry. Other requirements primarily address anti-corrosion features, thermal expansion coefficient, and atomic properties [4]. The main focus in this study is on the joining of two different aluminium alloys, as this will be of particular interest to the automotive sector, where it could spawn a whole range of previously undreamt of innovations.

2. Materials and Method

Al 7075 and 5754 alloy sheets with 200 x 200 x 2 mm size were joined by cold metal transfer (CMT) method. The chemical compositions of materials were given in Table 1.

Table 1. The chemical compositions of materials used in CMT operations

Material	Si	Fe	Cu	Mn	Mg	Cr
Al 7075	0.5	0.5	2.1	0.3	2.2	0.21
Al 5754	0.4	0.4	0.1	0.5	2.9	0.3
AlMg5 wire	-	-	-	0.1	5.1	0.1

2.1. CMT Process

Fronius A – 460 type CMT device was used to prepare the joints. A magnesium based 1 mm diameter AlMg5 welding wire was used in CMT operations. Butt joints were performed with 110 Ampere weld current and 25 seconds weld time by using 20o torch angle under Argon shielding gas. The weld current and time and torch angle in CMT operations were kept constant and the gas flow rate was chosen as 10, 12, 14 and 16 l/min.

3. Results and Discussion

3.1. Tensile test results

The tensile tests were done according to EN 895 standard and fractured samples were given in Figure 1. The ultimate tensile stress value increased with increasing shielding gas flow rate (i.e. Debby) up to 14 l/min where the highest value was gained as 145 MPa, and then decreases to 124 MPa for 16 l/min as shown in Figure 2.

Figure 1. *The tensile test samples.*

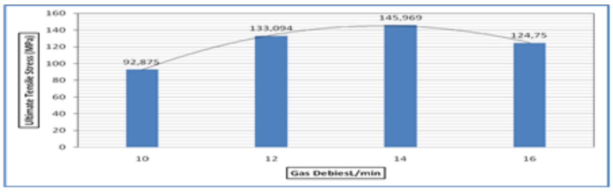

Figure 2. *The tensile test results.*

3.2. Macro-structure appearances

The butt joined cold metal transferred specimens were exposed to metallographic examination and etched by 3 wt. % HNO3, 2 wt. % HCl, 1 wt. % HF and 94 wt. % H2O Keller solution. The macro-structure appearances were seen in Figure 3.
The macro-structure pictures showed that there is not any weld defect for 4 different gas flow rates. Root areas of butt joints were seen extremely accurate. The similar macrostructure photographs were obtained by Shang et al. [3].

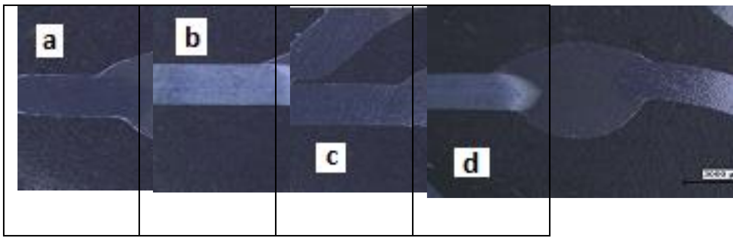

Figure 3. *The macro-structure of samples joined by (a) 10 l/min, (b) 12 l/min, (c) 14 l/min and (d) 16 l/min gas flow rate in butt joint form.*

3.3. Micro-hardness

The micro-hardness values were measured with 0.5 mm spacing by applying 100 g load (HV0.1) from base metal to weld zone at the points as marked in Figure 4. The hardness values of Al 7075 alloy are higher than that of Al 5754.

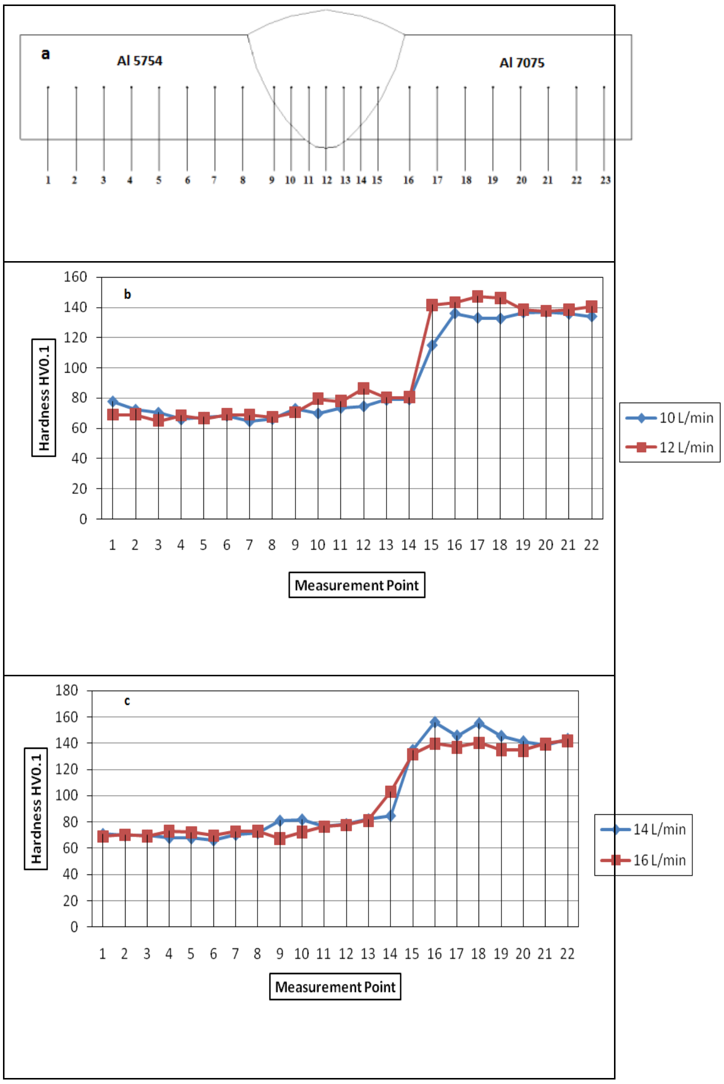

Figure 4. *(a) The hardness measurement points, (b) micro-hardness values for 10-12 l/min, and (c) for 14-16 l/min gas flow rate.*

Heat affected zone (HAZ)'s hardness value is approximately same with the base metal which is the main difference of CMT from other conventional welding methods. Since the fracture generally occurs in HAZ and grain growth is seen here. In CMT process, however, very low heat input is given to base metal, and most probably the reason of high ultimate tensile strength values determined by tensile test can be verified by this situation.
The hardness was measured in 60-80 HV0.1 range in base metal-HAZ and weld joint zone for Al 5754 alloy, and its value sharply increases to 140-160 HV0.1 range for Al 7075 alloy (Figure 4b and 4c).

4 Conclusions

Argon shielding gas was used with four different gas flow rates in joining of two dissimilar Al alloys by cold metal transfer (CMT) method, and the below items can be concluded from this research study:

- The tensile strength increases with a definite gas flow rate (debby), and then decreases.

- In the light of obtained results, there are no effect of flow rate on microstructure and microhardness of CMT welded joints. Similar macrostructure photos and same range hardness values were gained for 10, 12, 14 and 16 l/min rates. The low heat entrance causes high tensile stress values, and this makes favorable CMT technique than other classical welding methods.

- The hardness of Al 7075 alloys was 2-3 times greater than that of Al 5754 alloy during the CMT operations.

- The more heat that is applied, the poorer the mechanical properties of the joint will be. Previously, good results could only be achieved by mechanical means or by bonding. Of much greater interest, however, is the ability to use heat to join materials with differing properties.

References

[1] S. Yang, J. Zhang, J. Lian, Y. Lei, "Welding of Aluminum Alloy to Zinc Coated Steel by Cold Metal Transfer", Materials and Design. 49 (2013) 602-612.
[2] S. Akıncı, "5754 Investigation of Welding Behavior of Aluminum Alloy". Istanbul Technical University, Institute of Science and Technology, Department of Metallurgy and Materials Engineering. Master Thesis, 2008.
[3] J. Shang, K. Wang, Q. Zhou, D. Zhang, J. Huang, G. Li, "Microstructure Characteristics and Mechanical Properties of Cold Metal Transfer Welding Mg/Al Dissimilar Metals", Materials and Design. 34 (2012) 559-565.
[4] Fronius International, www.fronius.com.