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Micro-structure in the joint friction plane in friction welding of dissimilar steels

Nada Ratković[a], Dušan Arsić[a,*], Vukić Lazić[a], Ružica R. Nikolić[a,b], Branislav Hadzima[b]

[a] *Faculty of Engineering University of Kragujevac, Sestre Janjić 6, 34000 Kragujevac, Serbia*
[b] *Research Center, University of Žilina, Univerzitna 8215/1, Žilina 010 26, Slovakia.*

Abstract

In the friction welding of dissimilar base metals occurs an uneven heating in the outside and inside zones of materials what causes appearance of various structures in the joint zone. Considering that the objective is achieving of the homogeneous welded joint, an imperative is to analyze the microstructure of the realized welded joint. By the microstructure analysis, one can establish the relationship between the friction welding parameters and the structure that appears in each of the joint's characteristic zones. In addition, it is possible to analyze the potential appearance of flaws during the welding process and to discover the causes for their appearance in order to prevent those in the future. This paper presents a review and analysis of microstructures of the characteristic joint zones in the friction plane of the two different steels, the high-speed steel and carbon steel for tempering. The experiment consisted of varying the friction welding parameters (friction pressure and friction time) and monitoring of micro structure in the joint zone and its immediate vicinity, both from the side of the tempering steel and the HS steel, as well as defining the present phases and compounds. The emphasis was set on analysis of the melting and the mixing zones and carbides created during the welding.

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1. Introduction

The friction welding occupies an important place, whether it concerns the classical friction welding or the friction welding with mixing. The reason for that are the numerous advantages of the friction welding procedure, with respect to other welding procedures, primarily in regards with environmental protection and human health [1], while simultaneously one obtains the welded joints of the exceptional mechanical properties [2-5]. Analysis of mechanical properties, performed by Handa and Chawla in [2], has assumed studying of joining the austenitic and ferritic steels. That study consisted of the friction welding process parameter optimization, microstructure, mechanical characterization and fracture behavior. Their experimental results indicated that the axial pressure has a significant effect on the mechanical properties of the joint and that it is possible to increase the quality of the welded joint by selecting the optimum axial pressures. The same authors in paper [3] have shown the experimental results that indicate that the rotational speed and the axial pressure have a significant effect on the mechanical properties especially the torsional strength, impact strength and micro hardness. An analysis was conducted by Savić et al. in [4] of joining the high-speed steel HS 6-5-2C and the carbon steel C60, where an attempt was done to form a model of friction welding of the dissimilar materials, by monitoring the temperature cycles and variation of the microstructure during the welding process. Similar investigations were performed by authors in [5-7] where the results which are related to structural and chemical changes in the joint were presented, as well as to the influence of the welding parameters on the joint deformation – shortening and joint diameter. Those results have shown that one of the most important parameters is the welding time and that by its

* Corresponding author. Tel.:+381 64 276 39 81.
E-mail address dusan.arsic@fink.rs

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