CONSIDERATIONS ON THE DEVELOPMENT OF BRAZED JOINTS USING TWO MATERIALS WITH DIFFERENT PROPERTIES

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Abstract: Realization of brazed joints involves the use of different joining materials. These joints are designed for various industries including the machine building and special industries such as aeronautics through the use of ceramics and metal brazing joints. Due to differences in material properties of brazing, the thermal expansion, different wetting and dispersion, residual stresses can occur in the joint. These residual stresses can be reduced through proper choice of brazing materials, fluxes and brazing temperature.

Keywords: brazing, joint, base material, filler, wetting, dispersion

1. INTRODUCTION

Process known as brazing is based on heating the base metal at higher temperatures than the solidus. Especially when brazed different materials are must be taken into consideration the possibility of forming intermetallic compounds due to the difference between thermal expansion coefficients.

Numerous specialized studies have been conducted to examine how they can join two sheets with different materials. A special attention should be given to different mechanical properties of both base metals and filler metal protective atmosphere. If the materials are chosen wrong, in the material are high residual stresses can occurs even breaking of the brazed area [1-4].

The base materials should be chosen to be compatible with the brazing process, the filler materials and fluxes used to protect the brazed joints before and after brazing. To be fully charged, the filler metal liquid must be dispersed in the joint. In joining is formed a capillary zone in which the filler material must adhere to base materials due to the wetting and the dispersion [2, 3].

In scientific literature are presented the factors that influence behavior of the brazed materials (mechanical properties of the joint, corrosion resistance and residual stress levels) are: mode in which is realized heating of the brazing material, mechanical and chemical properties of base material, chemical composition of filler material, mode in which is realized cleaning of surfaces before brazing, fluxes and the protection atmosphere against the oxidation, Temperature and time of joint realization and aspect of brazed joint [3, 4].

In this paper we propose to determine the influence factors when using two materials with different mechanical and physical properties, thermal expansion coefficients are also different, some alternatives must be found so as not to appear premature rupture of the joint brazed.

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The materials to be brazed to withstand mechanical stress, in our case making stamped parts for the machinery industry, so that brazing joint must behave as the base material.

2. WETTING AND DISPERSION OF BRAZING MATERIALS

In order to choose brazing materials will take into account the phenomena that appear in case of brazing process. Wetting and dispersion are important phenomena that appear between solid, liquid and gas where there are two materials during brazing. Young-Dupre has defined the relation between surface tension of liquid-vapor, solid-vapor and solid-liquid states, as follows [4]:

$$\gamma_{LV} \cdot \cos\theta = \gamma_{SV} - \gamma_{SL} \quad (1)$$

Is found that the lower contact angles of filler and the base material (θ <90°) proper wetting occurs between this two materials. Figure 1 exemplifies the relationship defined by the Young-Dupre and shows us the brazed materials.

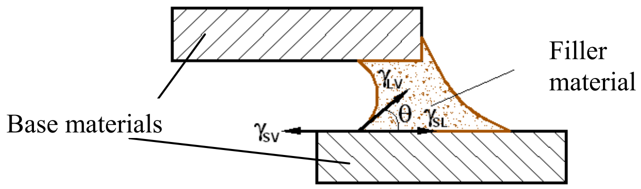

Fig. 1. The relationship between contact angle and surface tension [5].

Dispersion of filler material is made depending on contact angle θ and contact area ΔS. In Figure 2, is shown a liquid that is dispersed on a solid surface. It can be observed that with decreasing contact angle θ provides a better dispersion of filler metal on the base material. Fluid viscosity and its forces of inertia can influence the phenomenon of dispersion.

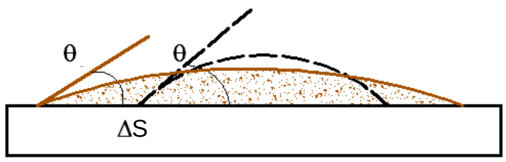

Fig. 2. The relationship between the dispersion of liquid at a solid surface and contact angle θ [5].

From equation (1), we can see that the left side can be considered as a resistance force that opposes wetting, right-hand term can be considered a positive wetting force of this two materials.

3. ANALYSIS AND TESTING OF BRAZED MATERIALS

In order to achieve test samples was chosen as a torch brazing process, where the brazing temperature is around 600° C. This type of brazing is a very commonly used for small volume production and repair. Depending on your needs the torch brazing can be easily automated, this technology is relatively simple and can be realized in a relatively short time.

Samples were made from thin sheets of dimensions 20 x 150 x 1 mm (width x length x thickness) joined between each by a brazing joint with filler material using torch brazing.

Base materials are of the type: AA6016-T4 and CuZn37, brazing rode type: L-CuZn40 AF 210, the chemical composition of the base materials is presented in Table 1 and Table 2.

Table 1. Chemical composition (%) of aluminum alloy, type AA6016-T4 [6].

Mg	Si	Fe	Cu	Cr	Ti	Mn	Zn	Others	Al
0.25-0.6	1.0-1.5	0.5	0.2	0.10	0.15	0.20	0.20	≤0.15	Balanced

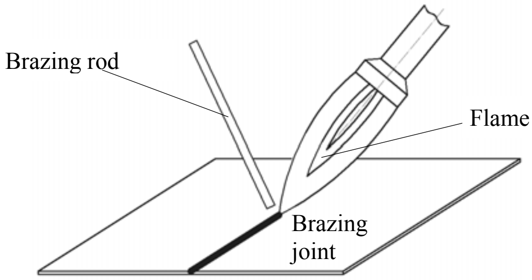

Fig. 3. Torch brazing process [2].

Table 2. Chemical composition (%) of copper-zinc alloy, type CuZn37 [7].

Cu	Ni	Cu	Fe	Sn	Al	Others	Zn
62-65	0.25	≤1	≤0.1	≤0.1	0.05	≤0.1	Balanced

After the brazing of sheet metal was performed microscopic analysis of the joints. For all four samples studied results a homogeneous structure with good wetting and dispersion of filler material for brazing joint. In Figure 4 is presented a microscopic image to the brazed area for TS1 samples before the tensile test. The other samples (TS 2, TS 3 and TS 4) present a similar structure of the brazed area.

Fig. 4. Micro structural analysis of the TS1 samples brazed area.

Each test sample was individually numbered and tested for tensile strength to follow when they break and how is produced rupture around the brazed joint. Figure 5 presents the variation of fracture strength for the four test samples used (noted TS1 ÷ TS4). We can see that the breaking strength of brazed samples was somewhere around 270 MPa.

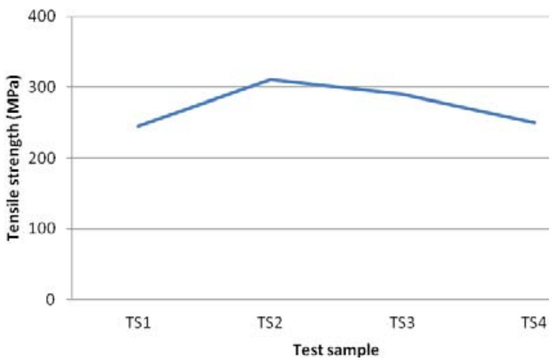

Fig. 5. Tensile testing of samples.

In Figure 6 it can be seen the samples after tensile tests and how they broke. After the mechanical tensile test samples of AA6016-T4 aluminum alloy sheet joined by brazing with CuZn37 alloy sheet with thickness of 1 mm brazed head to head didn't broke in the area where brazing was performed but was broken in the specimen material.

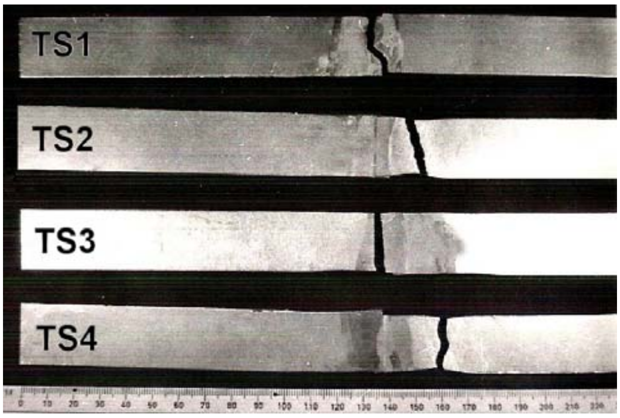

Fig. 6. Test samples after traction testing.

When verifying of microscopic adherence of filler material melts on the base materials by electronic microscopy analysis found that brazing material has a particularly low differentiation between the base metal and the filler metal that means that brazing is a very good quality.

4. CONCLUSIONS

As shown in the paper, a brazed joint is not a homogeneous body, but rather heterogeneous, composed of different phases with different physical and chemical properties. Partial dissolution of base material, combined with diffusion processes, can change the composition and therefore chemical and physical properties of the border area formed at the connection between the base and filler material and usually affecting the entire joint.

All brazing processes generally consist of the cleaning operation, adding filler metal in the joints with metal base and cycles of heating/cooling. Mechanical properties and corrosion resistance of joint dependent of brazing process and can be different for the same base and filler material. We conclude that the brazing process must take into account many variables to achieve a proper joint. Filler and base materials and brazing process must be well chosen to make durable joints.

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