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INFLUENCE TEMPERATURE ON THE QUALITY OF JOINT OBTAINED BY FSW PROCESS

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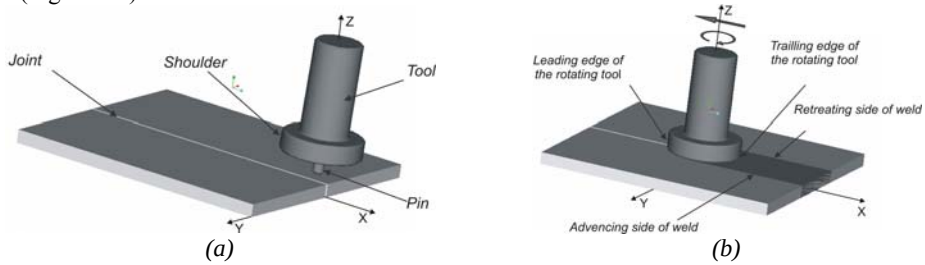
ABSTRACT
This paper describes information measurement system for recording temperature in the FSW, as well as the usage of measuring equipment. A brief review of the process of friction stir welding procedure and the process of temperature measurement is provided. The essence of the process is in connection of dissimilar metal alloys (primarily aluminum alloy) using a rotating tool, with the release of heat, so that the material is plastically deformed and jointed in the solid state. The paper includes the welding of material of aluminum alloy of thickness 7.8 mm, using tools from the plan of the experiment. The paper also discussed the effect of temperature on the quality of the obtained compound.
Keywords: temperature measurement, shoulder, pin, thermal couples, FSW

1. INTRODUCTION

Friction stir welding (FSW) is defined as a method for joining two or more workpieces where a tool, moving in a cyclic manner relative to the workpieces, enters the joint region, locally plasticises it and moves along the interface thus causing a join between the workpieces. Friction stir welding (FSW) is a relatively new technique for joining metals. The process is patented by The Welding Institute - TWI in England in 1991, and invented by Wayne M. Thomas who has successfully joined plates of aluminum alloys [1, 2, 3, 4, 5, 6, 7].

Friction stir welding process is performed in the way that et the work table the milling machines are places that have to be jointed and clamped to the work table. Tools that are used in the process of welding are cylindrical and consisted of two concentric parts, which are rotating at the great speed. A larger diameter part of the tool is called the shoulder, while the smaller diameter part is called the pin. Rotating tool slowly approaches the joint line (Figure 1.a) and plunges into material, which creates heat. (Figure 1.b).



(a) *(b)*

Figure 1. Tool and work piece

It is very important in friction stir welding process to have the knowledge of generated heat, that is obtained from two main sources: a) the heat generated from friction tool shoulder and the area of the work piece, and b) the heat generated from friction the plastic derormations ot the tool pin. [3, 5, 8, 9, 10]. Due to that the temperature increases to the heat metal forming where mechanical mixing and joining of materials is performed, enabling the tool to move in the longitudinal direction or along the joint lines. After passing of the tool along the joint lines the solid phase of weld (joint) remains, where the upper plane remains smooth and flat thanks to the tool shoulder, while the lower plane of the work piece is formed from the basis on which the work piece is standing and it is also smooth and flat [5].

2. TEMPERATURE MEASUREMENT

Temperature measurement in the process of friction stir welding of the similar and dissimilar materials is performed with precise analog-to-digital measuring equipment connected with information measurement system.

Information measurement system is consisted of: sensors - thermal couples, measuring module and the PC with software Measurement & Automation Explorer and LabVIEW where the processing of measuring signals is performed, and data are obtained in graphical and data form (Figure 2) [5].

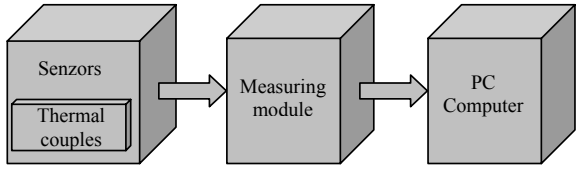


Figure 2. Block diagram of the measuring information system for temperature measurement [5]

Thermal couples are made of Al-Cr wire, which is welded at the top with the device for welding of thermal couples and fine wires. The other end of thermal couple is set in the aperture 1.5 mm of diameter, which was created in work piece to the position of a defined measurement point and it is glued with special adhesive. Scheme of the thermal couples placing is described in Figure 3, and Figure 4 presents thermal couples that are placed in work piece [5].

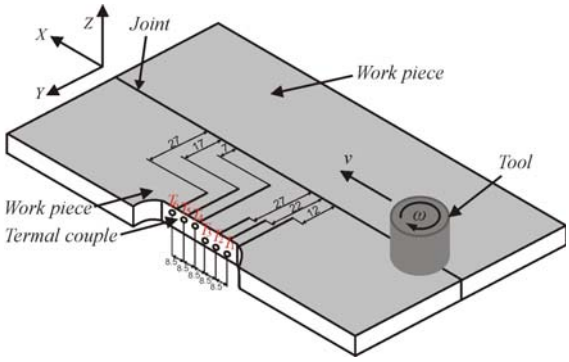


Figure 3. Scheme measuring points of temperature in welding work piece [5]

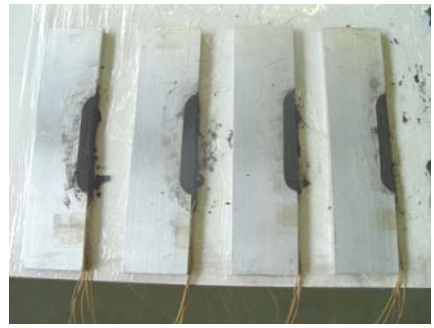
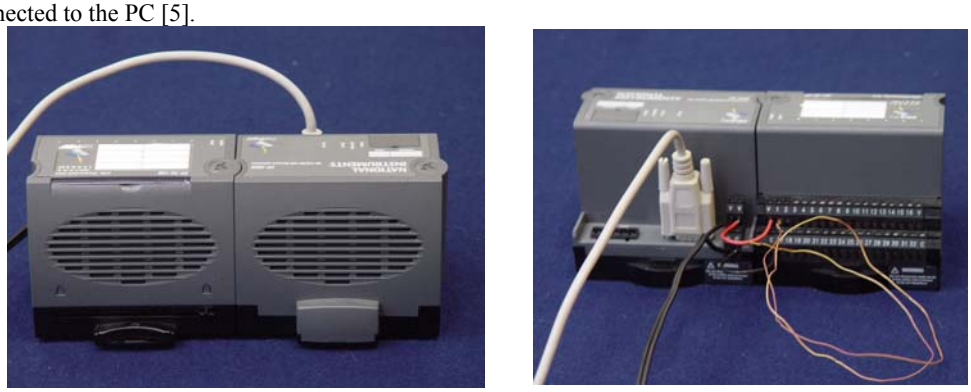


Figure 4. Thermal couples that are placed in work piece dimensions of 200x50x7.8 mm

Measuring module is consisted of a network module type "National Instruments' FP-1000, eight channel input module for thermal couples type" National Instruments' FP-TC-120 and the connection terminals with screws type "National Instruments' FP-TB-1.

Network module is connected to the eight channel input module with a parallel 40-pin port (Figure 5.a) and has the possibility of adding a sequence of input modules type FP-TC-120, for as many channels as there are thermal couples. Network module is connected to the unidirectional current source of 24 V, and over 9-pin standard port to the PC (Figure 5.b). Figure 6 presents a work piece

with thermal couples, which are connected over the input module to the network module that is connected to the PC [5].



(a) *(b)*

Figure 5. National Instruments equipment for temperature measurement - Measuring module [5]

Figure 6. Connected information measurement system for temperature measurement: 1 - work piece, 2 - tool for FSW, 3 - measuring module, 4 - thermo couples, 5 - connection terminals and 6 - PC computer [5]

For data acquisition, the program created with LabVIEW software is used whose manufacturer is National Instruments. Measured values of temperature in certain points of the sample are given in the Figure 7 [5].

3. CONCLUSIONS

Regarding to the pointed complexity of friction stir welding process in the introductory part of the work, it is necessary to make precise measuring of the experimental researches in this field. To achieve this goal a reliable and practical information measurement system for temperature measurement is needed as described in this paper. Information measurement system and other applied equipment can be used for other types of measuring in the above process, but also for other similar technologies, in which the temperature has an important role in the proceeding of the process. Digital data obtained by applying information measurement system such as this, are suitable for further application and processing using modern software such as MATLAB, in that way data processing can be automated. This procedure gets weld very good quality.

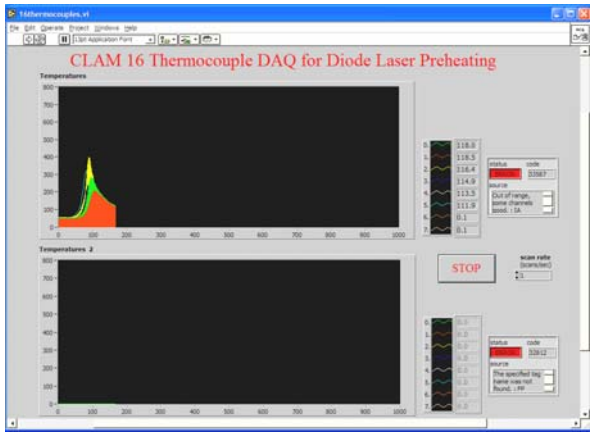


Figure 7. Experimentally obtained temperature [5]

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