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SUMMARY OF THE DISSERTATION

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Influence of selected friction stir welding conditions in FSW process on the structure and properties of joints in aluminum alloy EN AW-6082

Today's rail and aerospace industries are focusing their attention on materials and joining technologies that ensure the formation of structures with the lowest possible weight. In addition to minimizing weight, structures should be characterized by high strength and stiffness, as well as corrosion resistance. Materials used for such structures that meet the above criterias include wrought aluminum alloys. One of the most innovative technologies enabling the joining of wrought aluminum alloys including EN AW-6082 alloy is friction stir welding - FSW. In this method, a rotary motion and a reciprocating motion of the tool are used to heat the materials to be joined, to plasticize them and to form a weld. The use of the FSW method for welding, for example, aluminum alloy EN AW-6082 avoids typical welding incompatibilities, and for some types of structures it becomes the only method of their execution due to the possibility of welding complex shapes of structures and the lack of deformation of welded elements.

The structural phenomena occurring in a FSW joint made of aluminum alloy EN AW-6082, related to the mixing of the material in the solid state, are not fully studied. In addition, technological information in the area of making EN AW-6082 aluminum alloy joints is the guarded “know-how” of the structural component manufacturers. This became the basis for the formulation of the thesis of this work, the purpose of which was to determine the effect of selected FSW friction welding conditions on the structure and properties of aluminum alloy joints.

Dissertation consists of an introduction, eleven chapters and a conclusion.

The introduction, which is the chapter one of the dissertation, defines the research problem, the purpose and indicates the methods of scientific analysis. The second chapter

reviews the literature of the possibilities of joining aluminum alloys by various welding methods. The third chapter characterizes aluminum alloys including aluminum alloy EN AW-6082. The fourth chapter evaluates the possibility of joining this material using various welding technologies. The fifth chapter summarizes the theoretical part of the work. Chapter six indicates the thesis, the objectives of the work including the methodological objective, the cognitive and utilitarian objectives, and the scope of the study. Within the framework of the seventh chapter, the chemical composition was determined and the basic properties of aluminum alloy EN AW-6082 were described. In the eighth chapter, the methodology for testing the structure of the joints was determined, including the selection of the sampling site for structural testing. In chapter nine the temperature and strain field in FSW joints were analyzed. Resulting FEM model was validated against the temperature and strain measurements on the actual FSW joints. Chapter ten describes the technological tests of FSW welding including the parameters of FSW welding, the welding tool, evaluating the temperature field of the welding area, and presenting the results of the joint structure including the results of metallographic studies by the light and scanning microscopy. A 3D reconstruction of the joint using the FIB-SEM technique was also carried out. In the eleventh chapter, the properties of FSW joints were determined, among others, in the static tensile test and bending test as well as the resistance of FSW joints to various types of corrosion was assessed.

The conclusion summarizes the analyzed contents, presents the technological requirements of FSW welding and technological guidelines for welding in production conditions. An economic analysis of the legitimacy of the use of FSW technology was also carried out, and charts of potentially occurring inconsistencies in the FSW welding process were developed.

As a result of the work, the influence of the main parameters of the FSW welding process on the structure and properties of EN AW-6082 aluminum alloy joints was found. It was further assessed that the presented solution can be successfully applied in the conditions of the automotive, railroad and other industries.

The work was completed with the formulation of conclusions.

Keywords: friction stir welding, FSW, aluminum, wrought aluminum alloy, EW AW-6082 alloy.