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Influence of Friction Welding Parameters on Properties of the Al-Cu Joint

In this paper is presented a theoretical-experimental analysis of the aluminum-copper joining by friction welding. Considering that such Al-Cu bimetal joints are widely applied in industrial practice, experimental analysis in this paper was performed on the concrete elements used in electronics. The fact that the joining is done of the two dissimilar materials points to complexity of the problem, since phenomena that appear in the joint zone extremely influence physical, mechanical and structural properties of the welded/base metals. Besides the theoretical analysis of the basic phases and mechanisms of the friction welding process, the research also included experimental analysis of the geometry changes due to the plastic deformation, the change of microstructure and hardness in the joint zone, as well as of the basic mechanical properties of the Al-Cu joint, such as tensile strength. This paper presents some significant results, which point to the possibility for realization of the reliable joints of the two dissimilar metals.

Keywords: Friction welding, bimetal joint, aluminum, copper, mechanical properties, microstructure.

1. INTRODUCTION

Certain physical properties of copper and aluminum, like the high electric and thermal conductivity, enable their common application in electronics, thermo-technique and other areas, in the form of bimetals. The necessity for their joining is indispensable in joining copper and aluminum electric conductors or the cable endings. Studying and improvement of advanced welding technologies of various metals and their alloys, mainly Al, Ti, Mg and different types of steels, are at present in focus of the modern research. The friction by welding plays a significant role in those researches, whether the matter is rotational continuous friction welding (when the cylindrical elements are welded) or the FSW (when the welded elements are plates or thin sheets). Friction welding of various materials was the subject of these authors previous research [1-3], as well as of certain other authors [4-11]. In those articles, it was shown that successful joining by friction welding could be done for different classes of steel [1-5], steels and other metals [6] or the light metals [7-10]. In addition, joints realized by classical friction welding, considered in this paper, can be compared to joints obtained by the friction stir welding procedure [11-14]. Joints obtained by either of the two mentioned friction welding processes exhibit advantages, compared to joints executed by some other welding procedure and it was proven that they could withstand successfully both

static and dynamic loads in exploitation [13, 14].

The procedure of continuous friction welding of parts made of aluminum and copper is presented in this paper. The purpose was to determine the influence of the basic welding parameters (friction time, friction pressure and compacting pressure) on the mechanical and microstructural characteristics of the weld, since the bimetal joint characteristics depend on them.

2. BASIC CHARACTERISTICS, PHASES AND PARAMETERS OF THE FRICTION WELDING PROCESS

The friction welding process is very complex. When observing on the micro level, the mechanism of the joint realization is based on forming the metal bond (solid solution) between the base metals, all due to the diffusion process. That bond is created when the metal clean surfaces are coming close at distances that are of the order of magnitude of the crystal lattice parameters. At the beginning of welding, the contact of the welded parts is being realized only at the roughness tips, while the increase of the contact area is achieved by the plastic deformation of the surfaces in contact. Compacting is done until the boundary surfaces are brought close to each other to a distance that is of the crystal parameters size, what enables forming of the common crystal lattices. The technological process of the friction welding is done in three phases, as presented in Figures 1 and 2.

Friction welding was first applied for joining parts of various types of steel, while welding of light metals started later. The friction welding is a procedure of the compression welding, when the joint is realized by plastic deformation of by friction of the heated contact surfaces. The physical essence of the process is in

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