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MAPPING DROBOTENKO AND LASER FORMING OF STRUCTURES OF DURALUMIN

Aluminum alloy D16 relating to the alloys of the system Al – Cu – Mg (duralumin) after hardening and aging has a high level of specific strength and resistance to fatigue fracture. Because of these qualities, it is widely used in the production of power components in aviation and space technology and also for the manufacture of parts of machines and devices for various purposes. Quite a number of products from said alloy has the form of a thin-walled metal sheet structures made from thermally pre-hardened blanks. In the aircraft industry is a long panel of the fuselage skin, wing, etc. Most products of this type are manufactured in single and small batch production. Therefore, they are shaping conventional methods greatly increases the cost of production. For example, the complexity of manufacturing the snap-in tool die for processing the panel size 1000 ×12000mm is approximately 7,500 labor hours [1]. The use of more flexible and generic method of the fraction of the shock formation (DUF) significantly reduces labor costs for manufacturing such parts [1,2]. But DUF has a number of drawbacks the most significant of which are changing the shape of the part when operating in conditions of prolonged heating to temperatures ≈1000C, which is a consequence of relaxation of residual stresses, the existence of restrictions in the choice of effective bending radii depending on the thickness of and the need for further action Stripping to reduce the roughness of the machined surface (Fig.1).

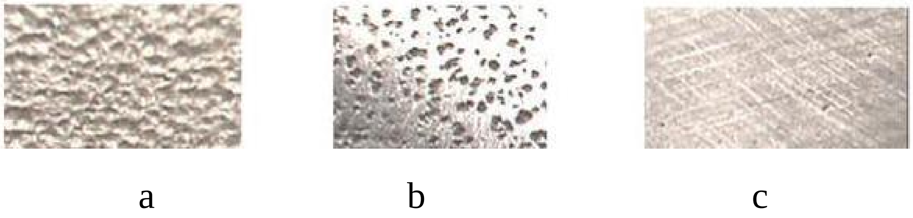

Fig. 1. The surface of the alloy D16T after treatment:
a) shot; b) draft Stripping; C) finish Stripping [3]

In recent years intensively investigated and used in the production technology of laser forming (LF) spatial structures from sheet materials [6]. The essence of the technology is that the laser beam is moved on the workpiece along a certain path. Its interaction with the surface resulting in parts with high temperature gradients, which in turn formed a high level of temporary thermal stress. During the heating step of the thermal cycle is their partial relaxation. The bending moment, which occurs in the cooling phase creates the final shape of the part. LF technology has a number of advantages compared to DUF. Namely, the laser treatment allows much easier to automate the technology of shaping, easy to change the power density of laser radiation and movement speed of the beam, the possibility of transport over long distances and supply in remote places, and the absence of dynamic effects on the surface. In contrast to DUF .parts manufactured using LF do not need additional surface treatment and have virtually no restrictions on the radius of curvature of bending because the laser beam can be focused to a tenth of a millimeter.. But LF designs from previously heat hardened alloys it is necessary to consider possible changes in phase composition, structure and substructure of the heat affected zone (HAZ). It is known that hardening alloys due to aging due to the release inside the grains of the solid solution of highly dispersed uniformly distributed particles of the strengthening phase (dispersion hardening), which efficiently inhibits the movement of dislocations. The increase in the yield strength of the alloy due to dispersion hardening (Δσд.h.) depends on obno fate (S) and size (l) particles [4]:

$$\Delta\sigma д.h. = And\sqrt{}/l \quad (1)$$

where A – coefficient depending on the burgers vector of dislocations and the shear modulus of the matrix.

The output values C and l (after quenching and natural or artificial aging) change significantly when re-heating furnace. The decrease with increasing temperature due to the dissolution of these phases due to the decrease of the maximum concentrations of Cu and Mn in the solid solution based on aluminium and through the process of returning [2]. Coagulation of the particles, which in a natural aged alloy D16 takes place at temperatures t ≥150 0C and holding time τ≥0.5 g significantly increases the value of l [3,4]. That is, when the furnace heating the aged alloy in it over time, the process of softening, which intensifitsiruetsa with increasing temperature. At LF there are two temperature parts of the thermal cycle with high velocity heating and cooling and the average temperature of the workpiece is determined at the points between successive passages (tc). Their experimental measurements and calculated values at different points in the HAZ of LF structures of the alloy D16T is consistent with a high accuracy under different parameters of laser radiation when irradiated with CO2 – laser (wavelength λ= 10.6 µm) [5] and Nd:YAG-laser (wavelength λ= 1.06 µm) [6]. The study of the structure and properties of the HAZ, in contrast, found significant discrepancies. So in the work of Smirnova N..[4] observed almost complete dissolution of hardening phases in the center of the HAZ of alloy D16T after a single passage of the beam, reduced its microhardness (Hµ) to the microhardness of the hardened alloy. In the study of alloy AA2024 – T3 (analog D16T) almost identical treatment parameters revealed non-uniform distribution of microhardness in the cross section of HAZ zones have an original value Hµ and area reduced by 30% for this parameter [4]. Even more significant discrepancies between the results of the study of the structure and mechanical properties of HAZ in case of multiple passing of the beam at similar treatment parameters of the alloy AA2024 –T3 [5].

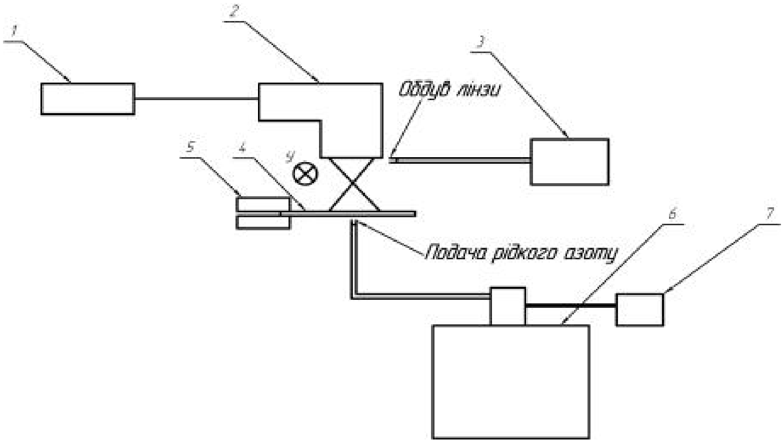

Fig.1. Diagram of LF with additional cooling vapors of liquid nitrogen.

1-emitter, 2-focususa system, 3-ventilator,4-sample,5-mounting for LF,6-Dewar-flask with liquid nitrogen,7 - voltage regulator

Conclusion. Possible by inhibiting the processes of weakening in the HAZ of the aged alloy at LF is a decrease in the average temperature of the workpiece.

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