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Summaries of the articles

M. Slováček, T. Kik – Numerical simulations of modern joining techniques illustrated with examples of the FSW and EBW methods

DOI: *10.17729/ebis.2017.5/1*

The article aims to present major advantages resulting from the use of tools for numerical analyses of modern welding processes, i.e. friction stir welding (FSW) and electron beam welding (EBW). The article presents basic issues related to the modelling of the FSW process, describes mechanisms to be taken into consideration in relation to numerical analyses of the above-named process and indicates problems which should be taken into account during the modelling of the EBW process. In addition, the article presents exemplary analyses of the FSW and EBW processes.

T. Kik, M. Slováček – Numerical analyses in the modelling of spot resistance welding processes

DOI: *10.17729/ebis.2017.5/2*

The article presents the basics of the modelling of spot resistance welding processes, describes mechanisms to be taken into consideration in relation to numerical analyses of the above-named processes, briefly describes their mutual correlations and presents a simple example of the two-sided single spot welding of two steel plates demonstrating the vast range of analyses offered by a Sysweld state-of-the-art software programme. The foregoing is of great importance during production where, e.g. because of manufacturing continuity, it is not possible to perform related tests. This article aims to present the new possibilities addressed to design

engineers and technologists and offered by the cutting-edge FEM-based software programme for numerical analyses of welding processes and heat treatment.

M. Stępień, Z. Mikno, B. Grzesik – Simulation tests of the welding machine secondary circuit

DOI: *10.17729/ebis.2017.5/3*

The article discusses the analysis of circuit parameters and power losses in the secondary circuit of the welding machine. The analysis was based on FEM calculations performed using the Ansys Mechanical APDL software programme. The tests resulted in the determination of the inductance of the secondary circuit of welding machine horns as the function of the overall dimensions of the above-named circuit. The foregoing made it possible to identify the current response of the circuit to applied DC rated voltage. The determination of power losses included the identification of the distribution of potentials (voltage drops) along welding machine horns, and, subsequently, the determination of the correlation of input power, output power and system efficiency. The tests involved the identification of primary sources of power losses, i.e. mechanical connections, mainly between electrodes and horns as well as in the elastic joint.

M. Korzeniowski, B. Białobrzeska, A. Kowal – Assessment of electrode consumption in resistance welding

DOI: *10.17729/ebis.2017.5/4*

The article discusses the assessment of electrode consumption during spot resistance welding processes. The process was performed using a manipulator provided with a welding head. During the process, welding parameters, environmental conditions and the material subjected to welding remained unchanged. The tests involved the performance of five welding cycles including the making of 100, 500, 1 000, 2 000 and 4 000 welds. Afterwards, to compare the consumption of six sets of electrodes, both used and not used in individual cycles, it was necessary to perform metallographic tests and hardness measurements. The tests revealed that the consumption of electrodes, leading to the lack of penetration in the central area of the weld, resulted from progressive recrystallization in the work area and from physical failure manifested by discontinuities having the form of intercrystalline cracks.

A. Pawłowska – Replacement of projection welding with the spot welding process illustrated using an example of a VW Crafter door window frame

DOI: *10.17729/ebis.2017.5/5*

The process of projection welding is widely used in the automotive industry, e.g. when welding nuts or joining thin car body sheets. The article presents the possible replacement of projection resistance welding with two-sided spot resistance welding performed using an electrode having a smaller work area than that of electrodes used in projection welding. The comparative study involved the performance of technological tests involving both welding methods. Elements subjected to welding were front door frames of a Volkswagen Cratfer (i.e. a light commercial van) manufactured by the Volkswagen factory in Września, Poland. The joints obtained in the technological tests were subsequently subjected to visual and destructive tests.

Z. Mikno. B. Grzesik – Strength of the spot weld with respect to its geometry

DOI: *10.17729/ebis.2017.5/6*

The research presented in the article involved the analysis of the shape of a weld made using the spot resistance double-sided overlap welding of sheets. The analysis was performed using the 3D model of the weld. The analysis of between ten and twenty weld variants enabled the determination of the structure of the ideal weld. The ideal weld structure is composed of three parts, where a thin intermediate element (connector) is placed between two joined sheets. The entire model constitutes a mechanically inseparable whole, where both sheets and the intermediate element are made of the same material. The ideal weld is not subjected to a thermal cycle. The above-named model was supplemented with numerical calculations aimed to identify the most favourable shape of the weld (nugget), e.g. circular, rectangular etc.. The criterion of assessment was the (highest possible) value of shear force obtained in a static tensile test [1]. The article presents the results of the initial stage of research on the ideal weld.

M. Alexy, J. Kundrat, G. Shannon – Resistance welding and laser welding for electrical contacting and micro joining solutions

DOI: *10.17729/ebis.2017.5/7*

The connection of conductive parts for the purpose of electrical contact is one of the oldest, most common joining applications and is required in almost every industry. The electrical contacts realized by welding have to fulfil a wide range of requirements, which have to stay stable within narrow tolerance window over the entire life cycle of a product. These requirements are very good met by both resistance welding and laser welding and these are the two most common joining techniques used in electrical contacting and micro joining today. To successfully apply the resistance welding process suitable materials for contacts must be used. In majority of the cases the cooper alloys are a good compromise between high electrical conductivity and sufficient mechanical strength. Within the cooper alloys CuSn 0,15 is the best compromise for a number of typical applications. While there are a number of choices for laser for micro welding, the CW fiber and nanosecond fiber have distinctive application specialties; Nd:YAG is the established source, with great all around micro welding capability; CW fiber lasers provide excellent speed/penetration characteristics and the ability to weld conductive and dissimilar materials; QCW fiber offers similar capability to the Nd:YAG laser, with additional small spot and penetration features; and finally, the nanosecond laser provides great control using sub 400 nanosecond pulses for thin materials and fine spot applications, as well as some dissimilar materials bonding.

M. Korzeniowski, B. Białobrzeska, M. Maciejewska – Effect of steel grades on technological properties of spot welds

DOI: *10.17729/ebis.2017.5/8*

Because of varying mechanical properties, (e.g. yield point, tensile strength), electric (e.g. electric conductance) and a heat conductivity coefficient, the use of the same welding process parameters leads to the formation of welds having various diameters depending on steels grades subjected to welding [1]. The article describes the effect of typical steels used in the automotive industry (e.g. DC 01, DP 600, DP 800) on the weld diameter, i.e. the primary technological parameter of a welded joint. To ensure process repeatability, welded joints were made using a robotic welding station. Afterwards, weld diameters were measured using destructive tests (technological peeling tests and metallographic examination) and non-destructive tests, i.e. ultrasonic tests performed using an RSWA machine provided with a phased-array transducer and acoustic scanning microscopy.

Z. Mirski, T. Wojdat, Z. Zimniak, I. Łącka, A. Pawełko – Effect of the preparation of aluminium, magnesium and titanium alloys surface on properties of adhesive bonded joints

DOI: *10.17729/ebis.2017.5/9*

The article presents issues related to the joining of hard-to-join metals such as aluminium, magnesium and titanium alloys as well as discusses problems accompanying the joining of the above-named materials and indicates the possible use of adhesive bonding when joining them. The article pays particular attention to appropriate surface preparation for adhesive bonding as a factor determining the proper functionality of joints. In addition, the article presents metallographic tests and results of static shearing tests of adhesive bonded joints in relation to the manner of surface preparation, i.e. grinding, abrasive blasting and low-temperature plasma treatment and demonstrates the significant effect of surface preparation using low-temperature plasma on the strength of adhesive bonded joints.

J. Bellmann, E. Beyer, J. Lueg-Althoff, S. Gies, A. E. Tekkaya, S. Schettler, S. Schulze – Targeted weld seam formation and energy reduction at magnetic pulse welding (MPW)

DOI: *10.17729/ebis.2017.5/10*

Magnetic pulse welding is based on the high velocity impact of two joining partners and a promising technology especially for the joining of dissimilar metallic components. Under proper conditions, a solid-state bond forms at the overlapping interface that is typically at least as strong as the weaker base material. However, high thermal and mechanical loads act on the tool coil and provoke a limited lifetime. Furthermore, the prevalent magnetic fields obstruct a comprehensive process monitoring with conventional means. In this manuscript, approaches for reducing the load on the tool coil without compromising the joint quality are presented. This is obtained by an adaption of the coil geometry and the application of a boundary layer on one of the joining partners. Moreover, a new measuring system taking advantage of the naturally occurring impact flash is evaluated and successfully applied for the process development and detection of process disturbances.

B. Richter – Robot-based Friction Stir Welding for E-mobility and general applications

DOI: *10.17729/ebis.2017.5/11*

There is a fast growing market for friction stir welding applications in many industrial areas of transportation where the focus is on light weight. Along with the aviation, railway vehicle and shipbuilding industries, the automotive industry is expecting a high growth rate over the coming years. Based on the advantages of the friction stir welding technology, such as excellent weld quality, high potential for saving and eco-friendly process, the market share for friction stir welding of automotive parts will also greatly increase. Following a general introduction to the friction stir welding process, a presentation of the tooling and expected quality of various types of joints will be given. Using examples from automotive manufacture, the requirements for component design for a variety of friction stir applications will be highlighted. Our process control and documentation system is the basis for the implementation of Industry 4.0 and ensures the required traceability, quality and data transparency. Kuka Industries has the experience and expertise to develop and implement cost-effective complete solutions with high process reliability. The benefits and special features of robot-based friction stir welding will be demonstrated with the aid of design concepts for production systems.

K. Kudła, K. Wojsyk – Selected possibilities of the FSW and FSSW methods in the removal of material defects and welding imperfections

DOI: *10.17729/ebis.2017.5/12*

The article describes unconventional applications of friction stir welding (FSW; linear) and friction stir spot welding (FSSW) processes including the possibility of removing material defects and welding imperfections. The article presents results of tests involving aluminium alloys and demonstrates various repair methods in relation to types of material defects and welding imperfections.

P. Nosal, M. Hebda – Effect of FSW process parameters on properties of aluminium joints

DOI: *10.17729/ebis.2017.5/13*

Ever since its development in the 1990s, the friction stir welding method (FSW) has been increasingly popular in various industrial sectors, e.g. in transport, power engineering or electronic industry. In spite of its numerous advantages in comparison with conventional joining methods, the FSW method continues to be intensively investigates to develop appropriate technological parameters and geometry of tools ensuring the obtainment of joints characterised by excellent properties. The process of optimisation is required for each new material. The adjustment of proper FSW process parameters, particularly the tool rate of rotation and the travel rate, enables the obtainment of imperfection-free joints as well as significantly affects process efficiency decreasing its laboriousness and costs. The article addresses issues connected with the optimisation of the FSW process by analysing the effects of changes in the tool travel rate and the rate of rotation on structural and mechanical properties of aluminium joints. The tests involved the use of aluminium alloy grade 6063. The test joints were subjected to visual tests, hardness tests, microstructural examination, static tensile tests etc.

P.N. Tkach, A.W. Moltasov – Development of methods for the assessment of stresses in welded structure elements. Part 2. The latest methods

DOI: *10.17729/ebis.2017.5/14*

Disadvantages of traditional methods for the determination of stresses in stress concentration zones of welded joints discussed in the first part of this overview required to be classified and inspired the development of technologically advanced solutions. The article contains an overview of works concerned with methods and approaches to the determination of maximum local stresses present in the abovenamed stress concentration zones. The article provides classification of methods in accordance with international documents and regulations, presents advantages and disadvantages of existing assessment methods concerning near-weld stresses as well as discusses further research trends.

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