MAIN TOPICS, ABSTRACTS & KEY WORDS

Preparation and performance analysis of a new type of SnZn medium-temperature high-strength lead-free solder paste

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(Tsinghua University, Beijing 100084, China). p1 – 5

Abstract A new type of SnZn-based lead-free medium-temperature high-strength solder paste was prepared. The alloy composition was Sn-9Zn-2.5Bi-1.5In with a melting point of 195 ℃, which has good printing performance and welding performance. The shear strength of SnZn solder paste was studied and compared with the leading SnAgCu solder paste on the market and SnBi solder paste. The results show that the shear strength of SnZn solder paste ishigher than that of the other two solder pastes on the surface tin-plated solder pads (14% higher than SnBi system and 25% higher than SnAgCu system), which is inferior to other nickel-gold pads. Two solder pastes are placed between the two on the OSP pad. At the same time, it was found that SnZn solder paste obtained the highest shear strength of 62.9 MPa when the maximum temperature of the temperature curve was 215 ℃. By observing the profile of SnZn solder paste solder joints, the element distribution was analyzed and the soldered joints were determined. An intermetallic compound (IMC) formed on the surface of the disk.

Key words: **lead-free solder paste**, **tin-zinc system**, **shear strength**, **profile analysis**, **pad surface process**

Study on diffusion bonding of structural steel/tin bronze

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Abstract The joining of 30Cr3MoA structural steel to ZQSn10-2-3 tin bronze was realized by vacuum diffusion welding. The tensile strength of the joints at different processes were tested, and the microstructure of the joints was observed by scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS). The results show that the quality of diffusion bonded joint is the best at 820 ℃. The strength of joint can be increased by increasing pressure and prolonging holding time. The tensile strength of joint can reach up to 294 MPa at 820 ℃/1 h/10 MPa process. The tensile specimens are all broken in tin bronze base metal. The weld seam is defect-free metallurgical bonding and the interdiffusion layer between Cu and Fe elements is about 3 μm in thickness.

Key words: **structural steel**, **tin bronze**, **diffusion bonding**, **properties**, **microstructure**

Arc welding data acquisition and analysis system based on Twin CAT and C#

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Abstract To ensure the real-time monitoring of the welding process and optimize the welding process parameters to improve the welding quality, a data acquisition and analysis system for the arc welding process was developed. According to the requirements of the production site and data acquisition analysis, a real-time acquisition system hierarchical framework model was constructed. The design scheme of distributed arc welding real-time data acquisition system was proposed based on sensors, real-time analog input terminals and embedded controllers, ADS protocol and real-time Ethernet as real-time communication protocol, TwinCAT PLC and C# as development language. The real-time acquisition, display, storage and welding quality analysis of arc voltage, current, ion gas and shielding gas were realized in the arc welding process. The digital integration of welding equipment was completed and the workshop management level was improved.

Key words: **TwinCAT**, **C#**, **real-time acquisition**, **quality analysis**

Laser micro-welding of flex lead with solder paste

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Abstract There are some problems of low efficiency and poor consistency in manual welding of flex lead. In order to realize automatic soldering, an experimental platform with micro-dispensing solder paste, visual location of soldered joints, laser heating and infrared temperature measurement was designed. Firstly, the emissivity calibration and accuracy measurement of infrared thermometer was performed, the coaxiality compensation between laser energy center and camera vision center was made. The micro-spot welding experiment was carried out on the gold-plated pad. Finally, the conductivity of the soldered joints of the 30 μm flex lead was measured. The experimental results show that there are some problems in laser micro-welding with solder paste such as pseudo solder joints, multi-tin beads generation, variability of contact area of soldered joints and flux residue. By optimizing the laser heating power curve and the process, a soldered joint with good conductivity about 0.2 mm in diameter has been obtained. The automatic design of laser and solder paste micro-welding of flex lead is feasible.

Key words: **laser micro-welding**, **solder paste**, **infrared temperature measurement**, **visual location**

Influence of section size of explosive on effect of welding residual stress relieved by explosive and its numerical simulation

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Abstract Through the theoretical analysis of the impulse generated during the relieving process of the residual stress by the explosion, it is explained that at the same explosive parameters and the mode of distribution, the effect of the width of the strip on the residual stress relieving is larger than that of the thickness of the strip. At the same time, the relationship between the width of the strip and the thickness of the strip was determined, and the calculation formula of the width of the strip was given. Based on the indirect coupling of welding temperature field and stress field to solve the welding residual stress, the ANSYS/ LS – DYNA nonlinear finite element analysis software was used to simulate the process of relieving residual stress at different explosives of different cross-section explosives. The results show that when the width of the strips is the same and more than twice the thickness of the explosive, as the thickness of the explosive increases, the impulse generated by the explosion does not change, and the level of welding residual stress is basically the same. When the thickness is the same, as the width of the explosive increases, the impulse generated by the explosion increases, and the level of welding residual stress is increased.

Key words: **explosion treatment**, **welding residual stress**, **impulse**, **strip section**, **numerical simulation**

Research progress on solid/liquid interfacial reaction of steel/aluminum dissimilar metals

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Abstract The essential problem of welding steel/aluminum dissimilar metals is how to suppress the formation of interfacial intermetallic compounds. In this paper, the types, morphology, thickness and factors affecting the growth of intermetallic compounds under solid/liquid interfacial reaction were summarized. In addition, a brief overview of the intermetallic compounds growth model was presented, and the problems in these models were analyzed. Most of the models do not consider the dissolution behavior. In some models the dissolution behavior was taken into account, but the approximate solutions do not fit well, and further research is needed.

Key words: **steel/aluminum dissimilar metals**, **solid/liquid interfacial reaction**, **intermetallic compounds**, **growth model**

Welding technology of expandable special section tube

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Abstract Expandable Profile Liner is a kind of special section tube which would have a large deformation with hydraulic differential pressure. The weld should have good mechanical properties because the tube string should remain sealed during expansion. In order to improve the performance of weld seam, a number of welding methods were adopted which include TIG bottom welding, arc welding or TIG consmetic welding, one-side welding with back formation and detailed welding process procedure. Horizontal and vertical alignment devices are manufactured for the workpiece on downhand and overhead welding position. For the purpose of avoiding the influence of weld defects on expansion performance, a digital X-ray imaging defect detection technology was used, which has the functions of defect type identification, location extraction and size measurement. The measurement accuracy is up to 0.01 mm. The results of stretching and winding qualitative assessment are up to standard. The finite element method is used to simulate the expansion state of weld seam so as to verify whether the welding seam meets the requirements of application in wellbore. The simulation analysis shows that the stress is less than the strength of weld seam in expansion process. The weld seam shows excellent performance in laboratory test and field application. Four wells have been used in the field, and the success rate is 100%.

Key words: **special section tube**, **expandable**, **welding process procedure**, **accompanying tools**

The technology of repairing the complex heat conduction structure of nickel/stainless steel

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Abstract Aiming at the difficulties in the repairing welding technology of electroformed nickel and stainless steel, manual TIG welding repairing technology was studied. The results show that the microstructures of electroformed nickel/stainless steel after one repair welding and two repair welding has no obvious difference. It was found that the tensile strength of the specimens after repair welding was similar to that of the electroformed nickel base material after primary welding. All the specimens were fractured on the electroformed nickel side, and the tensile fracture morphology showed that all the joints are ductile fracture, and the welded joints has high mechanical properties.

Key words: **welded joint**, **electroformed nickel**, **repair**

Coiled tubing all-position automatic TIG welding process and its microstructures properties of welded joint

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Abstract In order to solve the issue of unstable welding quality for manual TIG welding of coiled tubing, a kind of all-position automatic TIG welding process was designed. By using this welding technology to conduct butt welding of QT900 coiled tubing with ϕ50.8 mm × 4.11 mm in dimensions, and the joint appearance, microstructures and mechanical properties of the welded joint were analyzed. The results showed that for the coiled tubing pipe-pipe butt joint welded by this welding technology, the welds are well formed and the microstructures of weld, fusion zone and phase transformation zone are mainly consisted of equiaxed ferrite, granular bainite, granular pearlite and lath-like bainite under the effect of phase transformation recrystallization. At the same time, the grain sizes in the above zones become thinner compared with that of the base metal. The hardness of joint obviously increases, its tensile strength is improved about 2.6% and fracture occurs at base metal. Fine-grain strength and phase transformation strength are the main factor for the increase of hardness and tensile strength.

Key words: **coiled tubing**, **automatic TIG welding**, **welding process**, **microstructure**, **mechanical performance**

Application of simulation technology in feasibility study of space solar array wire welding

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Abstract Feasibility analysis of space solar array wire welding was carried out, and welding thermal field, temperature field and stress field were numerically simulated through finite element modeling and simulation. The results show that the welding process of space solar array wire includes the pre-pressing process of surface contact affected by elastic-plastic deformation and the indirect coupling process of electro thermal temperature field and welding stress field. By extracting the numerical simulation results of welding temperature field distribution, the reasonable distribution of welding temperature field can be quickly and intuitively analyzed. The changing trend of welding parameters during welding process provides theoretical support for the engineering application of space solar array wire welding.

Key words: **space solar array**, **resistance butt welding**, **finite element simulation**, **numerical simulation**

Properties of 2219 aluminum alloy additive manufactured by Cold Metal Transfer welding process

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Abstract Four different arc modes which includes CMT, CMT-pulse (CMT-P), CMT-Advanced (CMT-ADV) and CMT pulse advanced (CMT-PADV) were used to deposit 2219-Al wire. The effects of different power modes on porosity, pore size distribution, microstructure evolution and mechanical properties were analyzed. In order to test the mechanical properties of 2219 aluminum alloy, a number of single channel multi-layer thin wall walls have been deposited by four different arc modes. The statistical distribution of the porosity shows that the CMT-PADV model has the smallest pore area percentage, and there are almost no larger diameter stomata. The results of optical microscope and scanning electron microscope show that the grain of CMT-PADV mold is more uniform and fine, and the fine second phase Al_2Cu particles are precipitated. In addition, the X diffraction analysis of the sample shows that the lattice parameter of the sample at CMT-PADV mode is the least, and the content of solute Cu is the highest. The results of mechanical properties show that the tensile strength of CMT-PADV mode in horizontal direction is less than 5 MPa in vertical direction, and its mechanical properties have been improved obviously compared with other three modes.

Key words: **CMT additive manufacturing**, **2219 aluminum alloy**, **porosity**, **structure property**

Correction of structural stress method for fatigue test of T-joint

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Abstract In order to predict the fatigue life of the welded structure more accurately, a finite element analysis model was established based on the fatigue test of T-joint. At the 50% survival rate, the displacement control model of verity method, the load control model of verity method, and the VOLVO method were adopted respectively to predict the fatigue life of the T-joint. It is shown that the calculate results of the load control model of verity method are more safe and the results of VOLVO method are more dangerous. The results of the displacement control model of verity method are the closest to the actual ones. Then, based on the test data, the flexible *S-N* curve of the VOLVO method was revised, and the results of the modified model can reflect the actual project accurately.

Key words: **structural stress method**, **verity method**, **master S-N curve**, **VOLVO method**, **welding structure fatigue**

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