MAIN TOPICS, ABSTRACTS & KEY WORDS

Key technical problems and development status of hollow tungsten arc welding

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Abstract Arc characteristics of hollow tungsten arc in the atmospheric environment and low vacuum environment and its welding characteristics were briefly introduced. Technical characteristics and research status of hollow tungsten coaxial laser hybrid welding, coaxial electron beam hybrid welding, and coaxial wire filling welding were summarized. The unique technical characteristics of the organic integration between "high-efficiency welding" and "high-quality forming" of hollow tungsten coaxial wire filling welding were analyzed. The challenges faced by the engineering application of hollow tungsten arc welding were reviewed. It was pointed out that the progress of this technology would largely depend on researchers who could make breakthrough achievements on the following key scientific and technological issues, such as putting forward a new idea for the optimization design of hollow tungsten electrode welding gun from the perspective of arc stability and welding metallurgy, stable burning boundary conditions and control measures of welding arc in hollow tungsten and coaxial hybrid heat source, the coordinated control of welding wires' stable melting and the droplet transfer process in hollow coaxial filler wire welding, phase transformation and microstructure evolution of the weld in the non-equilibrium solidification process.

Key words: **hollow tungsten**, **coaxial welding**, **optimization design**, **process control**

Microstructure and properties of laser welded joint between 316L stainless steel SLMed and forged parts

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Abstract In this paper, laser welding technology was used to connect 316L stainless steel SLMed and forged parts. The process optimization was carried out and the microstructure and properties of the joint were studied. The results showed that the joints appeared good laser weldability without obvious defects. Microstructures of the SLMed parts and laser-welded joints consisted of the cellular dendrite in austenite matrix within the columnar grains. Compared with the SLMed parts, the joints exhibited a coarser dendrite microstructure, lower microhardness, tensile properties. Mechanical properties of the joints met the practical application requirements. The anisotropy of SLMed acted a negligible role in determining the microstructure and mechanical properties in the laser-welded joints. The joint obtained by welding SLMed parts parallel to the building direction to forged parts could obtain finer dendrite microstructure and higher tensile properties.

Key words: **selective laser melting**, **laser welding**, **316L stainless steel**, **anisotropy**, **mechanical properties**

Numerical simulation of plasma cutting arc in high pressure environment

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Abstract Taking plasma arc as the research object, a two-dimensional axisymmetric finite element mathematical model of the tip was established and the model was meshed by Anysy-workbench software under basic assumptions. Based on the hydromagnetics and arc plasma theory, the control equations and boundary conditions of the air plasma arc model were established. In the Flunent software, the user-defined equation UDF command was used to add the source term of the arc control equation and the physical parameters of the air plasma, and the UDF command was imported to compile and solve the arc model. The simulation results showed that with the increase of environmental pressure under

the same welding current, the maximum temperature of the air plasma cutting arc showed a downward trend. Based on the 2 MPa high pressure welding test chamber, the plasma arc cutting test system in high pressure environment was established. The system mainly consisted of high pressure plasma arc cutting power supply, automatic cutting car, arc monitoring device and so on. Through the designed horizontal output transformer, stable arc starting under 0.4 MPa was achieved. Based on this, plasma arc cutting experiments under normal pressure and high pressure were carried out, and the influence of pressure on the shape of plasma arc was studied.

Key words: high pressure environment, plasma cutting, arc, temperature field

Thermal analysis of LTCC substrates during reflow cooling

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Abstract A finite element thermal analysis model of welded component for an aerospace electronic product was established in the cooling process, and the variation of the thermophysical parameters of the Si-Al shell and Pb-Sn solder with temperature was investigated. Taking the minimum first principal stress produced in LTCC substrate as the optimization object, the optimized cooling process parameters were obtained by the orthogonal test method. Simulation and experimental research on the reflow welding cooling process were carried out under the process parameters. The results showed that the overall deformation of LTCC substrate was a bulge from the bottom of the substrate to the inside of the shell, which was consistent with the inspected results. The maximum value of the first principal stress of LTCC substrate distributed at the corners of the substrate, but it was not big enough to cause crack. The welding quality of LTCC substrate could be effectively improved by the cooling process parameters proposed in this paper.

Key words: welded component, reflow soldering, orthogonal test method; LTCC substrate

High temperature fatigue performance of 10%Cr heat resistant steel/Ni-based alloy welded joints

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Abstract Taking a new type of 10% Cr heat-resistant steel/ ENiCrFe-1 nickel-based alloy welded joint as the research object, its microstructure and high temperature fatigue properties were studied. The results showed that due to great differences in microstructure and element composition between 10% Cr heat resistant steel and ENiCrFe-1 nickel-based weld, the joint between the two materials formed a very obvious interface in the macroscopic view, while it was found that the interface was essentially a transition zone of microstructure and element composition with a width of about 11 μm in the microscopic view. From heat-resistant steel to nickel-based alloy weld, Fe content (mass fraction) decreased rapidly from 82% to 20%, while Ni content (mass fraction) increased rapidly from 0.3% to 60%. The microstructure of the interface near the heat-resistant steel contained lath martensite and other subcrystalline microstructure, while the interface near the nickel-based weld was smooth without subcrystalline microstructure. Under the condition of high temperature and low cycle fatigue, welded joints fatigue fractured at the interface.

Key words: welded joint, interface, microstructure, fatigue performance

Corrosion fatigue crack propagation behavior of AZ31 magnesium alloy friction stir welded joint

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Abstract In this paper, the corrosion fatigue crack propagation behavior of AZ31 magnesium alloy friction stir welded joint was studied. The results showed that the corrosion fatigue crack growth threshold and strength in all areas of AZ31 magnesium alloy joints in 1% (mass fraction) NaCl solution were lower than that in the air environment, but the crack growth rate was higher. In the air environment, the base metal area