MAIN TOPICS, ABSTRACTS & KEY WORDS

Effect of nitrogen in conjunction with oxygen on GPCA-TIG weld HUANG Yong[1,2], WANG Yanlei[2], ZHANG Zhiguo[2] (1. State Key Laboratory of Gansu Advanced Non-ferrous Metal Materials, Lanzhou University of Technology, Lanzhou 730050, China; 2. Key Laboratory of Non-ferrous Metal Alloys and Processing, The Ministry of Education, Lanzhou University of Technology, Lanzhou 730050, China). pp 1 – 4

Abstract: For the gas pool coupled activating TIG (GPCA-TIG) welding with outer mixing shielding gas of nitrogen and oxygen, by changing the relative position of the outer and inner nozzles of welding torch, the effect of coupling degree between the outer shielding gas and welding pool surface on nitrogen-oxygen content in the weld appearance, microstructure and properties. The results show that the gas pool coupled activating TIG weld was narrow and deep when nitrogen was introduced in conjunction with oxygen. The low temperature impact toughness of weld was 7.5% higher than that of parent metal and weld made by traditional TIG welding, while the tensile strength and yield strength of weld by GPCA-TIG was lower than those of parent metal. The grains in the weld were fine, and a small amount of ferrites distributed in the austenite grain boundaries. The nitrogen-oxygen content in the weld could be finely adjusted through changing the relative position of outer and inner nozzles in GPCA-TIG welding.

Key words: gas pool coupled activating TIG welding; introduction of nitrogen in conjunction with oxygen; coupling degree; nitrogen-oxygen content; microstructure and property

Technology and properties of $Ti_3Al/Ti/Ti_2AlNb$ diffusion welding WEI Hongmei[1], LI Wanqing[1,2], HE Peng[1], GAO Lijiao[1,3], LIN Tiesong[1] (1. State Key Laboratory of Advanced Welding and Joining, Harbin institute of Technology, Harbin 150001, China; 2. Beijing Institute of Aeronautical Materials, Beijing 100095, China; 3. Beijing Xinghang Mechanical and Electrical Equipment Co., Ltd., Beijing 100074, China). pp 5 – 8, 70

Abstract: Ti_3Al and Ti_2AlNb alloy were connected by diffusion bonding with Ti foil as interlayer. Through a number of analysis methods such as SEM, EDS and XRD, it was discovered that the typical interface structure of $Ti_3Al/Ti/Ti_2AlNb$ joint was Ti_3Al/α-phase + β-phase/B_2-rich phase/Ti_2AlNb. The effect of process parameters, including thickness of interface layer, bonding temperature and holding time, on the interface morphology and property of the joint was investigated. The results show that when the thickness of Ti foil was 10 μm, bonding temperature was 900 ℃ and holding time was 120 min, the resultant $Ti_3Al/Ti/Ti_2AlNb$ joint had the optimized microstructure and properties. Increasing the foil thickness caused uneven diffusion of Ti, Al and Nb. The direct bonding temperature of Ti_3Al/Ti_2AlNb was 1 000 ℃, the addition of Ti foil interlayer could reduce the bonding temperature to 900 ℃. So the damage of high temperature thermal cycling to Ti_3Al alloy was decreased. The tensile strength of the joint increased from 795 MPa to 906 MPa. The holding time from 90 min to 120 min could ensure sufficient diffusion and reliable connection.

Key words: diffusion welding; titanium aluminum alloy; microstructure; property

Research of seam tracker of capacitance inductance bridge HONG Bo, ZHU Yafei, LI Xiangwen, CHEN Yu (Department of Mechanical Engineering, Xiangtan University, Xiangtan 411105, China). pp 9 – 12, 24

Abstract: According to stagger problem of problem plate butt welding, this paper proposed a method with composite bridge by combining the capacitance and inductance for weld automatic tracking, and designed the structure of sensor. With sensitive detection of the plate spacing change by capacitance and of the edge change by inductance, this composite bridge seam tracking sensor can determine the relationship between horizontal and vertical position of the welding torch. This method is of non-contact, high sensitivity, strong anti-jamming capability, fast response speed and reliable operation, and can solve the misalignment problem during plate butt welding to a certain extent. Seam tracking experiments results made on a simple platform show that the effect was good and it provided a new method for seam automatic tracking technology.

Key words: bridge; capacitance; inductance; seam-tracking

Numeral simulation of root fusion in double-sided TIG backing welding of thick plate YANG Dongqing, LI Dayong, ZHANG Guangjun (State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China). pp 13 – 16

Abstract: A finite element model for double-sided TIG backing welding of thick plate was established, and the reasonableness and accuracy of the model were verified by welding experiments. Then, the temperature fields in backing welding thick plate were simulated for different groove designs with different sizes of misalignment and root face, respectively. The results show that, with the increase of the reserved groove gap, the allowable range of root face increased using double-sided TIG backing welding, and the allowable range of misalignment increased first and then decreased. In backing welding of thick plate, when the

sum of root face and misalignment was less than 4 mm, the weld with good root fusion could be obtained with reserved 2-4 mm groove gap. When the sum of root face and misalignment was more than 6 mm, incomplete penetration occurred. When the sum was between 4 mm and 6 mm, the root fusion changed with the reserved groove gap.

Key words: double-sided TIG backing welding; root fusion; numerical simulation of temperature field

Numerical simulation on temperature distribution of cold metal transfer joining magnesium to titanium dissimilar metals WANG Cen[1], CAO Rui[1], LIN Qiaoli[1], WANG Qing[2], DONG Chuang[2], CHEN Jianhong[1] (1. State Key Laboratory of Advanced Processing and Recycling of Non-ferrous Metal, Lanzhou University of Technology, Lanzhou 730050, China; 2. Key Laboratory of Materials Modification by Laser, Ion and Electron Beams, Ministry of Education, Dalian University of Technology, Dalian 116024, China). pp 17 – 20

Abstract: Using ABAQUS finite element software, a finite element model was established on magnesium/titanium dissimilar metal cold metal transfer lap joint to numerically simulate the temperature distribution. The simulated temperature field was verified by experimental results. The variation of temperature field and microstructure at specified location of the joint were compared at different wire feed speeds. The results show that the distribution of temperature field was asymmetric on magnesium and titanium sides. At two locations with the same distance from the weld center, the temperature rose rapidly on magnesium side, a higher peak temperature in Mg sheet was reached than that in Ti sheet, and the rate of decline was also fast. As the wire feed speed increased, the peak temperature became higher and reached the molten temperature of titanium sheet, then the amount of molten Ti increased, finally sound Mg/Ti interface formed.

Key words: Mg/Ti dissimilar metals; cold metal transfer; welding temperature field; numerical simulation

Electromigration failure of Al-Si interconnects CUI Haipo, DENG Deng (Shanghai Institute for Minimally Invasive Therapy, University of Shanghai for Science and Technology, Shanghai 200093, China). pp 21 – 24

Abstract: With development of microelectronics technology, the cross-sectional area of metal film used in very large scale integrated circuit interconnects are getting smaller and smaller, causing a sharp increase in its exposure of current density. Interconnects failure induced by electromigration has become particularly prominent. In accordance with the electromigration of metal interconnects in integrated circuits, the Black equation was modified. The electromigration of Al-Si interconnects was investigated by accelerated life time test. The relevant parameters of modified Black equation were obtained. The influence of test temperature, current density, initial resistance on the electromigration of Al-Si interconnects were analyzed. The results indicate that the electromigration life of Al-Si interconnects is inversely proportional to those parameters.

Key words: electromigration; accelerated life time test; interconnect

Prediction of fatigue life of titanium alloy welded joints based on RS_RBFNN ZOU Li[1], YANG Xinhua[2], SUN Yibo[2], DENG Wu[1,3] (1. Software Institute, Dalian Jiaotong University, Lvshun 116052, China; 2. School of Materials Science and Engineering, Dalian Jiaotong University, Dalian 116028; 3. Chongqing Key Laboratory of Computational Intelligence, Chongqing 400065, China). pp 25 – 29, 78

Abstract: An integrated model of rough set and neural network (RS_RBFNN) was proposed for predicting fatigue life of titanium alloy welded joints. The fatigue data were discretized by using the entropy-based algorithm, and the fatigue evaluation indices were reduced without information loss through a genetic algorithm. The reduced indices were used to develop the rules for fatigue life of welded joints and to train the RBF neural network. The rough set theory was used to determine the category of fatigue life for the test samples which matched the rules in the rule-base. The neural network was applied to those test samples which did not match any rules in the rule-base. Experimental results based on the fatigue data of titanium alloy show that the RS_RBFNN model for fatigue analysis of welded joints had improved fault tolerance and precision. Therefore this model is of practical significance for predicting fatigue life of titanium alloy welded joints.

Key words: rough set; neural network; welding; fatigue

Numerical simulation of influence of ultrasonic impact treatment on welding stress of 7A52 aluminum alloy joint JIA Cuiling[1,2], CHEN Furong[1] (1. Institution of Materials Science and Engineering, Inner Mongolia University of Technology, Hohhot 010051, China; 2. Engineering Training Center, Inner Mongolia University of Technology, Hohhot 010051, China). pp 30 – 34

Abstract: A thermal coupling numerical model was established for double-wire MIG welding of 7A52 aluminum alloy, based on the finite element software ABAQUS, and the welding residual stress field was obtained. A coupling model of ultrasonic impact treatment on the welded joint was built with numerical method and the residual stress field was obtained after ultrasonic impact treatment. The distribution characteristics of residual stress before and after ultrasonic impact and the influence law of residual stress by changing the needle moving speed were analyzed, aiming to study the effect of ultrasonic impact using on residual stress of 7A52 aluminum alloy joint. The simulation results show that the ultrasonic impact treatment could significantly improve the surface residual stress of weld seam and heat-affected zone, and the compressive stress in welded joint decreased with the increase of impact moving speed.

Key words: ultrasonic impact; residual stress; numerical

simulation; 7A52 aluminum alloy

Investigation on influence of iron/feld spar in flux cored wire for stainless steel on hexavalent chromium in welding fume BAI Jiantao[1], LI Zhuoxin[1], LI Yang[2], WOLFGANG Tillmann[3] (1. School of Materials Science and Engineering, Beijing University of Technology, Beijing 100124, China; 2. The FILARC Welding (Jiangsu) Co., Ltd., Changzhou 312245, China; 3. Institute of Materials Engineering, Dortmund University of Technology, Dortmund 24427, Germany). pp 35 - 38, 55

Abstract: The influence of iron powder/feldspar on the arc stability, average particle size, Cr (Ⅵ) content and Cr (Ⅵ)/ total Cr(n/N) were investigated by hanover arc analyzer, high-speed cameras and laser particle sizer. The experimental results showed that average particle size of welding fume inshort circuit transfer is smaller than the granular transfer; The proportion of Cr(Ⅵ)/ total Cr(n/N) is low in welding fume of short circuit transition. Under the same welding parameters, welding fumes average particle size is up to 1 154 nm, Cr (Ⅵ) and Cr (Ⅵ) / total Cr are 24% and 1 555.8 mg/kg respectively when iron powder/feldspar is around 1.8, under which the shortest short transition time is 1 033 μs.

Key words: Cr(Ⅵ); arc stability; size of welding fume

High power solid-state laser cutting mechanism of thick steel plates with O_2 WANG Wei, LIN Shangyang, XU Liang, TENG Bin (Harbin Welding Institute, China Academy of Machinery Science & Technology, Harbin 150080, China). pp 39 - 42

Abstract: 6 kW disk laser-oxygen cutting experiment on 30 mm thick steel plate was carried out to reveal the thick plate laser cutting mechanism. The influence of main process parameters on laser cut quality was investigated. The results indicated that two laser cutting modes, i. e., narrow kerf mode and wide kerf mode were found when performing thick plate laser cutting. Oxygen pressure and laser defocused distance had a significant influence on transformation between two laser cutting modes. Cross section of wide kerf was found to be V type, while narrow kerf is I type. The kerf surface of two laser cutting modes was observed, indicating two different laser cutting processes.

Key words: laser cutting; cutting mechanism; thick steel plate cutting; high power solid-state laser

Investigation on magnetron sputtering Ti film and vacuum brazing of SiCp/Al composites with high volume fraction WANG Peng[1], LI Qiang[1], GAO Zeng[1], CHENG Dongfeng[1], NIU Jitai[1,2] (1. School of Materials Science and Engineering, Henan Polytechnic University, Jiaozuo 454000, China; 2. State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China). pp 43 - 46, 82

Abstract: Ti film was magnetron-sputtered on SiCp/6063Al composite substrate containing 60% SiCp, and then the SiCp/6063Al composite was vacuum brazed with Al-Si-Mg foil as filler metal at 580 ℃ for 40 min. The interfacial microstructure and fracture appearance were investigated by SEM, EDS and XRD. The results show that the Ti film could improve the wettability of filler materials onto the composite materials. Transition layers existed not only between filler and Ti film, but also between the base metal and Ti film. A new phase $TiC_{0.981}$ was found in the interfacial layer, and sound bonding occurred between the filler material and SiC particles.

Key words: aluminum matrix composite; magnetron sputtering Ti film; vacuum brazing; wettability

3D visualization of FSW defects based on ultrasonic phased array SUN Changli[1,2], GANG Tie[1], LIU Bin[1], WANG Changxi[1], WANG Long[1] (1. State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China; 2. School of Computer and Information Engineering, Heilongjiang University of Science and Technology, Harbin 150022, China). pp 47 - 50

Abstract: An ultrasonic nondestructive testing method was presented, which included data acquisition, processing and three-dimensional visualization. Data acquisition was conducted with ultrasonic phased array probe, after the welded joint was scanned and the flaw data were collected. Subsequently, three-dimensional reconstruction was carried out by programming on platform of Matlab. This method was first verified with artificial defects of flat-bottomed holes, then it was applied to friction stir welded (FSW) joint, and the 3D visualization of the joint defects was achieved. The results show that this method increased the objectivity and intuitiveness in NDT, therefore the testers do not have to analyze a lot of two-dimensional images and imagine three-dimensional situation by themselves; the space distribution of the defects can be directly observed from three-dimensional reconstruction results, the morphology and direction of the defects within joints can be easily understood.

Key words: ultrasonic phased array; FSW defects; 3D reconstruction; visualization

Influence of tool pin-tip profiles on flow behavior of FSW joint-root material YAN Chaoying, XING Li, HUANG Yongde, KE Liming (National Defense Key Disciplines Laboratory of Light Alloy Processing Science and Technology, Nanchang Hangkong University, Nanchang 330063, China). pp 51 - 55

Abstract: Friction stir butt joints of 6061-T4 aluminum alloy plates with a thickness of 12 mm were welded by various pin-tip profiles of the tool. The morphology of different cross section of key hole was observed, and the influence of pin-tip profile on joint-root material flow behavior was analyzed. The results show that the metal of FSW weld zone migration along the weld thickness direction is mainly affected by the thread of pin surface. The impact of the pin-tip taper on the joint-root metals migration along the weld thickness direction can be divided into two aspects, one effect is on downward migration of metal breakaway

from pin thread, the another is on upward migration of weld nugget metal. The diameter of pin-tip affects the thickness of incomplete penetration of FSW butt joint. With the diameter of pin-tip face increases, the thickness of pin-tip affected zone increases, and thicher plate will be welded well.

Key words: pin-tip profiles; FSW; flow behavior; incomplete penetration

Weld bead formation in oscillating arc narrow gap vertical-up GMAW process XU Wanghui, LIN Sanbao, YANG Chunli, FAN Chenglei (State Key Laboratory of Advance Welding and Joining, Harbin Institute of Technology, Harbin 150001, China). pp 56 – 60

Abstract: The weld cross-section formation in oscillating arc narrow gap vertical GMAW was investigated and the effect of oscillating parameters on the wend cross-section formation was analyzed. The results show that the weld cross-section formation was characterized with convex surface during oscillating arc vertical-up GMAW, while it was concave during vertical-down GMAW. The increase in oscillating angle and oscillating speed was beneficial to the increase of weld width and reduction of convex height in oscillating arc narrow gap vertical-up GMAW, while the dwell time had little influence on the weld cross-section formation. The heat input per unit length in oscillating arc welding was divided into two parts which were input heat per unit length in oscillating process and in dwell process, respectively. The input heat per unit length in oscillating process could affect the convex height of weld cross-section, while that in dwell process could affect the weld width. The oscillating parameters controlled the weld cross-section formation by affecting the distribution of input heat in oscillating arc narrow gap vertical-up GMAW.

Key words: oscillating arc welding; narrow gap welding; GMAW; vertical welding

Effects of hybrid process combining pulsed electron beam and sandblasting on roughness and bonding strength of MCrAlY coating surface ZOU Hui[1], LEI Juanjuan[1], WANG Zhiping[1], CAI Jie[2] (1. Tianjin Engineering Research Center of Aircraft Maintenance and Civil Aviation Ground Special Equipments, Civil Aviation University of China, Tianjin 300300, China; 2. School of Materials Science and Engineering, Jiangsu University, Zhenjiang 212013, China). pp 61 – 65

Abstract: A hybrid process which combined high current pulse electron beam (HCPEB) technology and sandblasting technology was applied on MCrAlY coating surface. The results show that after HCPEB processing, the coating surface remelted and formed continuous cellular structure, and the remelted layer had dense structure. After HCPEB and sandblasting hybrid process, a large number of serrated points formed which continuously and uniformly appeared on the surface coating, and the surface roughness increased. The tensile test result shows that the bonding strength improved obviously between the MCrAlY coating after hybrid treatment and the YSZ ceramic layer. The hybrid technology not only strengthened the bonding of ceramic surface and the coating, but also ensured the integrity and uniformity of the interface.

Key words: high current pulse electron beam; sandblasting treatment; CoCrAlY coating; microstructure; surface roughness

Influence of maximum fatigue precracking force on CTOD value of DH36 flux-cored wire CO_2 protection welded joints DENG Caiyan[1], MENG Qingyu[1,2], WANG Dongpo[1], GONG Baoming[1] (1. Tianjin Key Laboratory of Advanced Joining Technology, Tianjin University, Tianjin 300072, China; 2. Xuzhou Construction Machinery Group, Jiangsu Xuzhou Construction Research Institute, Xuzhou 221004, China). pp 66 – 70

Abstract: CTOD tests were carried out for flux-cored gas protection welded joints of DH36 according to Standard BS7448. The effect of fatigue precracking force on the CTOD value was investigated by analyzing the microstructure and fracture surface of the joint and finite element simulation on the process of fatigue precracking. The results show that the maximum fatigue precracking force has a tremendous influence on CTOD value. When the maximum fatigue precracking force was less than the specified value in Standard BS7448, the test process was prone to pop-in phenomenon, and smaller CTOD value occurred. Conversely, when the maximum fatigue precracking force was close to or exceeding the specified value, the CTOD value would be larger. Thus the Standard should be strictly limited to the maximum fatigue precracking force to ensure the reliability of test results.

Key words: maximum fatigue precracking force; crack tip opening displacement; pop-in

3D numerical simulation of temperature and stress evolution in friction stir welding of aluminum alloy DONG Ping, DOU Zuoyong, ZHANG Pengcheng (Science and Technology on Surface Physics and Chemistry Laboratory, Mianyang 621900, China). pp 71 – 74

Abstract: The instantaneous velocity of stirring tool during friction stir welding (FSW) process was analyzed to build a heat source model of FSW, which took into account the heat difference near the weld line. The temperature and stress fields of 2024 aluminum alloy during friction stir welding were numerically simulated by using 3D finite element method. The results show that the asymmetry of temperature and stress fields was not obvious because the moving velocity was much smaller than the rotating velocity of stirring tool, but this asymmetry would be enhanced with increasing the moving velocity. The temperature at the weld center was lower than that at the tool edge during welding. The stresses were compressive at the weld front and on two sides, but tensile at the weld rear. After welding, the transverse and longitudinal residual stresses were large tensile stress within

the stirring tool, which gradually became smaller along the depth. Far from the weld line, the transverse and longitudinal residual stresses were very small. The residual stresses by finite element simulation were compared to those by short wavelength X-ray stress measurement; two results were basically identical in trend.

Key words: aluminum alloy; friction stir welding; temperature field; stress field; finite element analysis

CMT welding technology of thick aluminum alloy plates for high speed train LU Hao (CSR Qingdao Sifang CO., LTD., Qingdao 266111, China). pp 75 – 78

Abstract: For the demand of low heat input and high quality welding technology, the difference in multi-pass welding techniques for thick aluminum alloy plates with CMT welding and pulse MIG welding was investigated. The thermal cycles during welding were measured; the microstructure and mechanical properties (tensile, bending and microhardness) of the welded joint were analyzed. The tests show that comparing to pulse MIG welding, CMT welding technology could make weld with lower temperature field, decrease the softened zone, increase the impact toughness of the joint, and improve the weld microstructure significantly. The experimental results show that CMT welding can make better weld on thick aluminum alloy plate.

Key words: cold metal transfer; aluminum alloy; multi-pass welding

Shear behavior of copper column grid array interconnect structure ZHAO Zhili[1], XU Xirui[1], SUN Fenglian[1], YANG Jianguo[2] (1. School of Materials Science and Engineering, Harbin University of Science and Technology, Harbin 150040, China; 2. State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China). pp 79 – 82

Abstract: Considering the significant difference in mechanical properties between the flexible copper column and the solder ball, the shear behavior of the copper column grid array (CuCGA) interconnect was studied by experimental and numerical methods. Results show that the shear curves of CuCGA interconnects presented obviously different new features, comparing with the parabolic shear curve of solder ball in the ball grid array (BGA) interconnect. The shear force linearly increased at first with a larger slope when the shear displacement increased, but it subsequently changed into a smaller slope due to the flexural deformation of Cu solder column and the partial release of stress caused by the increased displacement. The shear curves displayed the same parabolic shape as BGA solder ball in the final stage, and all pull-off fractures occurred in solder/Cu column interface. The curves slopes decreased with the increase of aspect ratio of the Cu column and the decrease of stiffness of Cu soldering column in the first and second stage.

Key words: copper column grid array (CuCGA); shear curve feature; flexural deformation; shear force

Time and frequency domain analysis of metal droplet transfer by acoustic emission signals during pulse MIG welding of aluminum alloy LUO Yi[1,2], XIE Xiaojian[1,2], ZHU Yang[1,2], WAN Rui[1,2], HU Shaoqiu[1] (1. School of Materials and Engineering, Chongqing University of Technology, Chongqing 400054, China; 2. Chongqing Municipal Engineering Research Center of Institutions of Higher Education for Special Welding Materials and Technology, Chongqing 400054, China). pp 83 – 86

Abstract: The structure-borne acoustic emission (AE) signals during pulse MIG welding of aluminum alloy were detected in real-time and analyzed to investigate the time and frequency characteristics of metal droplet transfer. The results show that the order and periodicity of metal droplet transfer during pulse MIG welding were characterized by AE signals waveform and AE event of metal droplet transfer. As the pulse frequency and welding heat input increased, the metal droplet transfer was transformed from short circuiting transfer mode to spray transfer mode. The volume of metal droplet was refined gradually, which showed decreasing characteristics of AE energy release. With short circuiting transfer mode, the frequency domain of AE signals of metal droplet transfer was broad and distributed around the high frequency region. With spray transfer mode, the frequency domain of AE signals of metal droplet transfer was narrow and distributed around the low frequency region. As the metal droplet transfer was transformed from short circuiting transfer mode to spray transfer mode, the energy variation induced by metal droplet showed a parabolic trend.

Key words: pulse MIG welding; metal droplet transfer; acoustic emission; power spectrum; transfer frequency

Influence of preheating temperature on cold cracking sensitivity of 12Cr10Co3W2Mo heat resistant steel ZHANG Qunbing[1], NIU Jing[1], ZHAO Pengfei[2], HUANG Yong[2], LI Zhigang[1], ZHANG Jianxun[1] (1. State Key Laboratory for Mechanical Behavior of Materials, Xi'an Jiaotong University, Xi'an 710049, China; 2. Dongfang Steam Turbine Limited Company, Deyang 618000, China). pp 87 – 91

Abstract: The critical fracture stress of coarse grain heat-affected zone (CGHAZ) of 12Cr10Co3W2Mo heat resistant steel weld was investigated by implant test when the preheating temperature was room temperature, 100 ℃, 200 ℃ and 300 ℃, respectively. The highest microhardness in heat-affected zone was measured; the microstructure in the CGHAZ was observed; and the fracture surface of implant samples was detected with scanning electron microscopy (SEM). The results indicate that the critical fracture stress increased linearly with the increase of preheating temperature. The microstructure in CGHAZ was lath martensite and the microhardness was highest. The microhardness of CGHAZ decreased slowly as the preheating temperature increased. Under different preheating temperatures, the crack initiation zone in implant samples was mixed cleavage and quasi-cleavage hydrogen-induced cracking (HIC) morphology. And

with the increase of preheating temperature, the HIC features disappeared gradually.

Key words: preheating temperature; implant test; cold cracking sensitivity; fracture morphology

Effect of yttrium oxide on microstructure and mechanical properties of in high strength steel weld metal LIU Renpei, CAI Yongchuan, WEI Yanhong, CHENG Zhonggeng (College of Materials Science and Technology, Nanjing University of Aeronautics and Astronautics, Nanjing 211106, China). pp 92 – 96

Abstract: Based on Ni-Cr-Mo-V alloy system, the effect of yttrium oxide on microstructure and mechanical properties of weld made with 800 MPa high strength steel electrode was investigated. Experimental results show that, as the Y_2O_3 content changed in 0 ~ 0.02%, with the increase of Y_2O_3 content, the proeutectoid ferrite content reduced, the acicular ferrite content increased, and the strength and low-temperature impact toughness increased gradually. When the Y_2O_3 content was 0.02%, the low-temperature impact toughness of weld metal reached the maximum. When the Y_2O_3 content was over 0.02%, the acicular ferrite content in the weld reduced, and the low-temperature impact toughness decreased. Therefore, the optimum Y_2O_3 content for high strength steel electrode is about 0.02%.

Key words: yttrium oxide; 800 MPa high-strength steel electrode; acicular ferrite; low-temperature impact toughness

Theory solution of weld toe stress and strain of weld joint under cyclic loading in plane stress condition XUE Gang[1,2], WANG Tao[2], GONG Xuhui[2], FANG Hongyuan[1] (1. State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, Harbin 150001, China; 2. Luoyang Ship Material Research Institute, Luoyang 471023, China). pp 97 – 100, 105

Abstract: A theoretical method was proposed to precisely predict stress and strain in weld toe of butt joint under cyclic loading in plane stress condition, based on elastic-plastic mechanics theory. The analytical solutions of stress and strain in weld toe of butt joint under cyclic loading in plane stress condition were obtained. The stress and strain in weld toe could be calculated by analytical solution when the material properties, load value and stress concentration factor on the weld toe were known. The proposed method could predict fatigue failure of welded joint under cyclic loading.

Key words: cyclic loading; plane stress; stress and strain at weld toe; analytical solution

Vacuum brazing of $MgAl_2O_4$ transparent ceramics with AgCuTi active filler metal ZHU Chengjun[1,2], SHANG Changpei[1] (1. Henan Ploytechnical Institute, Nanyang 473009, China; 2. School of Mechatronics Engineering, Wuhan University of Technology, Wuhan 430070, China). pp 101 – 105

Abstract: $MgAl_2O_4$ transparent ceramics were vacuum brazed with AgCuTi active filler metal foil under conditions of 880 ℃/10 min and 880 ℃/60 min, respectively. The workpieces were metallurgically bonded, and the shear strength of the resultant joints under two conditions was 52.4 MPa and 61.3 MPa, respectively. The microscopic analysis results show that a consecutive diffusion layer appeared near the ceramics substrate. On the basis of XRD measurement, the layer was mainly composed of $CuAl_2O_4$ and TiO phases. The brazed seam consisted of Cu(s, s), Ag(s, s) and TiO Phases.

Key words: $MgAl_2O_4$; AgCuTi; vacuum brazing; diffusion reaction layer

Effect of high-temperature welding on fatigue life of 2.25Cr1Mo steel joint YIN Chengjiang[1], SONG Tianmin[2], LI Wanli[3] (1. Northeast Petroleum University, Daqing 163318, China; 2. Liaoning Shihua University, Fushun 113001, China; 3. Fourth Construction Company of China Petrochemical Corporation, Tianjin 300270, China). pp 106 – 108

Abstract: High-temperature welding of 1.25Cr0.5Mo steel at different temperatures (550 ℃, 650 ℃, 750 ℃ and 850 ℃) was carried out. Residual stress measurement and fatigue experiments were done after welding at room and high temperatures, respectively. The maximum longitudinal and transverse residual stresses in heat-affected zone of high-temperature welded specimens were significantly reduced, comparing to those at room temperature, the reduction rate for longitudinal and transverse residual stress was 50.1%, 48.9%, 74.8%, 67.4%, 83.9%, 79.4%, 91% and 89.7%, respectively. The average fatigue life was improved 31.02%, 38.84%, 47.23% and 62.28%, respectively. The results show that high-temperature welding can significantly reduce residual stress and improve the fatigue life of the welded joint.

Key words: high-temperature welding; residual stress; fatigue life

Effect of welding parameters on grain size in Inconel601H nickel-based alloy weld by P-TIG welding WANG Tao, ZHENG Zhentai, DONG Tianshun, ZHANG Lisheng (School of Materials Science and Engineering, Hebei University of Technology, Tianjin 300132, China). pp 109 – 112

Abstract: In order to control the grain size in nickel-based alloy weld, the effect of welding parameters on the grain size in the weld was studied. Pulse tungsten inert gas (P-TIG) welding of Inconel601H nickel-based alloy was carried out. With optical microscope, the microstructure of the weld was observed and the grain size was calculated. The results show that the effect of welding parameters on grain size of the weld was different during P-TIG of Inconel601H nickel-based alloy. With increase of peak welding current, pulse frequency and pulse duty in a certain range, the grain refinement was obvious. However, the grain tended to grow with the increase of base welding current. Therefore, the grain coarsening in nickel-based alloy weld can be improved using proper welding parameters.

Key words: nickel-based alloy; P-TIG welding; process parameters; grain refinement