Materials Science and Welding Technologies

Technologie Materiałowe i Spawalnicze

ISSN 2956-9273

Vol. 68
2/2024

Łukasiewicz
Upper Silesian Institute of Technology

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Editor

Łukasiewicz
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The Impact of Strontium Modification on the Microstructural Characteristics and Mechanical Performance of High-Pressure Die Cast AlSi9Cu3(Fe) Alloy

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DOI: 10.327730/mswt.2024.68.2.1

Key words: AlSi9Cu3(Fe) alloy, high pressure die casting, strontium modification, microstructure, mechanical properties

The microstructure of the HPDC AlSi9Cu3(Fe) alloy is characterized by fine dendrites of α-Al solid solution and α-Al+β-Si binary eutectic mixture. In addition, the alloy contains many intermetallic phases, such as α-$Al_{15}(Fe,Mn,Cr)_3Si_2$, β-Al_5FeSi, Al_2Cu, π-$A_8Mg_3FeSi_6$ and Q-$Al_5Mg_8Cu_2Si_6$. The paper presents results of research concerning the influence of Sr-based modification on the microstructure and mechanical properties of the HPDC AlSi9Cu3(Fe) alloy. The research-related tests involved three different high-pressure die cast specimens, i.e. two castings with different Sr contents (i.e. 40 ppm and 130 ppm) and one without an Sr addition. The addition of Sr was responsible for the fragmentation of eutectic silicate crystals, which was advantageous for the microstructure of the test specimens. However, the aforesaid addition also triggered an increase in the volume fraction of porosity in the structure, which, most likely, resulted in the deterioration of mechanical properties.

Advancements in Transition to Green Steel in Europe through Direct Reduced Iron Production

Alicja Szemalikowska

DOI: 10.327730/mswt.2024.68.2.2

Key words: direct reduced iron, direct reduction, green steel, greenhouse gases emissions, steel production in Europe

This article describes the current situation in Europe regarding methods of steel production and transition to green steel, produced in a sustainable way, i.e. with renewable energy and without fossil fuels, in order to reduce greenhouse gas emissions. The study focuses on direct reduction (DR) as potentially the best technology to eliminate the use of fossil fuels in the steel industry. The main commercial processes of direct reduced iron (DRI) production such as MIDREX, Energiron, PERED, SL/RN, Fastmet and Circored are described and compared in terms of the quality of finished products, operational conditions and efficiency. The article presents recent statistics regarding the production capacity of DRI, comparing Europe with the rest of the world. Plans concerning the construction of DRI plants across Europe are summarised alongside other projects aimed to support the process of transition to green steel by providing environmentally friendly materials or increasing efficiency of already implemented technologies by recycling waste materials.

Electron Beam Surface Hardening of Gear Teeth

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DOI: 10.327730/mswt.2024.68.2.3

Key words: electron beam, surface hardening, gear hardening

Surface hardening is an effective method enabling the improvement of the wear resistance of components subjected to friction, without the necessity of hardening the entire component. Because of easy dynamic deflection and focusing as well as due to very high heating rates, the use of electron beam enables the obtainment of layers characterised by suitable properties. The article describes the electron beam surface hardening of gear teeth made of steel 34CrAlNi7-10 (1.8550) as well as discusses metallographic test results and Vickers hardness measurement results demonstrating the effectiveness of the method in the obtainment of layers characterised by uniform thickness and a hardness of 660 HV0.1.

Spectral Analysis in Assessment of Multispot Projection Welding

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DOI: 10.327730/mswt.2024.68.2.4

Key words: resistance welding, projection welding, quality control, spectral analysis, non-destructive quality control methods

The article presents the possibility of an innovative use of spectral analysis to control the quality of joints welded using the multispot projection welding method. The tests discussed in the article included the analysis of welding machine and welding fixtures frequency. The analysis consisted in the impulse-based excitation of vibrations in the entire system (including the welding machine and elements subjected to welding) and the recording of the object response using an acceleration sensor. The results were afterwards subjected to spectral analysis using the Fourier transform. As a result, it was possible to identify the effect of the lack of a weld on the free vibration frequencies of the entire system. Related quality control was performed by comparing the free vibration frequency spectrum of reference elements with that of elements not containing a metallic joint between them. The acquisition and analysis of measurement data were carried out in the LabView environment. The test results confirmed the possibility of using spectral analysis to control the quality of the projection welding process.

Electron Beam Welding of High-Strength Aluminium Alloys

Piotr Śliwiński, Marek St. Węglowski, Kamil Kubik, Piotr Gotkowski

DOI: 10.327730/mswt.2024.68.2.5

Key words: welding, electron beam, aluminium, metallography, microstructures, mechanical properties

Owing to the greater precision of energy density control, the highest possible metallurgical purity of the process and the lack of sensitivity to reflectivity and surface roughness, electron beam welding is a suitable method for joining aluminium alloys. The paper presents results concerning the welding of aluminium alloy grades 6060 and 6061 as well as experimental alloys having higher copper contents. The tests discussed in the paper led to the obtainment of joints characterised by a high strength of up to 289.7 MPa and the lack of unacceptable imperfections.

Influence of Arc Ignition Voltage on Vibrations Generated in Autonomous RLC Circuits
Part. 2. Oscillations in Circuits with Arc of Undefined and Specified Ignition Voltage Values

Antoni Sawicki

DOI: 10.327730/mswt.2024.68.2.6

Key words: electric arc, arc ignition voltage, Lyapunov exponents

The determination of parameters and initial conditions responsible for the formation of chaotic vibrations necessitated the considering of mathematical models of simple circuits with electric arc of unspecified ignition voltage. The use of numerical calculations made it possible to identify ranges of circuit element parameters, where at least one of the Lyapunov exponents of chaotic attractors had a positive value. The subsequent stage of the research work discussed in the article involved the reduction of arc ignition voltage until all exponents reached negative values. The above-named situation corresponds to the disappearance of chaotic vibrations in the circuit. The tests revealed low relative current values of the arc model causing the aforementioned bifurcation.