EVALUATION OF EXPLOITIVE CHARACTERISTICS BA1032 ALLOY AFTER TIG WELDING METHOD TREATMENT

Tomasz LIPIŃSKI[a], Marcin CUDAKIEWICZ[b], Anna WACH[a], Paweł MIKOŁAJCZYK[a]

[a] University of Warmia and Mazury in Olsztyn, Poland
Faculty of Engineering and Technical Sciences
[b] BUJALSKI Sp z o.o.

Summary

The aim of this study was to make the diagnosis of the operating conditions of aluminium bronze BA 1032. Current intensity was selected on an experimental way to assure of stable melting of the surface layer together with inserted components at small current intensity. The examined questions were: the influence of surface treatment of aluminium alloy onto structure by collected energy source; the geometric parameters of the surface melted by TIG welding method of bronze surface plated alloy ingredients by using different current parameters.

The results of this study indicate that the thermic exposure value, it means: the sort of concentrated energy source as well as its speed, as well as the sort of alloy additives have an influence on exploitation parameters of tested samples.

Keywords: Cu alloys, welding, using properties, aluminium bronze.

OCENA WŁAŚCIWOŚCI EKSPLOATACYJNYCH STOPU BA1032 PO OBRÓBCE SPAWALNICZĄ METODA TIG

Streszczenie

Celem pracy była diagnostyka właściwości eksploatacyjnych brązu aluminiowego BA1032. Próbki do badań pobierano z obszaru ustabilizowanego oddziaływaniem skupionego źródła ciepła (stała, ustabilizowana szerokość strefy wpływu ciepła). Natężenie prądu dobrano eksperymentalnie zapewniając stabilne przetopienie warstwy powierzchniowej wraz z wprowadzanymi składnikami przy realnie małym jego natężeniu.

Z analizy wyników badań wynika, że zarówno wartość ekspozycji cieplnej, tj. rodzaj zastosowanej energii źródła skupionego ciepła, prędkość jego przemieszczania jak i rodzaj dodatków stopowych wpływają na parametry eksploatacyjne obrobionych elementów.

Słowa kluczowe: stopy Cu, spawanie, właściwości użytkowe, brąz aluminiowy.

1. INTRODUCTION

Aluminium bronzes are one of the most important cooper alloys. They have the highest resistance characteristics and considerable corrosion resistance comparable to the other bronze alloys. Another notable attribute of aluminium bronzes is that they retain mechanical properties at the high temperature, and especially at the low temperature. Because of these properties they are commonly used in many technical applications.

Aluminium bronzes, which contain aluminium in an amount of 9.5 to 11%, are susceptible to hardening [2, 4, 6]. The β-Phase of Aluminium Bronzes – a solid-solution based on intermetallic phase Cu_3Al with electron-concentration of 3/2 – crystallizes in a regular space-centered lattice. During slow (equilibrium) cooling it decays into eutectoid mixture ($\alpha+\gamma_2$). When the cooling exceeds the critical value, this phase becomes over cooled and it changes into a martensitic transformation. Hard and abrasion resistant phase is formed as a result of this transformation. The transformation of aluminium bronzes can be realized by surface or volumetric treatment. The TIG welding method is perfect for surface processing [1, 3, 5].

Direct-current electrode negative (DECN) is used for treatment of all metals except aluminium. This method enables a stable work of welding arc. About 60% of total heat quantity is generated on the surface layer of a test object, a large part of the heat is utilized to a melting of native metal. About 10% of the heat is wasted on the radiation, and only 30% generates on electrode. It is possible without any difficulties to maintain an electrode temperature below its melting temperature (3370^{0}C). The end welding electrode has a conical shape to maintain the arc on it, what increases the work stability and facilitates the ability of an operator to maintain a constant arc length. Pure argon gas is generally used as a shield gas for the TIG welding method. As an inert gas it ensures a good protection for both direct and alternating current and it can be used for all sorts of materials.

2. PURPOSE AND METHOD OF THE INVESTIGATION

The purpose of this investigation was to determine the geometric parameters and modifications proceeded in the surface structure melted by TIG welding method of bronze BA1032 surface plated alloy ingredients by using different current parameters.

BA1032 aluminium bronze was tested. This alloy was chosen as the base material because of its specifics possibilities of heat treatment

In order to remove the surface oxides and ensure comparable surface roughness, the tested surface, before a treatment of concentrated energy source, was polished with the help of abrasive paper of granularity of 400 and washed with alcohol.

Next the samples were surface-treated by TIG welding method in a shield of inert gas (Argon).
The treatment was realized for every sample by one concentrated energy source passage. Constant linear velocity 4.7mm/s of electrode feed speed (of reversed polarity) was assured with respect to sample surface in a shield of technical argon.
The electrode feed speed was selected on an experimental way by taking up a criterion of optimizing heat energy utilization. During small electrode feed speed the concentrated energy source causes "keeping" metal under heat influence for too long time, and after crossed the fixed value of intensity causes melting metal with formation of characteristic crystalline cavity (with applicable source power, metal was melting and then was subject to thermic convection). During very high electrode feed speed, it was found that there are no significant differences in a treatment of concentrated energy source into sample, despite of changing the heat energy (current intensity) in analyzed scope.

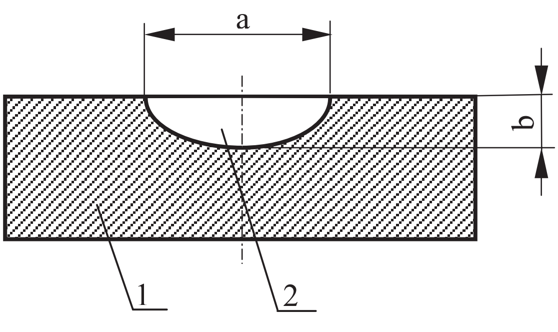

Fig. 1. Location scheme for measured parameters: 1 – tested sample, 2 – place treated by concentrated energy source

Test samples were taken from the stabilized area by the treatment of concentrated energy source (constant, stabilized width of heat-affected zone (HAZ)).

Current intensity was selected on an experimental way to assure of stable melting of the surface layer together with inserted components at small current intensity.

Geometric measurements were made on the automated test stand of image analysis MultiScan. Total width, depth of melted zone and heat-affected zone were measured. Measured parameters scheme is presented in Fig. 1.

Tab. 1. Treatment parameters

Tested point	Current Type	Current Intensity	Feed speed [mm/s]	Alloy additives
A	Direct	160	4.7	-
B	Direct	160	4.7	Al
C	Direct	160	4.7	40%Al + 60% Zr
D	Alternating	160	4.7	-
E	Alternating	160	4.7	Al
F	Alternating	160	4.7	40%Al + 60% Zr
G	Direct	100	2.3	42% $NaNO_3$ + 17% Mg + 6% Al + 35% Cr_2O_3
H	Direct	100	4.7	
I	Alternating	100	4.7	

3. RESULTS OF INVESTIGATION

A depth of melted zone for every tested point was presented in Fig. 2. The parameters were divided into two groups. 1st group; values for intensity of 160 A (dark colour of scheme), 2nd group; values for intensity of 100 A (light colour of scheme). For all tested points with a feed speed of 4,7 mm/s it was found that their melted zone is deeper after the treatment with alternative current than with direct current (compare points: A-D, B-E, C-F, H-I). Weld bead, without adding any alloy additives, was deeper than during using some. It can be explained by energy consumption needed to melt them down.

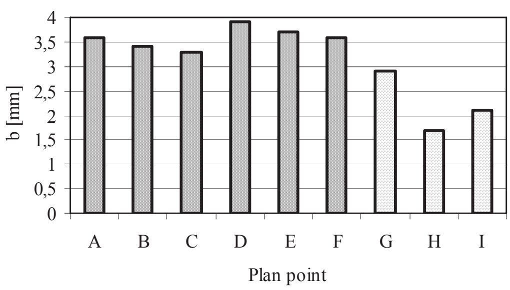

Fig. 2. Depth of melted zone for every tested point (Tab. 1)

Point G presents an alloy treated twice at small electrode feed speed. Evident increase of depth of weld bead was found. When observing metal and mixture reaction during treatment, it was noticed that in the central part of melted zone there are some movements reminding a boiling together with its thermic convection.

Width of melted zone for every tested point (a Fig. 1. was presented in Fig. 3. Width dimensions presented in Fig. 2 are similar to growth dimensions presented in Fig.3. Melted zone is wider after the treatment with alternative current than with direct current. After treatment without adding any alloy additives, wilder melted zone was obtained. While the alloy in the presence of mixtures was treated with intensity of 100 A, the width of weld bead differs not much from the dimension obtained during treatment of proper alloy additives with current intensity of 160 A. The width difference demonstrated (point G and H) is not as big as the depth of weld bead.

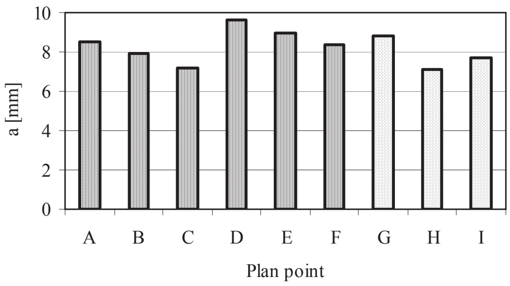

Fig. 3. Width of melted zone for every tested points (Tab. 1)

Comparison of proportion of width and depth changes was presented by quotient a/b (Fig. 1) in a Fig. 4. For direct and alternating current intensity of 160 A, the difference in groups (A-B-C and D-E-F) is insignificant. The proportional width changes of weld bead can be found. Differently quotient a/b can be found when using a mixture with exothermic effect. The highest ratio is in point H (Fig. 4). The highest difference of weld bead geometrical values (test conditions) was observed for direct current intensity of 100A and feed speed of 4.7 mm/s. During lower feed speed, quotient a/b decreases its value. For alternating current intensity, quotient a/b value oscillates between values of points G and H.

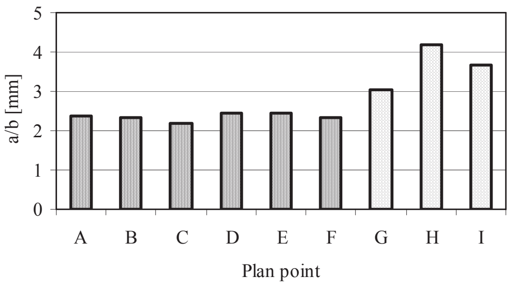

Fig. 4. Quotient width/depth of melted zone for every tested points (Tab. 1)

Structure of melted zones of alloy BA1032 for tested points was presented in Fig. 5-10. Fig. 5 presents a coarse-grained structure of test point G. Alloy structure of test point F crystallized with a finer grain (Fig. 6).

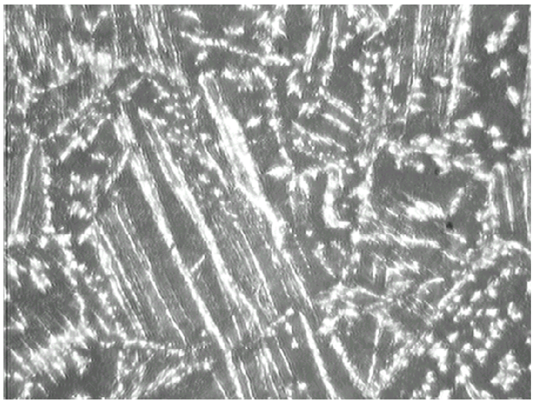

Fig. 5. BA1032 alloy structure, test point G, Magnification 230x. Etch Mi8Cu

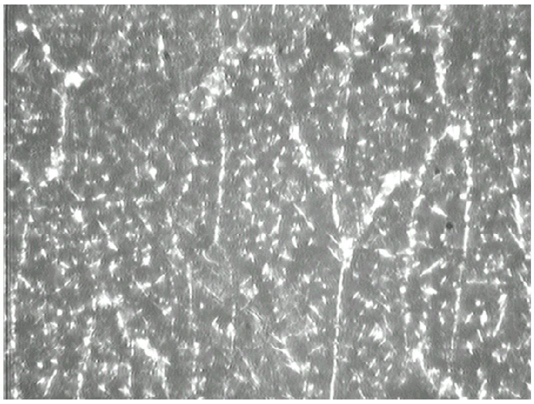

Fig. 6. BA1032 alloy structure, test point F. Magnification 230x. Etch Mi8Cu

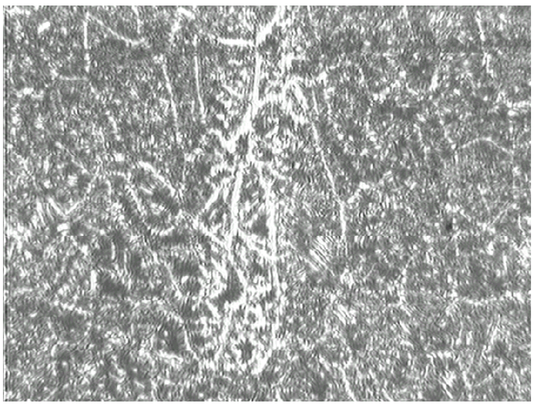

Fig. 7. BA1032 alloy structure, test point I. Magnification 120x. Etch Mi8Cu

Fig. 7 presents a transformation of structure into microstructure caused probably by convectional interaction of mixture components. Enlargement of a central part of this micro-zone was shown in Fig. 8. Fig. 5 shows an example of transformation, which probably was proceeded in the same grain boundary. The alloy was heated above a critical temperature, after it changed into liquid phase, but it hasn't enough time to stabilize and to crystallize with new gain. As a result a new quality of structure "with old grain" was formed. Enlargement of this structure was presented in Fig 10.

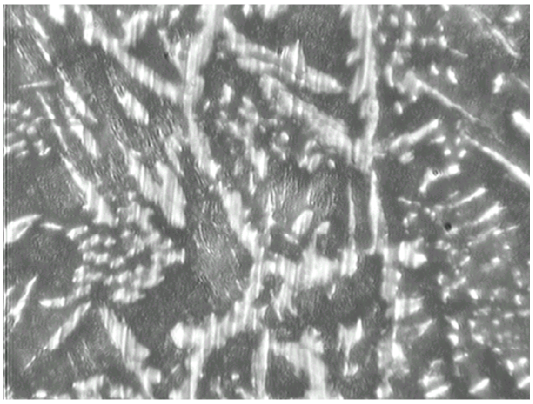

Fig. 8. BA1032 alloy structure, test point I. Magnification 470x. Etch Mi8Cu

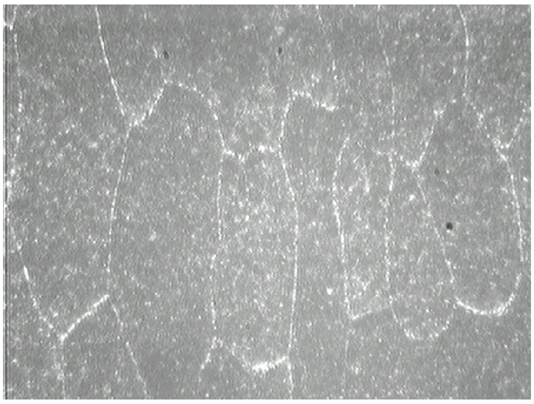

Fig. 9. BA1032 alloy structure, test point H. Magnification 230x. Etch Mi8Cu

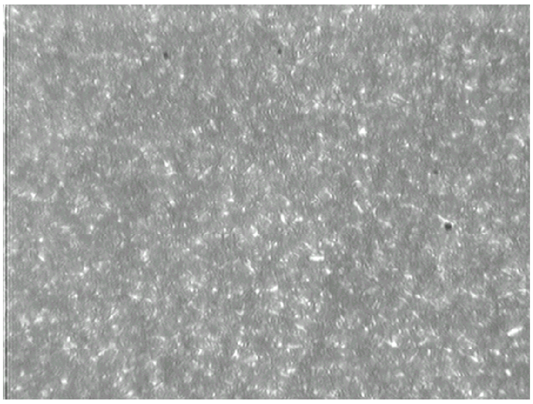

Fig. 10. BA1032 alloy structure, test point H. Magnification 470x. Etch Mi8Cu

4. STATEMENTS AND CONCLUSIONS

1. Use of alternating current to surface-treatment of BA1032 with alloy additives, causes the higher geometrical parameters of weld bead than use a direct one.
2. Treatment of BA1032 with mixtures creating exothermic effect, increases thermal efficiency of the process.
3. Quickly carrying away of heat causes reaction retention of alloy components moved into BA1032, which lead to form a micro-zones weld bead composed with part-reaction products.

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Dr hab. inż. **Tomasz LIPIŃSKI** zatrudniony jest na stanowisku prof. UWM na Wydziale Nauk Technicznych. Zajmuje się metalurgią, inżynierią materiałową, badaniami nieniszczącymi i diagnostyką.

Mgr inż. **Marcin CUDAKIEWICZ** zajmuje się spawalnictwem w firmie BUJALSKI sp. z o.o.

Mgr inż. **Anna WACH** zajmuje się badaniami materiałowymi.

Mgr inż. **Paweł MIKOŁAJCZYK** egzaminator spawalniczy, zajmuje się spawalnictwem, badaniami nieniszczącymi.