# Proceedings of TEAM 2015

7th International Scientific and Expert Conference
of the International TEAM Society

15–16th October 2015,
Belgrade, Serbia

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Publisher: Faculty of Mechanical Engineering, University of Belgrade

Editor in Chief: Prof. Aleksandar Sedmak

Editors: Zoran Radakovic, Simon Sedmak, Snezana Kirin

ISBN **978 – 86 -7083 – 877 – 2**

Circulation: 200 copies

Copied by Faculty of Technology and Metallurgy, Research and Development Centre of Printing Tehnology, Karnegijeva 4, Belgrade, Serbia



All papers are reviewed

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CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

62(082)(0.034.2)

INTERNATIONAL TEAM Society. International Scientific and Expert Conference (7 ; 2015 ; Beograd)
Proceedings of TEAM 2015 [Elektronski izvor] / 7th International
Scientific and Expert Conference of the International TEAM Society, 15/16th October 2015, Belgrade, Serbia ; [Editor in Chief Aleksandar Sedmak]. - Belgrade : Faculty of Mechanical Engineering, 2015 (Belgrade : Faculty of Technology and Metallurgy, Research and Development Centre of Printing Technology). - 1 elektronski optički disk (CD-ROM) ; 12 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovne strane dokumenta. - Tiraž 200. - Bibliografija uz svaki rad.

ISBN 978-86-7083-877-2

a) Техника - Зборници
COBISS.SR-ID 218229516

TECHNIQUE, EDUCATION, AGRICULTURE & MANAGEMENT
Belgrade, October 15-16, 2015

7th International Scientific and Expert Conference TEAM 2015
Technique, Education, Agriculture & Management
Belgrade, October 15-16, 2015

# INFLUENCE OF FRICTION WELDING PARAMETERS ON HARDNESS, MICROSTRUCTURE AND MECHANICAL PROPERTIES OF THE Al-Cu JOINT

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**Abstract**

*In this paper a theoretical-experimental analysis of the aluminum-copper joining by friction welding is presented. 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 structure and hardness in the joint zone, as well of the basic mechanical properties of the Al-Cu joint. 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, Aluminum, Copper, bimetal joint, 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 it 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 [4-10]. In those articles, it was shown that successful joining by friction welding could be done for different classes of steel [1-4], steels and other metals [5] or the light metals [6-9]. It was proven that thus realized joint could withstand successfully both static and dynamic loads in exploitation.

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

## 2. Basic characteristics, phases and parameters of the friction welding process

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 released heat is supposed to soften and to plasticize the near-the-contact layers of materials, but the melting temperature of the easier melting material must not be exceeded. In the considered case that is aluminum, which means that the joint weld should be formed at temperature little below than 600 °C. The quantity of the released heat depends on the nature of the base metals, thermo-mechanical properties and the friction coefficient.

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 Figure 1.