



## **DIFFUSION WELDING AND VACUUM SOLDERING OF STEELS, NICKEL-BASED ALLOYS, DISSIMILAR MATERIALS AND CERAMIC- METAL PRODUCTS WITH NANO-PHASE LAYERS**

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**Project objectives:** improvement of performance attributes of diffusion-welded joints by means of formation of modified surface nanophase microlayers with pre-defined structure and chemical composition.

### **Background and brief project specification**

*Technology description.* Treatment with high-current low-energy electron beam provides surface preparation and activation for joining. It also imparts the treated surface to pre-defined properties and helps to obtain modified surface microlayers with pre-defined chemical composition.

*Application results.* Surface treatment allows to obtain high-energy microstructure close to nano-structure with phase components' and grains' dimension less than 0.1  $\mu\text{m}$ . The treatment results in formation of micro- and submicrostructures with dislocation density increased by several number exponents. It also changes the crystal parameter of the material. Research of alloying of thin surface layers of the materials mentioned above with different chemical elements were done.

Mode of deformation of the material in joint zone greatly affects processes of 3D interaction. Mode of deformation control allows to increase operating characteristics of joints, decrease values of residual stresses and deformations, formation of nano-dimensional recrystallization nuclei.

Research were done to investigate how the active stress level and mode of deformation in units made of different materials (for different combinations of the materials) relates to properties of the materials and shapes of joint components. For the joints mentioned levels of tensions of 3<sup>rd</sup> kind were determined.

### **Practical application**

Diffusion welding including joining with melting layers (pressure soldering in vacuum) is used to produce joints of dissimilar steels and nickel-based alloys with their operating characteristics close to the ones of base material, metal-ceramic units for the needs of aircraft, transport and machine engineering.