MAIN TOPICS, ABSTRACTS & KEY WORDS

University of Aerospace Technology, Guilin 541004, China). pp 17 – 20

Abstract: The 3D finite element analysis models of 3D-TSV interconnect structure were developed. By using ANSYS, the finite element analysis of the stress distribution in the model was performed under the condition of thermal-structure coupling. The TSV height and the TSV diameter, the micro-bump height and the micro-bump diameter were selected as four key configuration parameters, combinations were designed. By using an $L_{16}(4^5)$ orthogonal array the 3D-TSV which have 16 different configuration parameters´ levels. The maximum stress values within 3D-TSV were obtained. Variance analysis was performed based on the values of stress. The results show that the TSV height has highly significant impact on the stress of 3D-TSV under random vibration with 99% confidence. The TSV height, the TSV diameter, the micro-bump diameter and the micro-bump height affect the stress of 3D-TSV in a descending order. The single-factor analysis of variance shows that the stress and strain in TSV interconnect structure increase with the height of TSV.

Key words: 3D stacked IC package; through silicon via; random vibration; finite element analysis; variance analysis

Random vibration analysis of QFP with different structure parameters CUI Haipo, CHENG Enqing (Shanghai Institute for Minimally Invasive Therapy, University of Shanghai for Science and Technology, Shanghai 200093, China). pp 21 – 24

Abstract: Random vibration responses of QFP with different structure parameters were analyzed based on the ABAQUS software. The stress distributions of whole packaging and solder joints were obtained. The influence regularities of different lead widths, lead distances and lead heights on the stress field of QFP have been studied. The results indicate that, under the random vibration loading, the solder joints are weak components of QFP. The maximum stress focuses on the sharp corner of exterior part of the solder joints. Stress concentration areas locate at that position and the junction of lead with solder joint, which will be the most likely failure regions. The maximum stress of QFP is in direct proportion to the distance and height of lead and in inverse proportion to the width of lead.

Key words: random vibration; quad flat packaging; influence regularities; solder joint

STM32 based power supply system for integrative twin-wire pulsed MIG welding WU Kaiyuan, ZHANG Tao, HE Zuwei, LI Huajia (School of Mechanical & Automotive Engineering, South China University of Technology, Guangzhou 510640, China). pp 25 – 28

Abstract: To solve the quest of realizing synchronization, alternation and random phase control between the master and slave output in the twin-wire pulsed MIG welding, the 32-bit STM32F103ZET6 is adopted in the STM32 based power supply system for integrative twin-wire pulsed MIG welding. Synchronization, alternation and random phase control between two output is realized by single STM32F103ZET6 chip, whose integrated pulse width modulation (PWM) module produces PWM signal for phase-shift full-bridge soft-switching control, so that PWM control for the master and slave inverter is fully obtained by software, with high frequency invert and low frequency wave-form modulation achieved. The results show that the proposed power supply system meets the requirement of the design, as stable and high-speed welding process with little splash is acquired and the weld seam formation is decent.

Key words: twin-wire pulsed MIG welding; integrative; synchronic control; STM32 power supply system

Research on rotating arc GMAW welding process characteristics SUN Qingjie[1,2], CHENG Wenqian[1], LIU Yibo[1,2], FENG Jicai[1,2], CAI Chunwei[1,2], LIU Zhun[2] (1. State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China; 2. Shandong Provincial Laboratory of Special Welding Technology, Harbin Institute of Technology at Weihai, Weihai 264209, China). pp 29 – 32

Abstract: Rotating arc GMAW welding method was used to weld low carbon steel. The effect of welding parameters including rotating frequency and welding speed were studied. The results show that welding spatter increases as the growth of the rotational frequency and the weld appearance is poor. When the rotating frequency is more than 70 r/min, the spatter significantly increased, welding process is unstable and the weld has a bad formation. The welding speed has no effect on spatter. The weld reinforcement increases at first, then stay a certain value as the rotating frequency increass, but decreases when welding speed increases. Rotating frequency and welding speed have little effect on weld width. Sectional area of the weld decreases with the increase in welding speed and rotation frequency has no contribution. Weld scales pattern spacing is inversely proportional to the rotating frequency, and proportional to the welding speed.

Key words: rotating arc; GMAW welding method; welding process

An ultrasonic clutter suppression method using adaptive filter CHI Dazhao, GANG Tie, SUN Changli (State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China). pp 33 – 36

Abstract: In ultrasonic TOFD (time of flight diffraction) collected waves, the lateral wave brings about difficulty in identification of near surface defect signal. To solve this problem, a clutter suppression method using an adaptive filter is presented. Through iterative the parameters, the filter can adjust the reference signal to meet the changes of the clutter wave to be suppressed. Then the clutter wave can be removed and the near surface defect signal can be separated. The principle of clutter suppression method based on adaptive technology is described. The proposed method is studied by using computer simulation technique. Artificial defect collected waves are clutter suppression processed. The results show that the proposed method can effectively suppress clutter and extract near surface defect signal.

Key words: ultrasonic TOFD; adaptive filter; signal processing; clutter suppression; defect detectio

Effect of inorganic fillers on properties of polymer solid electrolyte and metal aluminum bonding YIN Xu, LIU Cuirong, DU Chao, WU Changxiong (Taiyuan University of Science and Technology, Taiyuan 030024, China). pp 37 – 40

Abstract: Anodic bonding technology is a common method in MEMS packaging technology. Currently only glass and met-

al, the glass and semiconductor materials bonding can by realized. Test using the PEO as matrix, compound with a small amount of nano inorganic filler, the preparation of a new type of solid composite polymer electrolyte as a new anodic bonding materials, by means of DSC and XRD analysis means to study the interaction of PEO and inorganic filler and conductive mechanism, and then discusses the polymer solid electrolyte as a new type of packaging materials in the feasibility in application of anodic bonding, The results show that the addition of PEO can effectively inhibit the crystallization of PEO, and the bonding quality is good.

Key words: inorganic filler; anodic bonding; solid electrolyte; ionic conduction

System of underwater welding robot for large-scale structure

YE Yanhui[1], ZHANG Hua[1], PAN Jiluan[1,2], GAO Yanfeng[1], ZHENG Jun[2] (1. Key Lab of Robot & Welding Automation of Jiangxi Province, Nanchang University, Nanchang 330031, China; 2. Department of Mechanical Engineer, Tsinghua University, Beijing 100084, China). pp 41 – 44

Abstract: An underwater welding robot system for large-scale structure is introduced for the environment of underwater welding and the system is composed of a robot mechanism, laser vision sensor, control system and welding system. The robot mechanism is composed of a pedrailed mobile platform and a torch adjustment mechanism and which can move flexibly for meeting the requirements of underwater welding. The components of sensor are selected and the optical path is also designed for the laser vision sensor to automatic welding seam identification. The PLC control system for the welding robot is designed and the coordinated control method is also adopted to achieve seam tracking accurately. And the underwater welding test platform is also completed. The results show that the robot operates steadily, reliably and the satisfactory welding quality is also obtained.

Key words: underwater welding robot; laser vision sensor; seam tracking; coordinate control

Stiffness analysis considering joint geometry parameters of I-core steel sandwich plates

JIANG Xiaoxia[1,2], ZHU Liang[1], QIAO Jisen[1], WU Yixiong[3], LI Zhuguo[3], CHEN Jianhong[1] (1. State Key Laboratory of Advanced Processing and Recycling of Non-ferrous Metals, Lanzhou University of Technology, Lanzhou 730050, China; 2. School of Mechanical Engineering, Ningxia University, Yinchuan 750021, China; 3. Shanghai Key Laboratory of Materials Laser Processing and Modification, Shanghai Jiaotong University, Shanghai 201100, China). pp 45 – 48

Abstract: For laser welded I-core steel sandwich plates, in the design formulas of the stiffness the influence of joint geometric parameters are not considered commonly. Therefore the accuracy is lack in practice. The three-point bending tests were investigated for the sandwich plates with six kinds of joint geometric parameter by self-designed device together with the finite element simulations. The aim is to research the effect of joint geometric parameters on the bending stiffness and shear stiffness. The results showed that the increase of weld width can significantly improve the bending stiffness and shear stiffness. However, when the weld width is greater than 60% thickness of core plates, the increase of stiffness became slow. The influence of root gap to the stiffness can be ignored. Based on these results, the corrected and simplified stiffness formula was offered for sandwich plate stiffness design considering joint geometry parameters.

Key words: laser welded; I-core steel sandwich plate; bending stiffness; shear stiffness; joint geometric parameters

Influence of pad size on shear strength and microstructure of fine pitch solder bump

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Abstract: Stencil printing process was optimized to obtain fine pitch flip chip solder bump. In order to evaluate the printing process, bump morphology were observed and bump heights were measured. Furthermore, shear force was tested by Pull-Shear Tester to investigate the effect of pad size on shear strength for the fine pitch solder bumps. Fracture surfaces were inspected and intermetallic compounds (IMC) at the surface and in the bump were separately detected and identified. It was found that bump height with small pad size was larger than that with large pad size as well as bump uniformity. Bump shear strength decreased with reducing pad size, which appeared size effect. This phenomenon was attributed to load condition difference during shear testing and IMC variation. Scallop IMC was observed at the bump interface with large pad size and needle like was found at the interface with small pad size, which possibly led to crack stress and decrease shear strength.

Key words: flip chip; solder; shear strength; pad size; intermetallic compounds

Study on welding deformation of resistance spot welding using two-dimensional DIC technique

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Abstract: The effect of welding current, welding time and electrode force on warping deformation of lap joint during resistance spot welding were investigated by using two-dimensional digital image correlation technique. The results show that the deformation changes differently at different phases of resistance spot welding process. Under identical conditions, increasing with the of the welding current or welding time, the warping deformation induced with nugget formation increased. With the electrode force increasing while the other conditions were identical, the warping deformation induced by nugget formation reduced while that induced by electrode impact increased. The two-dimensional digital image correlation technique was used for the first time researching the resistant spot welding process and it will provide new approach for the resistance spot welding process research and the weld quality improvement, which is of great significance for the development and improvement of the resistance spot welding process.

Key words: resistance spot welding; DIC technique; lap joint; warping deformation

Effect of reserved groove gap on backing welding of high-strength steel thick plates YANG Dongqing, LI Dayong, ZHANG Guangjun (State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China). pp 57 – 60

Abstract: The finite element simulation of the backing welding of the high strength steel plates was built by using MSC. Marc and the effects of the reserved groove gap on backing weld root fusion was investigated based on the welding temperature field. And the results of simulation were verified and supplemented by the experiments. The results showed that, under the low alloy high strength steel required welding heat input, when groove gap size was less than 2 mm, the backing weld root appears incomplete fusion defects. When the gap increases to 2-4 mm, the backing weld has single face welding-double face forming. When the gap increased to more than 5 mm, the heat resource could not reach to the base metal of the groove sidewall and the weld root appeard incomplete fusion, and was necessary to use swing welding with high heat input for good fusion.

Key words: high-strength low-alloy steel; backing welding of thick plates; reserved groove gap; fusion of weld root

Prediction on welding residual stress and deformation in Q345 steel butt-welded joints CAI Jianpeng, SUN Jiamin, XIA Linyin, Deng Dean (1. College of Materials Science and Engineering, Chongqing University, Chongqing 400045, China; 2. China Construction Steel Structure Co. Ltd., Shenzhen 518040, China). pp 61 – 64, 68

Abstract: Based on ABAQUS software, a thermal-elastic-plastic finite element method (FEM) was developed to simulate welding temperature field, residual stresses and deformation for multi-pass joints. The residual stresses and deformation in Q345 butt-welded joint with 16 mm thickness were simulated through using the developed computational approach. Meanwhile, experiments were carried out to measure the welding residual stresses and angular distortion in the butt-welded joint. Through comparing the measured data and the simulated result, it is found that both the residual stress and deformation predicted by FEM are in good agreement with the experimental results. In addition, the results show that the angular distortion and transverse shrinkage increase with the number of weld pass. The numerical results also suggest that the region with high tensile longitudinal stress slightly decreases when the number of weld pass changes from three to five, while the peak value of longitudinal residual stress is not sensitive to the number of weld pass.

Key words: weld pass; finite element; residual stress; deformation

Influence of heat affected zone microstructure of 12Cr1MoVG reheat cracking susceptibility SHI Yunzhe[1], WANG Gangang[1], CHENG Peng[1], ZHANG Wei[2], ZHAO Jiancang[1], SONG Libin[3] (1. Suzhou Nuclear Power Research Institute, China Guangdong Nuclear Power Group, Suzhou 215004, China; 2. Dongfang Electric Group, Dongfang Boiler Group, Zigong 643001, China; 3. Shenhua Shenwan Chizhou Jiuhua Power Generation, Chizhou 247100, China). pp 65 – 68

Abstract: The heat affected zone (HAZ) simulation test was done on two sorts of 12Cr1MoVG specimen. One of which was ferrite and pearlite for base metal and bainite for the other, by using Gleeble Thermal-force simulation machine. Then, for studying the reheat cracking susceptibility in the two different weld structures, the tensile test was done on the two different HAZ structures at different high temperatures slowly. The result showed that when HAZ structure is ferrite and bainite, its reheat cracking sensitive temperature range is 640-760 ℃ and the most sensitive point is 690 ℃ in our study. When HAZ structure is bainite, reheat cracking tendency is obvious after 650 ℃, especially at 690 ℃. Analysis result showed that when bainite exists in HAZ, its reheat cracking susceptibility is high. However, 5% to 8% ferrite exists in HAZ can reduce the reheat cracking sensitivity.

Key words: reheat cracking; heat affected zone simulation test; bainite; ferrite

Effect of Si on microstructures and properties of SAl5356 aluminum alloy wire HUANG Jie[1], XUE Songbai[1], GU Ronghai[1], WANG Bo[1], LIN Zhongqiang[2] (1. College of Materials Science and Technology, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China; 2. Zhejiang Yuguang Aluminum Material Co., Ltd., Wuyi 321200, China). pp 69 – 72

Abstract: The effects of the addition of Si on the microstructures and properties of SAl5356 aluminum alloy wire and its tensile properties of butt-welded joints with SAl5356 as the filler were investigated. Results showed that, when the content of Si ranged from 0 to 0.12%, the tensile strength of SAl5356 wire and its welded joint was improved slightly with the increase of Si content, while the plasticity was just the opposite. When the content of Si was higher than 0.12%, some coarse silicon rich phases were found in the microstructures of SAl5356 wire and its weld, and all properties, especially plasticity, dropped with the increase of Si content. In particular, when the Si content was above 0.2%, the coarse silicon rich phases were enriched at the grain boundaries, and forming fish-bone-shaped eutectic structure with α(Al) matrix, and their tensile properties dropped more obviously. The tensile strength of SAl5356 aluminum rod with Si content 0.25% was decreased 12% from its peak, while the elongation was decreased 45% from its peak. Therefore, to improve the performance of SAl5356 aluminum wire and its weld, Si content should not be more than 0.2%, and the optimum content of Si was less than 0.12%.

Key words: Si element; SAl5356 aluminum alloy wire; microstructure; mechanical property

Microstructure and mechanical properties of dissimilar barrier butt joints of AA6061/SiC/55p to AA2024 in friction stir welding SONG Xuecheng, FENG Xiaosong, ZHAO Huihui, GUO Lijie (Shanghai Aerospace Equipment Manufacturer, Shanghai 200245, China). pp 73 – 76

Abstract: Dissimilar barrier butt joints of SiC particles reinforced aluminum matrix composites with a volume fraction of 55% to 2024 aluminum alloy were fabricated by friction stir welding. Investigation of microstructure and mechanical properties of the joint was conducted. Results show that, a large amount of small SiC particles, with a strip-shaped distribution,

was found in the advancing side in SAZ. Microstructure features of the weld in direction of weld thickness changed a lot in WNZ1, which at the lower side was the interval distribution of large SiC particles riched bands and small SiC particles riched bands. Grain size of the upper side was larger than that of the lower side in WNZ2, while grains surrounded by SiC particles were prone to grow larger. Bonding level of the material was different in different locations in IZ, which was affected also by debris fallen from the welding tool. A higher tensile strength was obtained in rotational speed of 750 r/min, 83.1% that of the composite base material. Fracture mode of the joints was detected to be the the matrices fracture and matrices segregation to SiC particles.

Key words: friction stir welding; 2024 aluminum; aluminum matrix composite; special docking form

A dynamic simulation model of short circuit transfer based on energy balance SU Dongdong[1,2], LV Xiaoqing[1,2], WANG Ying[1,2] (1. School of Materials Science and Engineering, Tianjin University, Tianjin 300072, China; 2. Tianjin Key Laboratory of Advanced Joining Technology, Tianjin University, Tianjin 300072, China). pp 77 – 80

Abstract: By means of welding power system circuit model, thinking of the enthalpy changes on the wire tip, and energy balance on the droplet, the more precise CO_2 short circuit transfer dynamic simulation model is put forward. Through this model, it explores changing trend of current waveform, and makes a comparison of characteristic parameters (average current, peak current, valley current, short circuit frequency, short circuit time and arcing time) between the practical measurement and the simulation under matching and mismatching welding parameters. And the related deviations of the characteristic parameters are analyzed. The results indicate that the model is basically consistented with practice. At last, this research will contribute to further development of simulation in short circuit transfer process.

Key words: short circuit transfer; energy balance; simulation model; characteristic parameter

Effect of heat treatment on interface microstructure and property of Cu/Al-3.25Si cold-press welded joint WANG Zeyu, ZHAO Yingying, CHANG Dongxu, WANG Ping (Key Laboratory of Ministry of Education for Electromagnetic Processing of Materials, Northeastern University, Shenyang 110819, China). pp 81 – 84

Abstract: The influence of heat treatment process on the interface thickness, interfacial bonding strength and the compounds change of Cu/Al-3.25Si cold-press joining was investigated by measuring the mechanical properties and observing microstructure. The results showed that the inter-layer thickness was firstly growing quickly with the increase of heat treatment temperature and holding time, and then it was growing slowly. The kinetics of the diffusion layer growth hasa index of 0.5 – 1. The interfacial shear strength is also growing quickly with the increase of heat treatment temperature and preservation time and then slowly. The intermetallic compounds is Cu_9Al_4, CuAl, $CuAl_2$ from the copper side to the aluminum side under the optimum condition of 300 ℃ × 2 h.

Key words: cold-rolling cladding; Cu/Al-3.25Si alloy; heat treatment; interfacial layer; compound

A new algorithm for detecting defects of sub-arc welding x-ray image based on compress sensor theory GAO Weixin[1], HU Yuheng[2], WU Xiaomeng[1] (1. School of Electrical Engineering, Xi'an Shiyou University, Xi'an 710065, China; 2. Department of Electrical and Computer Engineering, University of Wisconsin-Madison, Madison WI53705, USA). pp 85 – 88

Abstract: An efficient X-ray radiography image analysis algorithm is developed for submerged-arc welding defects detection. The compress sensor theory is incorporated into the new algorithm, and the problem of defect detection is changed to a model recognition problem. The given X-ray image is represented by a linear combination of few model X-ray images. If a dictionary of model defect images and noise images are obtained, the coefficient vector can give important information for deciding the given image is defect or noise. Thus a sparse vector representation is sought by performing l0, l1 and l2 norm minimization. Finally, the sparse representations of the defect part and noisy part are compared in the context of a maximum likelihood ratio test which leads to the final classification. Tested with 800 x-ray radiography images obtained from a factory production line, the proposed algorithm achieves a sensitivity 99% and specificity 98%.

Key words: defect detection; compress sensor; X-ray; image recognition

Study on brazing process of Ti-22Al-25Nb alloy sheet JING Yongjuan, CHAI Lu, GAO Xingqiang (Beijing Research Institute of Aviation Engineering, Beijing 100024, China). pp 89 – 92

Abstract: The brazing process of Ti-22Al-25Nb alloy sheet was studied. The influences on the microstructure and the tensile strength of the matrix from the brazing process were studied in this paper. The strength of the brazing joints was tested. A few of short rod O phases were dissolved and lots of O phases were grown up in the matrix during the brazing process as the brazing temperature being 960 ℃. The grain size of the matrix was increased without phase transition. With heat preservation time by 15, 30 and 60 min extended gradually, the room temperature strength of the matrix was decreased from 1 257 to 1 100 MPa and the average room temperature elongation was increased from 2.9% up to 3.4%, 5.8% and 5.0%. The optimized brazing technology parameters of Ti2AlNb alloy plate is 960 ℃/30 min/furnace cooling with the higher shear strength of the brazed joints as 152 MPa.

Key words: Ti2AlNb alloy; brazing; mechanical properties

Interfacial microstructure of pre-brazed diamond composite segments using Ni-Cr composite alloy DUAN Duanzhi, XIAO Bing, WANG Wei, DING Xiaoyang (College of Mechanical and Electrical Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China). pp 93 – 96

Abstract: Pre-brazed diamonds were fabricated by using diamonds and Ni-Cr composite brazing alloy, which were consisted of Ni-Cr alloy and A alloy. Brazing temperature was 1 050 ℃ and the holding time was 30 min. Abrasive composite segments consisting of the pre-brazed diamonds and metal matrix were sintered at the heating temperature of 810 ℃ for the dwell time of 4 min. The static compressive strength of the pre-brazed diamonds and the bending strength of the abrasive composite segments were measured. The interfacial microstructure of the pre-brazed dia-

monds and the composite segments fracture surface were characterized. Results obtained show that the chemical combination interface between diamonds and Ni-Cr composite alloy was developed when pre-brazing and the thermal damage to the diamonds was greatly reduced. The bending strength of the abrasive composite segments (10% -50%) was much higher than that of the conventional segments. In the composite segments the metallurgical bonding between the pre-brazed diamonds and metal matrix was formed and the diamonds were embedded firmly.

Key words: pre-brazed diamonds; Ni-Cr composite alloy; abrasive composite segments; bending strength; interfacial microstructure

Numerical simulation of stress field in variable polarity plasma arc welding of aluminum alloys MOU Quhan, HAN Yongquan, ZHAO Peng, DONG Junhui (Material Forming Key Laboratory, Inner Mongolia University of Technology, Hohhot 010051, China). pp 97 -100

Abstract: Based on the theory of heat transfer and thermal elastoplastic finite element analysis, temperature field and stress field numerical simulations were calculated by ANSYS FEM software in variable polarity plasma arc welding of aluminum alloys. Combining heat source model which is Gaussian plus double ellipsoid was built. Temperature field and stress field were achieved accurately by loading different-size heat source models in positive and reverse polarity period alternatively. The values of residual stress were measured at different points in longitudinal and transversal directions after welding. The results show that the distribution law of residual stress, which was achieved in different directions on simulation model, was the same with theory analysis and the area of high stress was obviously smaller than that in TIG welding. The difference between actual residual stress and calculating residual stress is small. It proves that the calculation of numerical simulation is of great value on theory.

Key words: variable polarity plasma arc welding; numerical simulation; aluminum alloy; stress field

Effect of welding methods on microstructure and mechanical properties of 1 000 MPa grade deposited metal AN Tongbang[1,2], TIAN Zhiling[2], SHAN Jiguo[1], PENG Yun[2], WEI Jinshan[2] (1. Department of Mechanical Engineering, Tsinghua University, Beijing 100084, China; 2. Central Iron & Steel Research Institute, Beijing 100081, China). pp 101 -104

Abstract: With the same heat input, deposited metals were welded with 1 000 MPa grade solid welding wire as filler material by MAG (Metal Active Gas) and TIG welding methods, respectively. The effects of welding methods on microstructure and properties of deposited metals were studied by means of optical microscopy, transmission electron microscope (TEM) and fracture analysis etc. The results show that the deposition efficiency of MAG is significantly higher than TIG, and there is a clear "finger penetration" in MAG weld bead. The microstructure of primary weld region and reheated weld region of MAG deposited metal is significantly coarsing than TIG. TIG diposited metal has more refinement microstructure. The distribution is diversification and it includes more uniform distribution of retained austenite, which is one of the reasons for excellent low-temperature impact toughness. Besides, a large number of non-metallic inclusions in the MAG diposited metal, which is the initiation source of cleavage fracture. Therefore, non-metallic inclusion is another reason for deterioration low temperature impact toughness of MAG diposited metal. The results show that the integrated mechanical property of TIG diposited metal is much better than MAG, which is generated by the welding method for different microstructure type, morphology and characteristic of the non-metal inclusion.

Key words: metal active gas; tungsten argon arc welding; microstructural; inclusions; mechanical properties

Three-dimensional numerical simulation on welding residual stress in weld between RPV head and CRDM nozzle FU Qiang[1], LUO Ying[1], YANG Min[1], LIU Chuan[2] (1. Science and Technology on Reactor System Design Technology Laboratory, Nuclear Power Institute of China, Chengdu 610041, China; 2. Provincial Key Lab of Advanced Welding Technology, Jiangsu University of Science and Technology, Zhenjiang 212003, China). pp 105 -108

Abstract: A mock-up of control rod drive mechanism (CRDM) nozzle on the reactor pressure vessel (RPV) head was manufactured with J-type groove. The temperature during welding and the residual stress were measured. The segmented temperature heat source model and the thermal-mechanical coupling method were adopted to efficiently simulate the welding temperature field and residual stress field, and the simulated results were compared with the experimental ones. Based on the simulated results, the residual stress distribution characteristic in the J-weld was analyzed. The investigated results show that the proposed model and the simulation procedure can efficiently obtain the residual stress field in the J-weld between RPV head and the CRDM nozzle, the simulated results generally agree with the measured ones; the longitudinal stress in the J-weld is greater than the axial stress. The stresses on the outer and inner wall of the nozzle are non-uniform. In addition, the stresses in the weld and the nozzle at the up-hill and down-hill regions are larger than those at the side-hill region.

Key words: J-groove welding; welding residual stress; three-dimensional finite element; numerical simulation; experiment

Research on experimental system of welding process with molten metal filler WU Shaojie, GAO Hongming, ZHANG Zongyu (State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China). pp 109 -112

Abstract: A novel welding process with molten metal filler is invented to solve the problem of controlling the welding heat input and to suit the require of high-efficient manufacture. The design and principle of welding system and its elements are mainly introduced. Meanwhile, testing the system by overlaying weld using tin-lead alloy. The results show that the system accurately control welding heat input by output steady flow with required temperature and diameter, welding speed and air pressure. Therefore, the system could meet the requirement of welding process with molten metal filler, and the depth-to-width ratio of bead can reach 6 by using it.

Key words: molten metal filler; high-frequency power supply; graphite crucible; tin-lead alloy; depth-to-width ratio