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Characteristics of Phase Transformations in Medium-Carbon Nanobainitic Steel of High Hardenability
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Key words: isothermal and continuous phase transformations, medium-carbon steel, nanobainite, dilatometric analysis, microstructure, mechanical properties

The article presents results of phase transformations taking place in steel having a carbon content of 0.55 %, characterised by high hardenability (NBH) and intended for the industrial fabrication of sheets. Phase transformations were examined using the dilatometric method under continuous cooling conditions (CCT) and during isothermal holding (TTT), using results of microstructural observations and those of hardness measurements of dilatometric specimens. The research work involved developing the diagram of phase transformations under continuous cooling conditions, using a cooling rate range of 0.025 °C/s to 50 °C/s and a fragment of a diagram of isothermal phase transformations within the temperature range of 200 °C to 275 °C. The Authors proposed a new type of isothermal diagram of phase transformations developed for a specific cooling rate from austenitisation temperature, equal to v (TTTv), enabling its application in the precise design of industrial isothermal specimens. The analysis of dilatograms as well as that of microstructural observations and dilatometric specimen hardness test results enabled the identification of experimental parameters applied in the heat treatment of specimens made of the NBH steel used in tensile tests. The research-related tests confirmed information contained in scientific reference publications that the presence of retained austenite of blocky morphology did not necessarily resulted in the low plasticity of nanobainitic steel. After the isothermal transformation into nanobainite at a temperature of 225 °C and that of 235 °C, the steel (NBH) contained approximately 20 % of retained austenite, including blocky austenite transformed into martensite during deformation and characterised by favourable plasticity restricted within the range of 13.6 % to 15.5 % of ultimate elongation in relation to a strength of 1.9 GPa.

Application of classical titration and ICP-OES techniques for the determination of total iron, metallic iron, and iron(II) as a tool to assess the feasibility of ferrous metallurgical waste management
Piotr Knapik, Aleksandra Latacz, Michał Kubecki
DOI: 10.32730/mswt.2024.68.1.2

Key words: ferrous waste, classical analytics, ICP-OES, iron speciation

The introduction of ferro-bearing waste into a technological process requires knowledge of the quantitative contribution of iron at different oxidation levels. The work aimed to develop an effective strategy for handling the test material to obtain information on iron speciation, relevant for the assessment of the ferro-bearing waste reuse potential. To determine the different forms of iron in metallurgical waste, titration methods and the optical emission spectrometry with inductively coupled plasma technique (ICP-OES) were used. The iron content in the waste material ranged from a few to more than 90 %, and the proportion of the different forms varied. The effectiveness of ICP-OES in the determination of total and metallic iron was confirmed, while classical methods did not always provide reliable results.

Determination of Welding Characteristics of Controlled Metal Transfer in the Arc of Self-Shielded Electrodes
Krzysztof Makles
DOI: 10.32730/mswt.2024.68.1.3

Key words: pulsed welding, metal transfer, pulse parameters

Surfacing with self-shielded flux-cored wires, referred to in scientific publications and encountered in industrial practice, is performed using welding equipment of output voltage characteristics. The transport of metal in arc is stochastic, usually within mixed arc, where the short-circuit flow is accompanied by unfavourable, i.e. globular, one. For this reason, the above-named processes are characterised by significant spatter. The research work presents an original method for shaping the characteristics of pulsed arc, enabling the controlled short-circuit-free transport of droplets. The impulse characteristic differs considerably from that applied previously in pulsed arc, used to melt solid wires.

The Effect of a Heat Input to the Joint during the Gas Metal Arc Welding of Ferritic-Austenitic Steel 1.4462 on Welding Deformations
Stanisław Pałubicki, Wiesław Czapiewski
DOI: 10.32730/mswt.2024.68.1.4

Key words: ferritic-austenitic steel, heat input, welding deformations, welded joint macrostructure

Welding is a special process, the result of which cannot be fully guaranteed despite the use of all possible and available procedures leading to the correct fabrication of the welded joint. The quality of a joint made in the welding process cannot be fully verified during inspection and testing, where any discrepancies may only become apparent during product operation. The aim of the tests presented in the article was to determine the impact of changes in the value of welding linear energy (heat input) and of correlations between values of process parameters (current, arc voltage and welding rate) on welding deformations of joints made of ferritic-austenitic steel using the GMAW method. The testing methodology, involving the performance of tests based on an experimental scheme, enabled the development of a mathematical model of test object (MMTO). The analysis of the MMTO revealed its usability in explaining (and forecasting) the mean square surface flatness deviation (i.e. a parameter used to assess the value of joint flatness deviation) in relation to values of welding process input parameters under specific implementation conditions and assumed significance level $\alpha = 0.05$. The tests revealed the existence of a narrow range of heat input, in relation to which welding deformations were relatively small (as the correlation between welding deformations and heat input during the welding process was not a monotonic function).

Effect of Welding Parameters on the Strength of Safety Cages

Mateusz Sowa

DOI: 10.32730/mswt.2024.68.1.5

Key words: automotive industry, safety cell, testing of welded joints, safety cages, welding, racing sports, roll cages, motorsport

Safety cages, constituting essential equipment in sports cars, aim to reduce consequences of potential accidents. These structures should provide the highest possible and reproducible level of workmanship aimed to ensure their strength as that assumed at the design stage. Because of the fact that welding is the primary technology used in the fabrication of safety cages it is highly necessary to analyse the effect of welding parameters as well as the choice of welding methods on process repeatability and strength properties of welded joints. The aim of this study was to determine the influence of the welding method on the strength of test cruciform joints of tubes as well as to investigate the effect resulting from the change of MAG and TIG welding current parameters on the linear deformation of welded joints. The article discusses the effect of welding process conditions on the static strength of cruciform joints in steel E355 +N (used in the fabrication of safety cages). The tests revealed that an increase in heat input during welding significantly reduced the strength of cruciform joints as well as significantly contributed to an increase in post-weld linear deformation, which, in terms of spatial safety of cage structure, could lead to a significant pile-up of stresses.

Electron Beam Welding of Butt Joints in Titanium Grade 2

Paweł Pogorzelski

DOI: 10.32730/mswt.2024.68.1.6

Key words: electron beam welding, titanium, titanium Grade 2

Titanium's excellent mechanical and physical properties make it a popular structural material commonly used in industry. However, the high chemical activity of titanium at high temperature necessitates the use of high-quality shielding gas during the welding process. The study discussed in the article aimed to assess the effect of welding parameters on the structure and mechanical properties of 3 mm thick butt joints in titanium Grade 2 (3.7035) made by means of the electron beam welding method under vacuum conditions without using the filler metal (511). The verification of joint quality involved the performance of hardness measurements, tensile tests, bend tests as well as macro and microscopic metallographic examinations. The tests results revealed the obtainability of joints characterized by appropriate penetration depth and geometry as well as optimum mechanical properties.

Effect of Arc Ignition Voltage on Vibration Generated in Autonomous RLC circuits. Part 1: Mathematical Models of Circuits and Criteriafor Classifying Their Solutions

Antoni Sawicki

DOI: 10.32730/mswt.2024.68.1.7

Key words: electric arc, arc ignition voltage, chaotic oscillation criteria

The article discusses reasons for the occurrence of non-linear vibration in selected welding systems. Special attention was paid to the effect of auxiliary systems on the reduction of arc ignition voltage and, consequently, self-excited vibration. The study involved the development of mathematical models of simple autonomous circuits with electric arc of specific ignition voltage. The article also describes selected criteria for enabling the recognition of non-linear vibration types. Particular attention was paid to difficulties accompanying the identification of conditions triggering the formation of deterministic chaos.