METABK 54(2) 383-386 (2015)
UDC – UDK 669.715:621.791.3:620.18=111

RESEARCHES AND STUDIES REGARDING BRAZED ALUMINIUM ALLOYS MICROSTRUCTURE USED IN AERONAUTIC INDUSTRY

Received – Prispjelo: 2014-06-13
Accepted – Prihvaćeno: 2014-10-15
Preliminary Note – Prethodno priopćenje

Brazing is applied to the merge of the pieces which are most required, tensile strength of the solder can reach high values. By brazing there can be assembled pieces of most metals and ferrous and nonferrous alloys, with high melting temperature. This paper presents an analysis of the microstructure of materials from a brazed merge of aluminum alloy L103 which is often used to produce pieces of aeronautical industry. Brazing material was performed using several technologies, and after examination of the microstructure of materials from the merge area it was established as optimal technology the technology which consist of pickling in Aloclene 100 solution with the deposition of filler material on both sides of the base material and the use of spectral acetylene and neutral flame.

Key words: aluminium allloys, microstructure, braze technology, structural homogenization

INTRODUCTION

Structural imperfections may be realived by distructive testings followed by metal examinations. Distructive testings are very usefull to determine the hard glue process tendency or any influences to base or addition material [1, 2]. Distructive testing methods may be considered a real guide to metal junction quality determination but are not able to determine the imperfections causes. The imperfection concequences depends, on a hand, by the proceses that shortage the junction life time, and on the other hand by the life time request specific to hard glue [3, 4]. The brazing frequent junction are design considering the stacked metal pieces. Most frequently discontinuities placements are situated in the junction zone because of the capilarity phenomenon. The discontinuities axis are paralel to joining plane [5, 6]. Any other imperfections (inhomogeneity, other material inclusions, surface of interior defects) are the result of base material or added material stress before the hard joining process.

In the case of standard sample, the proper distructive testing is the metallografic examination because the achieved informations are relevant for the brazing qualification [7].

MATERIALS AND METHODS

Concerning SR EN 12797 [8] “Hard glue joint quality and fundamental informations about chemical reaction between base material and addition material, diffusion characterstics and other aspects can be investigated by macro and microscopic investigations”. Informations about section surfaces are offered by this distructive method. Bigger surfaces sets of probes are needed cutted from the same material in the same technological condtions.

For the examination of metallographic microstructure there were comprised the following stages:

- debiting which was done on automatic debiting machine ISOMET 4000;
- recording and noting the samples which were taken from the brazed cord. It should be noted that they were debited inside the cord from a minimum distance of 5 / mm from the edge;
- embedding samples was used on a embedding machine with interchangeable resin IPA 40;
- polishing which was performed on an automatic polishing machine Vector;
- chemical attack which was carried out with reagents 3, 2, 6, whose chemical composition is shown in Table 2.

The experiments consists in sixteen probe, four probes for each glue technology as presented in the Table 1.

The forth preparing technologies of the alluminium alloy probes are according to the following. Because exact references about aluminium 3L59 brazing using L103 aluminium alloy are not offered by specialized literature, qualitative and cantitative interpretations are needed. Considering this, comparative interpretation between experimental results and ideal model is very difficult to be done. Because constant and uniform temperature environment was used for whole surface joint brazing, the probes are considered closed to ideal situation. To be sure that the structure is not modified, high

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Table 1 **Preparing technology for brazing technology**

No.	Preparing technology	Heating time		Simbol	Glue area / mm^2
		t_1 – 30 / min	t_2 – 20 / min		
1	TP I AL	X		T1	30 x 10,3 = 309
2	TP I AL	X		T2	30 x 6,8 = 204
3	TP I AL		X	T3	30 x 7,6 = 228
4	TP I AL		X	T4	30 x 7,5 = 225
5	TP II AL	X		A1	30 x 7,4 = 222
6	TP II AL	X		A2	30 x 6,9 = 207
7	TP II AL		X	A3	30 x 7,1 = 213
8	TP II AL		X	A4	30 x 7,4 = 222
9	TP III AL	X		V1	30 x 7,4 = 222
10	TP III AL	X		V2	30 x 7,2 = 216
11	TP III AL		X	V3	30 x 8,1 = 243
12	TP III AL		X	V4	30 x 7,9 = 237
13	TP IV AL	X		M1	30 x 6,3 = 189
14	TP IV AL	X		M2	30 x 7,8 = 234
15	TP IV AL		X	M3	30 x 7,2 = 216
16	TP IV AL		X	M4	30 x 8,6 = 258

attention has to be given to probe cutting. Cut position has to be marked and registered to avoid any confusion and done not closer than 5 / mm of probe extremity. Cutted surfaces has to be polished to get a corresponding surface quality. A plate section, without scratches, pinches and specially oxides in the case of alluminium alloy has to be prepared for microscopic axamination. To get all, short time between probe preparation and examination is allowed. Table 2 presents reagents chemical composition.

Table 2 **Reagents chemical composition**

Reactive	Composition	Utilization instructions
2	1 / g NaOH 100 / ml water	- 10 seconds dabbering for general structure making evidence; - 10 - 20 / sec. imersion; - 10 / min. washing in water for film formation that varies with grain orientation;
3	2 / ml HF 3 / ml HCl 5 / ml HNO_3 150 / ml water	- Immersion for 10 - 20 / sec. Washing in current of hot water current. General structure evidentiation; - dillution with Diluarea cu 4 water portions. Constituents colouring.
6	25 / ml HNO_3 75 / ml water	- Immersion for 40 secunde 70 / ^{0}C temperature. Cold water rinsing.

Surface preparation was done by the following technological process: polishnig with water at 300 / rpm during 3 / min, using 00/600/800/1000/1200/2500 abrasive disc; emery cloth polishing using TOPOL 2, 0,7 / µm alumina water suspension at 50 rpm with 20 / N force during 6 / min; emery cloth polishing using TOPOL 3, 0,25 / µm alumina water suspension at 50 / rpm with 20 / N force during 6 / min;.

EXPERIMENTAL RESEARCHES

Metallic plates used for standard probes manufacturing, before preparation process has a homogenous structure, without elongate composite elements as presented in Figure 1.

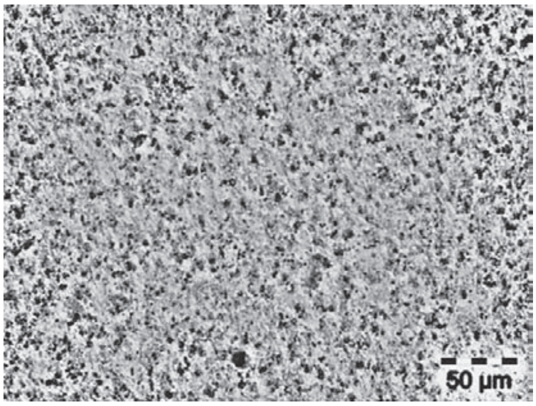

Figure 1 Drawn probe from the base material without thermal influence

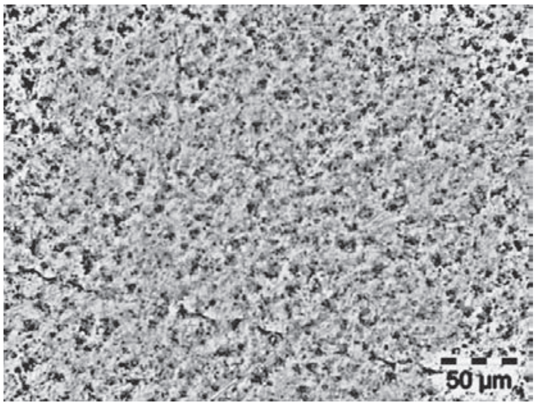

Figure 2 Base material probe after baking oven maintenance at 570 / ^{0}C.

A slight grain dimension increasing is observed after maintenance in baking oven at brazing temperature. In volume, base material structural characteristics are not changed, that means the 570 / ^{0}C is corectly set. Figure 2 presents the base material probe after baking oven maintenance at 570 / ^{0}C.

Absence of continuum difusion layer between the two materials revealed in the microstructure analisys of the brazed layer showed a sufficient time maintenance for chemical and structural homogenization of the materials in the contact zone. Figure 3 presents a typical brazing structure of the T4 probe.

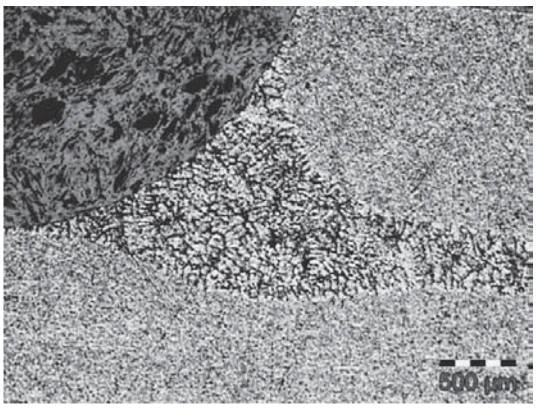

Figure 3 Typical brazing structure of the T4 probe

The image study shows (Figure 4):

- structural modification only in the brazing zone;
- continuous difusion layer appearance on the whole brazing bead;
- the two materials chemical and microstructural homogenization is not possible in the contact zone

Because of temperature rapid increasing on the brazing bead free zone, the intercristaline oxidation and corrosion appeared as a result of supratemperature.

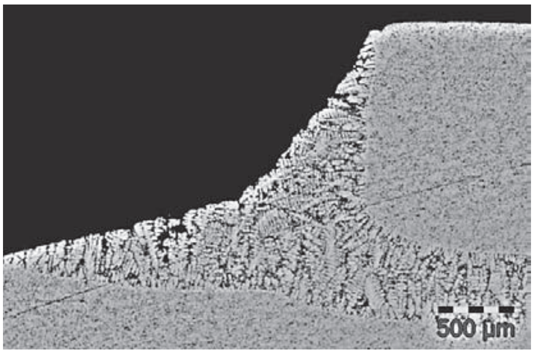

Figure 4 Typical image of the brazed layer for the A1 probe

In the case of defective capping, on the first brazing, minor damages appeared on the base material-allowance material interface and continuous damages at the second brazing (Figure 5).

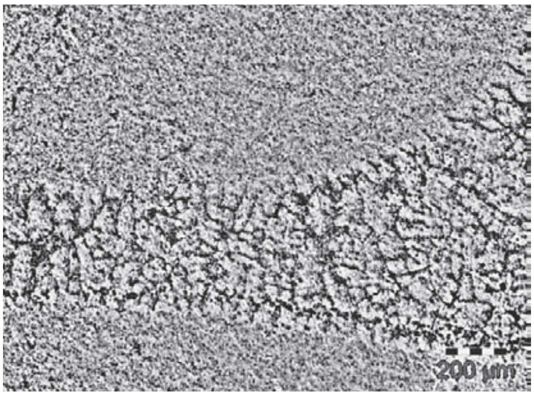

Figure 5 Technology No. 49: Technological process TP II AL for surfaces preparation, allowance material bed on a base material surface; M1 probe

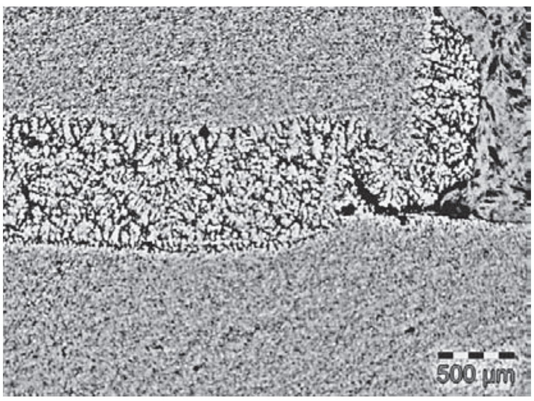

Figure 6 Technology No. 50: technological process TP IV AL for surfaces preparation, allowance material bed on a surface base material, M 3 probe

In the normal situation, of a well done base material capping process, on the first brazing process, detached damages appeared on the base material-allowance material interface. At the second brazing process, local damages appeared because of sinterized layer bad capping process as presented in the Figure 6.

In the case of initial sinterizing process, lack of damages are encountered between base and allowance material. At the second brazing, the izolate defects reproted on the same interface shows that superficial oxides on the sinterized layer were not removed using this technology (Figure 8).

Figure 7 Technology No. 51: Technological process TP III AL for surfaces preparation, allowance material bed on a base material surface; V1 probe

Figure 8 Technology No. 52: Technological process TP III AL for surfaces preparation, allowance material bed on a base material surface, A3 probe

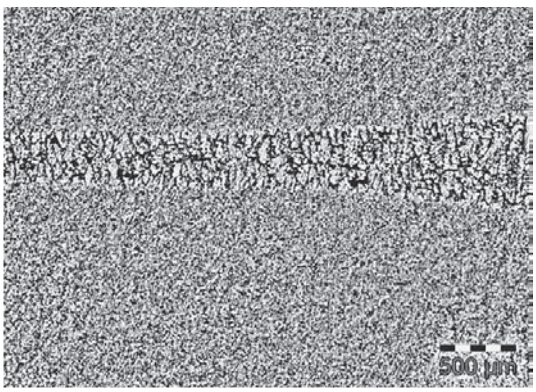

Figure 9 Technology No. 53: Technological process TP IV AL for surfaces preparation, allowance material bed on a base material surface; M4 probe

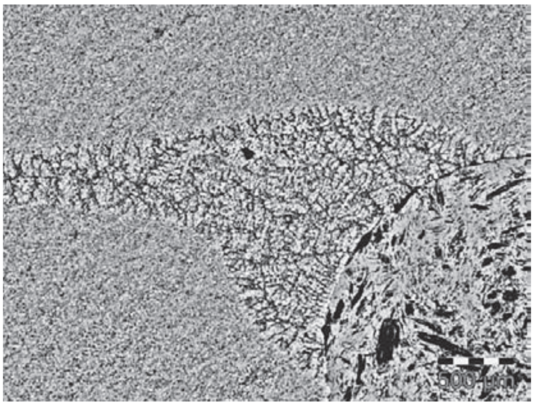

Figure 10 Technology No. 54: Technological process TP III AL for surfaces preparation, allowance material bed on a base material surface; V4 probe

As presented in Figure 8, because of material bad capping process, inclusions remained on its surface difused on brazing material that causes a defected structure and an uncoresponding difuzion zone (inclusions, cavity, able to affect brazed joining strenght)

Because the both material partial capping process, izolate inclusions apeared between base and allowance material (Figure 9).

For a good capping process and in the situation of simultaneous both materials brazing, no defects were reported at both base material - allowance material interfaces as presented in Figure 10.

CONCLUSIONS

To obtain a homogeneous microstructure at the reconditioning of aluminum alloys by brazing is recommended:

- use the brazing method by flame;
- the brazing of aluminum alloys is recommended to be done with the use of oxyacetylene flame by fuel type;
- the brazing of aluminum alloys is recommended to use high purity acetylene known as spectrum acetylene;
- the brazing of aluminum alloys is recommended to be done with the deposition of the filler material on the both surfaces of the base material and then contacting the pieces and heating them;
- deposition of filler on both surfaces of the base material has superior results to other deposition methods by lack of isolated defects between the initial sintered layer and the last one brazed;
- holding time of the sample in the oven (30 to 20 / min.) at the brazing temperature (570 / ^{0} C) does not significantly affect the microstructure of the base material, the filler material or the diffusion zone between the base material and the filler one;
- in case of using the preparation technology of TP III AL surfaces (pickling in Aloclene 100 solution), diffusion zones between the base material and the filler material have larger widths and predominate structural constituents specific to base material and filler material;
- using surface preparing technology, named here TP III AL, a total oxides removal from base material surface is obtained. As a direct result, allowance material deposition on both material surfaces has better results compared with other techniques. No izolate defects are reported between initial sinterized layer and brazed layer in final;
- in the case of experimental samples realised using oxidizing flame type occurs defects by type of lack of penetration and burnt surface;
- technology which consist of pickling in Aloclene 100 solution, with the deposition of filler material on both sides of the base material, the use of spectral acetylene and neutral flame may be considered optimal because, after the examination of metallographic microstructure there are not revealed significant defects in brazed materials of merge.

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Note: The responsible translator for English language is S.C. PURTRAD S.R.L., Targu Jiu, Romania