TECHNOLOGY FOR HETEROGENEOUS JOINING OF THIN ZINC-PLATED STEEL SHEET WITH ALUMINUM

Stela MUNCUŢ, Doina MORTOIU, Gheorghe SIMA
University „Aurel Vlaicu" ,Arad, Romania, muncutstela@yahoo.com, doina.mortoiu@gmail.com, gheorghe.sima@klastorf.ro

Abstract: This paper describes the procedure to join thin zinc-plated steel sheet with aluminum, called *weld-brazing*, by means of MIG-CMT. It presents an experimental program that was originally made a comparative study of weld-brazing for galvanized sheet metal and alloyed steel non-galvanized sheet in order to find the joint influence of the zinc layer. Further a study to determine the influence of parameters on superelevation determined using macrostructure, intermetallic layer thickness and composition of the samples microstructure. Experimental determination of the relationship between intermetallic thickness and tensile strength, hardness samples that standards achieved.

Keywords: zinc-plated thin sheet, joining, aluminum, welding, brazing

1. INTRODUCTION

In order to solve some corrosion problems and achieve simultaneous and light construction it recourses to heterogeneous blend technology of galvanized sheet steel alloyed with aluminum. It must be that the protective layer to fulfill the following conditions: to be continuous, adherent to the metal support, to have uniform thickness and strength not to break during operation. [1]

Weld-brazing is a joint process between two materials with different melting points; in the molten bath enters only material and material of lower melting temperature, the connection between the seam and the base material which is identical with soldering melts. Thus the filler material is chosen based on similar material that melts taking into account the following characteristics: melting temperature, hardness, resistance, conductivity, chemical composition, grain flow of filler material and filler material compared with basic material not melt.

When MIG-CMT weld-brazing aluminum steel plates, aluminum only melts in the joint. The weld-brazing process of alumina with steel is realized by overlapping corner joints, filler material is melted and deposit on the surface of alumina and steel, in the present case galvanized surface.

2. THE DESCRIPTION OF MIG-CMT PROCESS COLD METAL TRANSFER

Under the action of arc heat occurs melting peak wire electrode metal droplet formation; the droplet touches metal, increasing the size molten bath in a point. The current decreases and a bridge connecting wire with molten bath. The initial point contact transforms into a firm contact on the surface of circular cross section.

The microprocessor of the welding power in the moment of welding of the thin metal cylinder and forming a very narrow bridge (tenths of mm) around the time of vaporization and rupture (expulsion), withdraw wire actuator control by making bathroom detached drop before the current fall value 0A. The main consequence the possibility of combining with low linear energy transfer comparable to the short circuit, without splashing. [2]

3. EXPERIMENTAL PROGRAM

The program started with a comparison study about weld-brazing of galvanized and non-galvanized carbon steel sheet. The study showed that the presence of zinc on the surface has the following disadvantages; through evaporation it leads to the appearance of pores and cracks in the seam and regardless of the process it is very difficult its conservation. The advantage of the presence of zinc layer acts as a pickle making to increase wetting.

At the realization of this experimental program the following materials have been used:

- galvanized steel sheet DX51D + Z150-NAC (EN 10327:2004) 1mm thick.
- rolled aluminum alloy EN AW 1200 (SR EN 1706: 2000) with a thickness of 1 mm. Plate dimensions were 150x250x1mm.

As filler alloy wire electrode according to DIN 1732 AlSi5 diameter of 1.2 mm, using DC + polarity.

Argon shielding gas was used pure (Ar 100%), aluminum alloys because the inert gas is recommended for technical documentation studied. [3]

The experimental program consisted of making heterogeneous joints "by overlapping" corner because many applications can be found in mechanical engineering (automotive, rail, etc.). [4, 5]

The objectives pursued experimental and structural characterization intermetallic layer formed at mechanical joints made with different types of heterogeneous weld-brazing and choosing specific parameters of the weld-brazing technology for joining aluminum alloy galvanized steel.

In order to optimize the weld-brazing process with galvanized sheet metal process aluminum CMT were selected following influencing factors:

- $x_1 \Rightarrow$ superelevation $b[mm]$
- $x_2 \Rightarrow$ welding speed $v_S[cm/\min]$
- $x_3 \Rightarrow$ dynamic correction factor of the arc I_{na}

As objective function was chosen tensile strength, a joint measurable factor, combined with the analysis of intermetallic layer and storage layer of zinc corrosion function.

In Table 1 the parameter values used to make galvanized steel joints heterogeneous - aluminum alloy.

Table 1 Values of parameters used to make connections

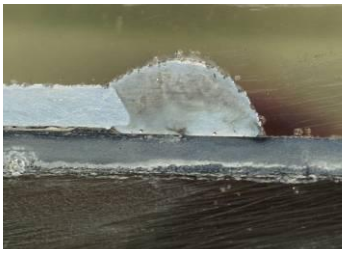
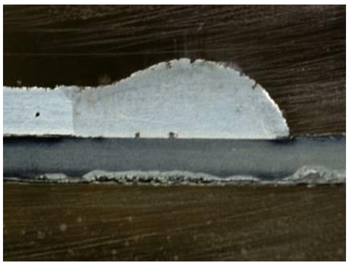
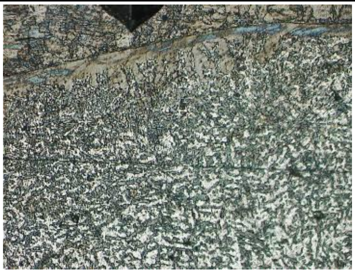
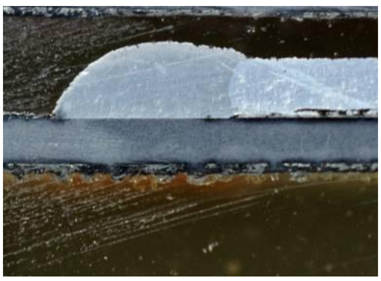
No. variant weld-brazing	$I_S[A]$	$U_a[V]$	$v_{as}[m/\min]$	superelevation b[mm]	$v_s[mm/\min]$	I_{na}
0	70,0	12.9	3,80	0,71	1000	+5
1	67,2	11,7	3,70	0,62	800	+5
4a	62,6	11,3	3,64	0,29	1000	+5
4b	62,6	11,3	3,64	0,86	1000	+5
8a	61,0	11,3	3,47	0,23	800	-5
8b	63,6	11,6	3,69	0,31	1000	-5

4. MICROSCOPIC EXAMINATION OF THE JOINT MACRO-HETEROGENEOUS ALUMINUM ALLOY-GALVANIZED STEEL

Macroscopic examination on cross sections of joints heterogeneous variants realized in the analyzed variants did not show welding defects such as cracks, but at the variants 0 and 1 have appeared in welding fine pores with maximum diameter of 0.3 mm (Table 2).

- at the CMT process by changing only the dynamic correction factor 4b cord samples is 0.86 mm elevation and elevation to 8b cord is 0.31, which shows that only by changing the dynamic correction factor of elevation changes, without changing other parameters. This shows that this factor should be chosen to get a good seam more slender and good penetration.

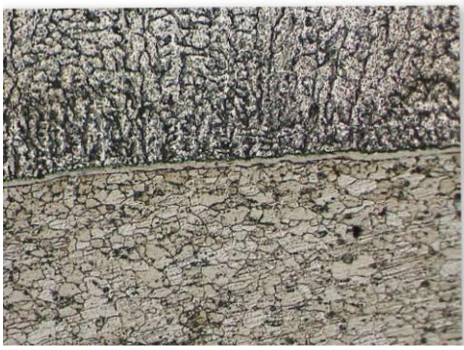
Table 2. Micro- and macro-examination of samples.

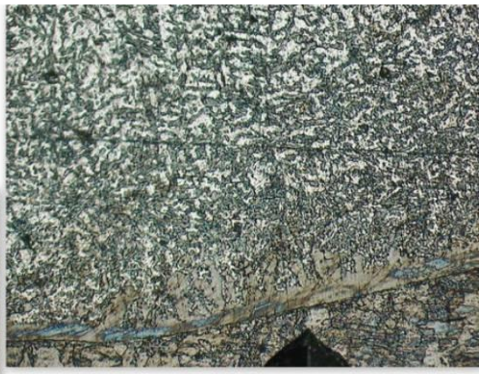
Nr. of test	CMT macro sample	CMT micro sample
Weld-brazing version 0 [Atac Nital]		
Weld-brazing version 1 [Atac Nital 10%]		
Weld-brazing version 4a [Atac Nital 10%]		
Weld-brazing version 4b [Atac Nital 10%]		
Weld-brazing version 8a [Atac Nital 10%]		
Weld-brazing version 8b [Atac Nital 10%]		

5. THE RESULTS OF THE STUDY

Microscopic study allows us to see the causes which led to rupture and therefore to correct the parameters so that the joints will be good. In our case will present evidence 4th, 8th and sample with CMT that were made with the same parameters. (Figure 1).

Varianta de sudobrazare 8a





Varianta de sudobrazare 4a

Fig.1. A comparative study on CMT weld-brazing for the dynamic modification of the correction factor I_{na} ("sudobrazare" = weld-brazing)

The CMT process is observed with an alternation of dentritic zones with smooth areas. By metallographic analysis of the dentritic area it was determined structure made by multi-Zn-Al without any other material.

The presence of dentrites more at CMT $I_{na} = -5$ to CMT $I_{na} = +5$ can be explained by a more rapid cooling on the interface steel / cord, thus there is no connection between the cord and steel.

Interface located between the seam / aluminum is much more complex. Figure 1-4a shows a flow phenomenon of the zinc in aluminum, a phenomenon that makes the combination to have cracks and pores. We notice the presence of transverse cracks cord. The starting point of the crack is in the interface between aluminum and cord. These cracks are due to regions rich in zinc debris structures. The development of cracks during solidification exclude their formation.

Table 3 Intermetallic layer thickness, hardness and tensile strength

Variant analysis / weld-brazing process	Intermetallic layer thickness μm	Hardness	Resistance at break R_m, [N/mm^2]
0/CMT	12	34	77
1/CMT	14	33	78,1
4a/CMT	50	43	81
4b/CMT	22	25	80
8a/CMT	18	33	81
8b/CMT	17	27	81

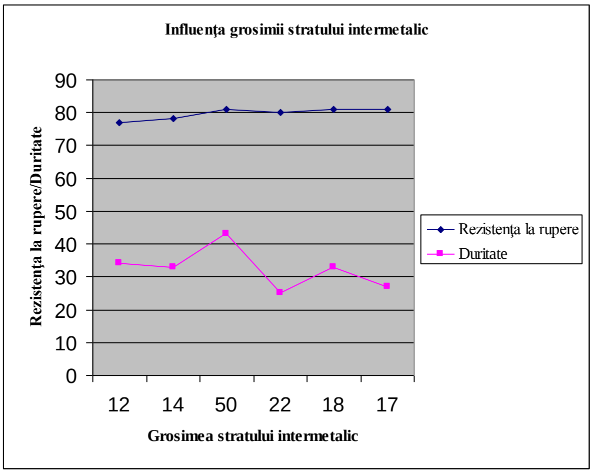


Fig. 2 The correlation between the intermetallic layer thickness and hardness / tensile strength

For $I_{na} = +5$ 4b jointing sample is 0.86 mm thick layer intermetallic elevation 22 μm, but the hardness decreases and 25HV1 $I_{na} = -5$ 8b at 0.31 elevation and thickness of cord is 18 and hardness intermetallic layer 27HV1, ie an increase in intermetallic layer thickness with elevation.

Intermetallic layer that conclusion must be tempered with toughness and chemical composition of the layer, choose dynamic correction factor having a significant influence on film hardness.

6. CONCLUSIONS

It is noted that the choice of a correction factor is growing and dynamic + elevation and intermetallic layer thickness, hardness to drop. As an important conclusion of this work, intermetallic layer thickness must be maintained between the hardness correlated with aluminum interface / seam. So those will be possible to weld-braze dissimilar materials which atoms of a material other material can migrate to the network. Future studies will focus on the chemical composition of the intermetallic layer, hardness and temperature influence weld-brazing rough area and keeping Breakthrough corrosion properties of newly formed structure.

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