MAIN TOPICS, ABSTRACTS & KEY WORDS

Microstructure and mechanical properties of Mg/Al friction stir lap welding joint assisted by stationary shoulder XU Zhiwu[1], LI Zhengwei[1], FENG Yan[1,2], YAN Jiuchun[1] (1. Harbin Institute of Technology, State Key Laboratory of Advanced Welding and Joining, Harbin 150001, China; 2. College of Materials Science and Chemical Engineering, Harbin Engineering University, Harbin 150001, China). pp 1 – 6

Abstract: In this work, stationary shoulder was used in friction stir lap welding (FSLW) of dissimilar magnesium alloy to aluminum alloy. Effect of the welding speed on microstructure and mechanical properties of the lap joint were mainly studied. Results show that the stationary shoulder can enhance the material mixing between the two alloys. The stir zone (SZ) is characterized by a big onion ring after welding, in which plenty of intermetallic compounds (IMC) can be obtained. Excellent metallurgical bonding can be observed at the lap interface. Microhardness of the onion ring is higher than other regions of the joint due to the IMC. X-ray diffraction (XRD) pattern analysis shows that the main IMCs formed in the SZ are Al_3Mg_2 and $Al_{12}Mg_{17}$. Lap shear failure load of the joint firstly increases and then decreases with increasing the welding speed. The maximum load is obtained when using 40 mm/min.

Key words: Stationary shoulder; friction stir lap welding; dissimilar alloys; onion ring; intermetallic compounds

Numerical simulation of arc in sheet slanting electrode tungsten insert gas welding LI Yuanbo, LI Xiao, WANG Shiqing, DONG Hui (College of Materials Science and Engineering, Xi'an Shiyou University, Xi'an 710065, China). pp 7 – 12

Abstract: The three-dimensional quasi-steady state mathematical model of arc in sheet slanting electrode tungsten insert gas welding is presented based on the fluid dynamic equations and Maxwell equations. The distributions of temperature field, velocity field, electrical field and current density about arc in sheet slanting tungsten electrode are obtained. The results show that the temperature field, velocity field, electric field and current density of arc are symmetric in the thickness direction of sheet slanting tungsten electrode. The maximum temperature, velocity and current density of arc in sheet slanting tungsten electrode are lower than those of arc in cylinder tungsten electrode under the similar parameters. The sheet slanting tungsten electrode can change the gap width of arc discharge to lead the current density concentrate on the location with smaller gap width, whereas the current density would also flow backward along the hypotenuse of sheet slanting tungsten electrode due to that the arc lags behind sheet slanting tungsten electrode's motion, consequently the distribution range of current density and temperature field expand in width direction of sheet slanting tungsten electrode. The local extensive distribution of current density would occur with variation of tilt angle of hypotenuse of sheet slanting tungsten electrode, and this causes the shift of cathode jet and region with higher temperature near cathode.

Key words: welding arc; sheet slanting tungsten electrode; three-dimension model; numerical simulation

Simulation and experiments of ultrasonic welding temperature field of 6061 aluminum alloy LI Yulong[1], LIU Dafan[1], CHA Yingpeng[2] (1. Key Lab for Robot & Welding Automation of Jiangxi Province, Mechanical & Electrical Engineering School, Nanchang University, Nanchang 330031, China; 2. Jiangxi Isuzu Motors Co., Ltd, Nanchang 330200, China). pp 13 – 16

Abstract: An attempt in situ monitor temperature evolution during the ultrasonic welding process within a few hundred milliseconds, a 3D thermal-mechanical coupling finite model in ANSYS software was established. In this study, the ultrasonic welding process of 6061 aluminum alloys was analyzed, the temperature fields of different welding parameters were simulated, and the associated welding temperature was tested by using fine-wire thermocouples. The results show that the accuracy of the finite model was verified for the highest temperature errors between the experimental values and the simulated values were within 5%, the highest temperature regions located in the central region of welding zone and the area of the highest temperature regions enlarged as the welding time increased, and the temperature fields were mainly effected by the welding pressure and time.

Key words: ultrasonic metal welding; finite element analysis; plastic deformation; aluminum alloy; temperature measurement

Fatigue life prediction of SnAgCu-X solder joints based on Anand model KONG Da[1], ZHANG Liang[2], YANG Fan[2] (1. College of Water Conservancy and Electric Power, Heilongjiang University, Harbin 150080, China; 2. School of Mechanical & Electrical Engineering, Jiangsu Normal University, Xuzhou 221116, China). pp 17 – 21

Abstract: Based on Anand model, finite element method was used to analyze the stress-strain response of Sn3.8Ag0.7Cu-X (Ce, Fe) solder joints in WLCSP device, and the fatigue life of solder joints were calculated using fatigue life prediction model. The results indicated that deformation of the WLCSP device in service was found, and the significant warp of the PCB can be observed, the deformation-stress-strain in the ball array increased obviously from central solder joint to corner solder joint, the corner solder joints under the chip become the danger area of the whole device. The fatigue lives of SnAgCu, SnAgCuCe and SnAgCuFe solder joints were calculated, it was found that the fatigue life of SnAgCuCe and SnAgCuFe were higher than SnAgCu solder joints, which demonstrated in theory that the addition of Ce and Fe can improve the fatigue life of SnAgCu solder joints, which can provide the theory support for the researches of lead-free solders.

Key words: creep model; lead-free solder joints; stress-strain; fatigue life

Intergranular corrosion behavior of 2219 aluminum alloy's welding join ZHANG Shufang[1,3], HAO Yunfei[2], WANG Xiaomin[3], CHEN Hui[1], LIAO Xiaoyao[3], LI Mingxing[3] (1. Research Center of Sichuan Advanced Welding and Surface Engineering, Southwest Jiaotong University, Chengdu 610031, China; 2. Capital Spaceflight Machinery Company, Beijing, 100076, China; 3. School of Life Science and Engineering, Southwest Jiaotong University,

Chengdu 610031, China). pp 22 – 26

Abstract: The corrosion behavior of 2219 aluminum alloy and its welding joints (made by FSW and TIG welding) were investigated through intergranular corrosion test and polarization curve measurement. Metalloscope, laser scanning confocal microscope and scanning electron microscopy were employed to analyze the corrosion morphology, and corrosion products were measured by energy spectrometer. The results show that the corrosion behavior of 2219 aluminum alloy and its welding joints are related to precipitated phase, and the precipitation of Al_2Cu phase leads to the dissolution of poor Cu zone as the anode. The base metal shows the worst corrosion resistance ability, whose pitting corrosion develops to exfoliation corrosion along the rolling direction in corrosion media (NaCl + H_2O_2). The corrosion resistance of FSW joint is superior to that of TIG joint. TIG joint shows intergranular corrosion with network cracks, and FSW joint shows corrosion pits distributing scatteringly on the surface.

Key words: 2219 aluminum alloy; welding joint; pitting; intergranular corrosion; polarization curve

Simulation research of plates collision in process of electromagnetic welding YING Zhiding[1], LIN Qijun[1], LIN Jianpin[2], GU Lingyan[1], YAN Song[1] (1. Institute of Railway & Urban Mass Transit Research, Tongji University, Shanghai 201804, China; 2. School Mechanical Engineering, Tongji University, Shanghai 201804, China). pp 27 – 30

Abstract: This article describes a welding test of two aluminum plates both about 1mm thick, a test that performed on a designed plate-welding test platform. The observation of the microstructure of the wavelike welding interface which is scanned by SEM is shown in this article as well. In order to make some explanations, a 3D numerical modeling of the collision between two welding plates during the EMW process is performed. Then the regularity of the changable vertical stress and the curve of colliding velocity are obtained and the simulation corresponds with the experimental observation. As a result, not only the colliding velocity but also the colliding position affect the colliding stress, the colliding velocity, stress and the fluidity of materials lead to the wavelike welding interface, so controlling them is the key to improve welding effect.

Key words: plate; electromagnetic welding; collision simulation; press; velocity

Fatigue life and strengthening research of welded joints with hole defects by using electromagnetic heating FU Yuming[1], ZHAO Huayang[1,2], DU Wenlian[1], LI Yanfang[1], ZHENG Lijuan[1] (1. Mechanical Engineering College, Yanshan University, Qinhuangdao 066004, China; 2. Mechanical Engineering College, Inner Mongolia University for the Nationalities, Inner Mongolia 028043, China). pp 31 – 34

Abstract: Aiming at the hole defects in the welded joints, by the ZL-2 super pulse discharge generator, the welded joints of 9CrSi steel with hole defects were discharged by electromagnetic heating and the fatigue life were tested before and after discharge by using self-designed fatigue testing machine. The discharging instant stress intensity factors were theoretically calculated. The result shows that there is an optimal discharge voltage for the fatigue life. Under the action of 5.5 kv pulse discharge voltage, the average fatigue life of welded joints after discharge are increased by 10%. The electrothermal stress intensity factor is negative that weaken the crack driving force, thereby extending the fatigue life of the welded joints.

Key words: electromagnetic heating effect; hole; crack arrest; fatigue life; welded joints

Electromigration induced growth behaviors of tin whisker on tin coating YAO Zongxiang[1,2], LUO Jian[1], YIN Limeng[2,3], JIANG Deping[2], WANG Gang[2], CHEN Zhigang[2] (1. The State Key Laboratory of Mechanical Transmission, Chongqing University, Chongqing 400030, China; 2. School of Metallurgy and Materials Engineering, Chongqing University of Science and Technology, Chongqing 401331, China; 3. State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China). pp 35 – 38

Abstract: In this paper, the effect of electromigration on growth behaviors of tin whisker on the tin coating with a thickness of 6.5 μm was investigated, the current density was 0.3×10^4 A/cm^2, and electromigration loading time was 0 h, 48 h, 144 h and 240 h respectively. The results show that electromigration accelerate the tin whisker formation and growth on the electroplated tin coating, and the length of the tin whiskers increases with the increasing of electromigration time. In addition, voids occur firstly at the cathode after current loading. With longer loading time, voids are observed at both anode and cathode, and cracks are also found at the cathode. The length of tin whiskers increases with the increasing of current density. The average maximum crack width is close to 9.2 μm with the current density of 0.5×10^4 A/cm^2.

Key words: electromigration; tin whisker; tin coating; void; crack

Microstructure and cavitation erosion performance of WxC reinforced Ni-base alloy composite coating by plasma transferred arc welding LIU Shunyao[1], ZHANG Song[1], CUI Wendong[2], ZHANG Chunhua[1], WU Chenliang[1], SUN Zunlai[3] (1. School of Materials Science and Engineering, Shenyang University of Technology, Shenyang 110870, China; 2. Shenyang Blower Works Group Corporation, Shenyang 110869, China; 3. Shenyang Vacuum Technology Institute, Shenyang 110042, China). pp 39 – 42

Abstract: In-situ synthesis of W_xC particle reinforced Ni-base composite coating was synthesized on 316L stainless steel by plasma transferred arc welding. Microstructure, phase constitent, the distribution of reinforced particle, microhardness and cavitation erosion property were investigated by using SEM, EDS, XRD, microhardness tester and ultrasonic vibrator, respectively. Results indicate that Colmonoy 88 coating exhibits a perfect plasma hardfacing tracks and the microstructure is dense. When the molten pool temperature is below 1 655 K, WC and W_2C reinforced particles are in situ synthesized during the melting process. When the molten pool temperature is higher than 1 655 K, the in situ synthesized WC particles are dissolved. The phase constituents of the coating are mainly composed of γ-Ni solid solution, in-situ synthesized W_xC particles and a small amount of Cr_7C_3, Fe_3W_3C and CrB_2. The average microhardness of the coating is 1 619 HV, which is 8 times than that of the substrate. The cavitation erosion resistance of the Ni based composite material is 5 times than that of the substrate in 3.5% NaCl solution.

Key words: plasma transferred arc welding; nickel base alloy; in situ synthesized WC; cavitation erosion

Detection of tight-butt joint weld based on multi-scale morphology of magneto-optical image GAO Xiangdong, CHEN Tingyan, ZHANG Yanxi, YOU Deyong, ZHANG Nanfeng (School of Electromechanical Engineering, Guangdong University of Tech-

nology, Guangzhou 510006, China). pp 43 – 46

Abstract: A magneto-optical sensor is applied to acquire magneto-optical images of tight-butt joint weld whose width is less than 0.1mm. Edge details are often missed and the accuracy of weld detection is influenced when traditional morphology algorithm is applied to detect the edge of micro-gap weld magneto-optical image. Thus, selecting structure elements of three different scales at each different four directions with an approach of multi scales and multi structure elements based on morphology is used to acquire the micro-gap weld edge information. Also, the multi-scale edge detection result is compared with those results using traditional wavelet transform and Sobel algorithm. Three groups of experiments are carried out under different magnetic induction fields to detect the weld center by using the approaches based on multi-scale morphology and traditional morphology, respectively. According to the results, the multi scales and multi structure elements approach can obtain the micro-gap weld center more effectively, which provides a testing basis for tight-butt joint weld recognition and tracking.

Key words: magneto-optical imaging; tight-butt joint weld; morphology; multi-scale structure element

Corrosion and deposition mechanism at position of defect in circumferential weld of gas pipeline XU Zhenzhen, WEI Chao, ZHANG Jianxun (State key laboratory for mechanical behavior of materials, Xi'an Jiaotong University, Xi'an 710049, China). pp 47 – 50

Abstract: Metallographic microscope and EDS (energy dispersive spectrometer) were used to investigate the reason which caused the pipe blockage of the gas field in Jingbian. Results showthat there are CO_2 corrosion, H_2S corrosion and crevice corrosion in the natural gas pipeline. The deposits are mainly corrosion products such as iron oxides, iron chlorides and iron sulfides at this stage. As the corrosion continues, the pipe and the fluid inside the pipe are separated by the compact corrosion products. The type of deposits transforms from corrosion products to dust as the corrosion rate drops. When the height of deposits reaches a certain value, the top of the pipe suffers from erosion corrosion because the flow direction of fluid inside the pipe changes. And the corrosion rate accelerates. The thickness of pipe is so thin that it endangers the safety operation of the pipeline.

Key words: welded joint; gas pipeline; corrosion mechanism; deposition mechanism

Effect of addition amount of TiO_2 on morphology and microstructure of slag during underwater wet welding LI Haixin, YANG Zhenlin, YIN Ziqiang, ZHANG Linlin (Shandong Provincial Key Laboratory of Ocean Environmental Monitoring Technology, Institute of Oceanographic Instrumentation, Shandong Academy of Sciences, Qingdao 150011, China). pp 51 – 54

Abstract: In this paper, the autonomous rutile type carbon steel electrode was used for underwater wet welding. It focused on the effect of the addition amount of TiO_2 in the coated on the morphology and microstructure of slag. By composition and phase analysis of slag, the main phase of slag was $Fe_2MnTi_3O_{10}$, and it also contained a small amount of Ca_2SiO_4 and free oxides. By morphology and microstructure analysis of slag, it found that when the addition amount of TiO_2 was larger, the slag was compact. Furthermore, the gray stripe phase in the microstructure of slag was bulky, which was advantageous to the detachability of slag. With the decrease of addition amount of TiO_2 and increase of addition amount of $CaCO_3$, the slag became loose and viscous slag occurred. Meanwhile, the gray stripe phase in the microstructure changed thin, which was not advantageous to the detachability of slag.

Key words: TiO_2; underwater wet welding; slag; microstructure

Influence of residual stress on drop-weight test performance of rail welded joint ZHU Zhiming[1], FAN Kaiguo[1], LIU Han[1], WANG Yongdong[2] (1. Department of Mechanical Engineering, Tsinghua University, Beijing 100084, China; 2. Institute of Materials Science and Engineering, Heilongjiang University of Science and Technology, Haerbin 150022, China). pp 55 – 58

Abstract: The residual stress distributions of rail joint welded by narrow-gap arc welding are measured before and after heat treatment and are compared, and then the influence of welding residual stress on the drop-weight test performance of rail welded joint is analyzed by combining the drop-weight test results with fracture appearance. The experimental results show that, there exists a comparative large residual tensile stress in the parts of web and jaw of rail welded joint before heat treatment, where the crack source forms easily under the action of shock load from drop weight, afterwards, the crack extends and propagates to base metal along the rail web, until the rail welded joint ruptures. The maximum value of residual stress in rail welded joint declines 1/2 ~ 2/3 after heat treatment, the resistant capability of rail welded joint to shock load is improved significantly, and the rail welded joint ruptures vertically along the weld center or heat affected zone during drop weight test. When there is larger residual stress within rail welded joint, the crack is easy to generate and accelerating propagate in the part existing larger residual stress under the action of shock load from drop weight, and resulting in final fracture.

Key words: welding residual stress; flame heat treatment; drop-weight test; narrow-gap arc welding

Comparasion of methods to determine CTOD from single edge notched specimens LI Yizhe[1], WANG Dongpo[1], DENG Caiyan[1], GONG Baoming[1], WANG Sheng[2] (1. School of Materials Science and Engineering, Tianjin University, Tianjin 300072, China; 2. Shenzhen Chiwan Wins Treasure Prosperous Engineering Co., LTD, Shenzhen 518000, China). pp 59 – 62

Abstract: The determination of CTOD (crack tip opening displacement) has significantly affected the safety margin of design as well as the service life in enginnering critical assessment. Single edge notched tension (SENT) specimens is considered appropriate for the determination of CTOD in pipelines. There are several calculation methods against CTOD of SENT specimens while no unified standard has been agreed. In this paper, comparasion between various methods and the double-clip method for API X70 steel through SENT experiment is conducted. Evaluation of influece on critical crack size by different calculation methods with Crackwise 4.0 is performed. Compared with the double clip method, other calculation methods for CTOD deviated significantly, and the accuracy of fracture toughness has a great inlfuence on critical crack size of ECA assessment.

Key words: fracture toughness; fitness for service; validation; evaluation

Effect of graphene nanoplates on microstructure and properties of Sn-58Bi solders QIU Xiliang[1], HAO Chengli[2], XIU Ziyang[1], HE Peng[1] (1. State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China; 2. Beijing Huahang Radio Measurement & Research Institute, Beijing

100013, China). pp 63 – 66,71

Abstract: In the present work, Sn-58Bi composite solders with different amount of graphene nanoplates (GNSs) have been prepared by powder metallurgy method. The melting point of the solder was slightly affected by the addition of few amount of GNSs. With the increase of the amount of GNPs, the density and vickers microhardness were firstly increased to the peak value and then decreased with further addition of GNSs. It has been found that the brazed joint of Sn-58Bi/Cu substrate could be significantly improved by the addition of GNSs. The improvement should be attributed to the grain refinement and the dispersion strengthening effect of GNSs.

Key words: graphene nanoplates; Sn-58Bi solder; microstructure; shear strength

Analysis of mechanical properties and microstructure of flux-cored wire for railway transportation equipment steel

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Abstract: Aiming at 450 MPa level low-alloy high-strength steel for railway transportation equipment, a flux-cored wire with excellent welding performance, high strength toughness and good fatigue resistance was developed. The tensile property, low-temperature impact toughness, fatigue strength and microstructure of flux-cored wire deposited metal were analyzed. The results indicate that the composition of flux-cored wire is designed reasonaby. The microstructures are mainly acicular ferrite and granular bainite. The grain size is fine. Therefore the strength toughness is effectively improved and the excellent low-temperature toughness and fatigue strength are obtained. The tensile strength, low-temperature impact toughness at −40 ℃ and fatigue strength of flux-cored wire deposited metal achieve 620 MPa, 96 J and 354 MPa, which are 1.1, 1.6 and 2.2 times of the target value of design respectively. The developed flux-cored wire can meet the welding requirement of 450 MPa level low-alloy high-strength steel for railway transportation equipment.

Key words: flux-cored wire; composition design; low-temperature toughness; fatigue strength

Influence of the parameters of welding procedure on mechanical properties of laser welded SS/Nb joint

SHI Mingxiao[1], ZHAO Jian[2], HU Qingxian[1], CHEN Shujin[1], ZHOU Fangming[1], WANG Weilin[3] (1. School of Materials Science and Engineering, Jiangsu University of Science and Technology, Zhenjiang 212003, China; 2. School of Materials Engineering, Shanghai University of Engineering Science, Shanghai 201620, China; 3. Engineering Technology Research Institute, PetroChina Southwest Oil & Gas Field Company, Chengdu 610017, China). pp 72 – 76

Abstract: The influence law of the parameters of welding procedure on the tensile strength of laser welded stainless steel/niobium joint was studied by the orthogonal experiment. The results show that the tensile strength of joint decreased with the increase of welding speed, the strength of joint gradually rose with the laser beam moving from niobium to steel, and the influence of laser power on the strength of joint is very little. Among the three parameters of welding procedure, the influence of welding speed on the strength of joint is the largest, subsequently followed by the beam offset, and the influence of laser power on the strength of joint is minimum. The welding method of low welding speed and beam-offset to steel can improve the tensile strength of welded joint. The weld zone mainly consists of the IMC zone on the niobium side, the dendrite zone at the weld center and the dendrite zone on the steel side. The microstructure of joint mainly consists of plenty of γ austenite phase and a certain amount of Fe_2Nb with little δ ferrite phase. The forming of Fe-Nb intermetallic compounds is the main reason for reducing the strength of joint.

Key words: niobium; 304 stainless steel; laser welding; parameters of welding procedure; strength of joint

Performance study of high boron clad layer welded by PTA on hydraulic support piston rod surface

DING Weidong, LI Zhuoxin, LI Guodong (College of Materials Science and Engineering, Beijing University of Technology, Beijing 100024, China). pp 77 – 80

Abstract: In this paper, plasma transferred arc welding (PTA) is used to prepare high boron clad layer on hydraulic support piston rod surface. The microstructural, component distribution, phase constitution, microhardness, wear resistance and corrosion resistance are analyzed. The results show that four high boron clad layers is formed well and no cracking, microstructure homogeneity are found. With the increase of the boron content, the microhardness of clad layer increases gradually with the maximum 440 HV_{20}, and wear resistance increases first, then decreases. In salt spray test, No. 1 and No. 2 clad layers don't have corrosion points after 480 hours, which shows the good corrosion resistance. Finally it is concluded that No. 2 wire has high corrosion resistance which has well microhardness and wear resistance at the same time. It meets the demand of hydraulic support piston rod.

Key words: plasma transferred arc welding; hydraulic support piston rod; high boron clad layer

Stability evaluation of laser-pulsed MIG hybrid welding process based on MATLAB

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Abstract: Since the stability of welding process is directly related to welding quality, and the larger number of electrical signals collected during laser-pulsed MIG hybrid welding are difficult to extract valid data rapidly, a method based on MATLAB to evaluate the stability of laser-pulsed MIG hybrid welding process is proposed in this paper. The current cycle T with average and standard deviation was considered to estimate the cyclitic of welding process, the difference value d between peak current and base current with average and standard deviation was considered to estimate the volatility of welding process respectively, combining with two aspects to above evaluate the stability of welding process comprehensively. To verify the reliability of the method proposed in this paper, four groups of laser-pulsed MIG hybrid welding experiments were carried out. The analysis results with current wave form, arc shape, droplets transfer characteristics and welds appearance of test were consistent with the results by using the method put forward in this paper. The evaluation method proposed in this paper is proved to be effective and reliable.

Key words: MATLAB; laser-pulsed MIG hybrid welding; stability evaluation

Microstructure and properties of dissimilar high-temperature alloy joints (GH648/K42) brazed with BNi68CrWB filler metal

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Abstract: Dissimilar high-temperature alloys (K24 and GH648) were joined by using BNi68CrWB filler metal. Influence of brazing temperature, holding time and fit-up gap on microstructure and properties of joints were studied. It indicated that three typical microstructure areas were observed in the joints, e.g. eutectic area, isothermal solidification area and diffusion area. When brazing temperature was too high, the counts of W-Cr-Ni phase increased and then the mechanical properties decreased. Prolonging the holding time promoted the diffusion between brazing filler metal and matrix, and did benefit to obtain uniform solid-solution, and consequently the strength of joints increased. However, overlong holding caused the strength of joints decreased. The fit-up gap had little influence on the joints. Maximum strength value could be reached for the joints with fir-up gap of 0.05 ~ 0.10 mm brazed at 1 150 ℃ for 30 min.

Key words: BNi68CrWB filler metal; GH648/K42 joint; microstructure; mechanical property

Analysis of sea test results of underwater wet multi-pass welding of DH36

CHENG Fangjie[1,2], LIU Yang[1], GAO Wenbin[1], WANG Dongpo[1,2], LIU Yongliang[3], XU Wei[3] (1. School of Materials Science and Engineering, Tianjin University, Tianjin 300072, China; 2. Tianjin Key Laboratory of Advanced Joining Technology, Tianjin 300072, China; 3. Offshore Oil Engineering Co., Ltd. Tianjin 300452, China). pp 111 – 114

Abstract: In this paper, underwater wet manual multi-pass welding of different joint types was successfully completed through the diver welders after training. Butt joints in the flat position, lap joints in the horizontal and vertical positions, and T-joints in the vertical and flat positions were obtained under 11 m and 22 m water depths in the Bohai Sea. The test results indicate that all of the indexes of the joints welded at 11 m and 22 m water depths meet the requirements of the Class B Weld according to AWS D3.6 M: 2010. Compared with the joints welded at 11m water depth, the microstructures in the weld seam obtained at 22m depth have much more block ferrite and less amounts of acicular ferrite. The coarse-grained heat-affected zones of the joints at the two water depths are mainly composed of lath martensite.

Key words: underwater welding; underwater wet electrode welding; multi-pass welding; sea test

Effect of finishes of oxygen-free copper on laser welding cracks

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Abstract: Utlilizing 300 W Nd:YAG laser with the wavelength of 1.06 μm for laser weld to study the effect of electroless plating and electroplating on the weldability of oxygen-free copper shell microwave module. Based on the orthogonal test of five factors and four levels as well as setting multiple-pulse waves to match laser weld technological parameters, the typical laser weld technological parameters are established. By using the above-mentioned typical parameters, a beautiful, homogeneous microstructural, and sealed weld seam can be obtained. It is studied that the difference of electroplating technology has great effect on the quality of weld seam. When electroless plating nickel, there exists P can vaporize easily and form multiple low-melting compounds, which increases the tendency of cracks during solidification. When electroplating nickel, there existis no any P, which can form well-shaped weld seam without cracks. The seal test shows that the air impermeability of oxygen-free copper microwave module is below 5×10^{-9} Pa·m^3/s, the one-off qualified rate of product is above 95%.

Key words: laser weld; cracks; electroless plating nickel; electroplating nickel

Investigation on friction stir welding of Mg-Li Alloy

ZHANG Jing, FENG Xiaosong, ZHANG Chengcong, HUANG Hui, YIN Yuhuan (Shanghai Aerospace Equipments Manufacturer, Shanghai 200245, China). pp 119 – 123

Abstract: The friction stir welding of MBL10-200 Mg-Li alloy with a thickness of 3 mm was investigated. Concentrating on the process characteristics, the effects of friction tools, welding parameters on weld appearance, and mechanical properties of the joints were studied. The mechanism and solution of joint ductility loss were both investigated. The results show that with relatively wide process window (rotation speed 800 ~ 1 600 r/min, welding speed 200 ~ 500 mm/min), welds with good appearance can be obtained. Joints under most welding parameters fracture at base metal, and shows comparable strength with base metal. The joint elongation shows apparent decrease, 8% ~ 57% of base metal under varied welding parameters. The non-uniform deformation of WNZ, TMAZ and base metal in the joint is the main reason of ductility loss. Annealing of the welded joints can effectively increase the elongation, nearly 96% of base metal.

Key words: Mg-Li alloy; friction stir welding; process characteristics; mechanical properties

Development of intelligent brazing technology

HE Peng, ZHANG Ling (State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China). pp 124 – 128

Abstract: Intelligent brazing as one part of the five major projects in Intelligent Manufacturing Engineering, based on the new brazing material, new technology and the new development of computer skills, control theory, artificial intelligence, will enter into a totally new stage of development. At the same time, the high speed of the internet provides a platform for the database technology, expert system, artificial neural network and fuzzy control system of brazing. It is concluded that the intelligent brazing development is the inevitable trend of the progress of the world. In this paper, it proposed the intelligent brazing concept, and designed the process of the overall intelligent brazing, introducing the knowledge database, expert system, neural network and fuzzy control theory, furtherly, analyzing the intelligent brazing technology. In the end, the development trend of intelligent brazing is discussed.

Key words: intelligent brazing; artificial intelligence; brazing technology