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The effects of laser shock processing of welded connections

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Laser shock processing is a cold process in which the internal laser radiation falls on the surface and causes the formation of shock waves that penetrate to a greater depth under the surface of the material. The method is applicable to various materials, regardless of their hardness and mechanical properties and can be an alternative to such methods as ultrasonic impact treatment and shot blasting.

The paper considers the use of laser shock processing for processing welded joints of aluminum and titanium alloys. When welding these materials, the structure of the seam is sharply different from the structure of the main material, the size of the grain in the seam and the transition zone can vary by an order of magnitude. The sharp boundary between the weld and the base metal creates conditions in which the zone is the tensile stress concentrator and a sharp change in hardness. Increased hardness in the transition zone leads to its cooling and, consequently, to destruction during tests at loads lower than required. In addition, tensile residual stresses are formed in the ZTV, which also affect the reduction of mechanical properties of the welded joint.

To eliminate these defects, heat treatment in the form of the old of the entire welded product is used. However, in many cases, especially for large-sized products, this technology is not applicable.

We used the method of laser shock processing to equalize the properties and structure of welded joints of Aluminum and titanium alloys, as it allows achieving a greater amplitude and depth of residual compressive stresses, with a lower tendency to stress relaxation than other methods, and provides locality of exposure up to 0.5 mm.

The influence of this method on the microstructure, microhardness and residual stresses in the weld and the heat-affected zone of welded joints is investigated.

For shock treatment, Solar 919 LQ laser system with pulse energy up to 1.0 j and pulse duration up to 10 NS was used. The treatment was carried out by one and several pulses with pulse energy from 180 to 400 MJ.

It is shown that the increase in the number of pulses leads to greater plastic de-formation and grain grinding. In addition strengthens the weld metal and increases its MIK-retardati. Due to this, there is no sharp jump in microhardness between the base metal and the welded joint. As a result, the plasticity in this zone increases.

It is shown that the laser pulse generates a voltage wave or a shock wave of high amplitude on the treated surface. This tension wave propagates deep into the material, forcing the surface layer to deformation plastically, developing residual compressive stresses. When analyzing the processed seams of aluminum and titanium alloys by x-ray method, it was found that tensile stresses in the transition zone are reduced by 2-3 times.

It is established that the effect of improving the efficiency of welded joints can be achieved by using a laser source with relatively low energy in multi-pulse processing.

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Research of the effect of laser beam power and scanning speed on the structure and properties of items made of titanium alloys for aircraft engine building

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Technologies of laser growing of products from titanium alloys are used in the manufacture of critical case-shaped parts and blades in aircraft engine building. Unlike casting and welding, using laser growing can produce products of any geometric shape and smaller weight.

The report presents the results of a comparative analysis of the structure and properties formation of products made of VT6 alloy using direct laser growing (PLA) technologies and layered laser synthesis (PLS) depending on the growing regimes and options for subsequent heat treatment. Specific features of the microstructure of materials obtained by the methods of PLV and PLS are determined. It is shown that, as a result of optimization of the technology, it is possible to obtain products in which porosity is almost completely absent. In this case, the mechanical properties can vary depending on the heat treatment conditions and satisfy the requirements that are imposed on cast and welded structures.