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MAIN TOPICS, ABSTRACTS & KEY WORDS

Multi-information fusion of droplet transfer in pulsed GMAW

PAN Cun-hai, LI Huan, LI Jun-yue, YANG Yun-qing, XUE Hai-tao (Tianjin University, Tianjin 300072, China). p1 ~ 4

Abstract: Electric and spectral information of droplet transfer in pulsed GMAW are collected by using picking system, the image of droplet transfer is also quasi-synchronously shot by high-speed camera. There is explicit characteristic of correspondence reflecting the droplet transfer among the electric, spectral and image information based on time information fusion. Thereinto, the variation of spectral information is the greatest when the transfer appears and it can reach 47% of the total intensity. All of the necking down, droplet growing up and falling apart during droplet transfer of pulsed GMAW process can be found in spectral information. Further, DFT (Discrete Fourier Transform) analysis shows that the electric and spectral frequency information and the droplet transfer frequency also matches well.

Key words: gas metal arc welding; droplet transfer; information fusion; spectral information; electric information; image information

Research on small type of spectrum sensor of droplet transfer

YANG Yun-qiang[1], PENG Tao[1], LI Jun-yue[2], ZHANG Xiao-qi[1] (1. Zhuzhou Institute of Technology, Hunan Zhuzhou 412008, China; 2. Tianjin University, Tianjin 300072, China). p5 ~ 8

Abstract: Spectrum information is the best single to respect the droplet transfer discovered by far, but the system based on spectrograph can not apply to test welding droplet on line. Guided by the thought of spectrum sensing droplet transfer, a small type of spectrum sensor of droplet transfer is developed in this paper. The idea of the design and theory explore on the practice system is introduced in detail, also the practice structure of the sensor is give out. The sensor worked well on line control.

Keywords: droplet transfer; spectrum; on line; sensor

Locating system for planar workpiece based on hand-eye stereo vision in arc welidng robot

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Abstract: Arc welding robots applied in the industrial production all are the teaching and playback robots. This robot requests that the workpiece is located conformably every time in the instance of the batch quantity production, otherwise teaching is requested over againg. Also there is locating problem in arc wedling robot with off-line program system. If the workpiece is located inaccurately, arc welding robot can't finish welding along the original track made by off-line program. In the paper, the locating system for planar workpiece based on hand-eye stereo vision in arc welding robot is developed. First the inside and outside parameters of the camera and the hand-eye relation are calibrated. And then the robot is controlled and moved to the two positions. The images are captured by the camera mounted in the end effector of the robot at the two positions. Finally the workpiece's 3D coordinates in the basal coordinate of the robot are calculated by image processing and stereo vision. Experiments show that the workpiece's locating information got by locating system is accuracy. The locating system laid the foundation of independent welding.

Key words: image processing; stereo vision; camera calibration; workpiece locating

Thermodynamic analysis of a Ag-Cu-Ti active brazing alloy

QU Shi-yao, ZOU Zeng-da, WANG Xin-hong (School of Materials Science and Engineering, Shandong University, Jinan 250061, China). p13 ~ 16

Abstract: A Ag-Cu-Ti alloy is one of the most extensive brazing alloy for joining of ceramics to metals with active metal brazing method.

The activity of Ti as a alloy element is a key factor influencing the interface reaction between ceramics and the brazing alloy, and plays an important role in wettability and joining ability of ceramics by the brazing alloy. In this paper, the Ag-Cu-Ti brazing alloy has been analyzed thermodynamically, the Ti activity and its relation to the concentration of the alloy components have been studied, and the interaction parameters of the alloy components have calculated. Results of the analysis and calculation have shown that the activity of Ti decreases with increasing Cu and decreasing Ag content. There is a certain repulsive interaction, 32. 83 kJ/mol of calculated value, between Ag and Ti, while a strong attractive interaction, -16. 14 kJ/mol, between Cu and Ti. In order to improving the activity of Ti, it is helpful to adding some alloy elements to the Ag-Cu-Ti alloy, which has a strong bond with Cu, a weak bond with Ti, and no formation of the high melting point compounds or brittle phases with alloy components.

Key words: Ag-Cu-Ti alloy; active brazing alloy; activity; thermodynamics

Adaptive control based on vision technology for aluminium alloy TIG welding   WANG Jian-jun, LIN Tao, CHEN Shan-ben, HU Jun-chuan (School of Materials Science and Engineering, Shanghai Jiaotong University, Shanghai 200030, China). p17~20, 24

Abstract: In this paper, the vision technology with adaptive control technology are used in TIG welding quality control of the aluminium alloy. The specialties of the TIG welding process for aluminium alloy are analysed, introduced stochastic system theory into the welding process. Then, stochastic models between welding condition and the parameters of weld pool have been established and the on-line identification of the model parameters is realized. The adaptive welding current adjuster based on the minimum variance theory is designed. The experiments show that adaptive system is excellent in controlling weld bead for aluminium alloy TIG welding.

Key words: aluminium alloy; TIG welding; system identification; adaptive minimum variance control

Design and implementation of control system for numerically controlled welding positioner   SHI Yu, FAN Ding, WANG Zheng (State Key Lab of Gansu New Non-ferrous Metal Materials, Gansu Univ. of Tech., Lanzhou 730050, China). p21~24

Abstract: The development of numerically controlled positioner for arc-welding robot is of vital importance to the design of welding flexible manufacturing center (WEMC) of arc-welding robot. The control system has taken 2-aixs servo motor control card as its core and use the two-mode controller that based on Fuzz and PID control method as its position controller. In two-mode controller, the outputs of Fuzz and PID act on object at the same time, but weights of the Fuzz and PID are differ from value of error. The weight of Fuzz controller is big when error is big; on the other hand the weight of PID controller is big when error is small. This structure avoids concussion effectively when from one controller switch to other controller. Two-mode controller has realized the precise control over position of welding positioner. The thesis has made a detailed theoretical analysis of the constitution design and real-time controlled software and brought up the design and fulfillment method of multi-task real-time controlled software of high precisely numerically controlled welding positioner, which has a good result in practice.

Key words: numerically controlled welding positioner, intelligent two-mode controller, multi-task real-time control system, arc welding robot

Metallurgy characteristics of interface with titanium alloy coated by molybdenum for non-oxidation spray   LI Xiao-quan, YU Zhi-shui, WANG guang-yao (East Chinese Shipbuilding Institute, Jiangsu Zhengjiang 212003, China). p25~27, 32

Abstract: In this paper, coating interface microstructure of TA7 titanium alloy, which was coated by the metal molybdenum with spraying in the argon atmosphere and then kept at high temperature diffusing, was analyzed with microscope, scan electrode microscope, electrode probe and X-ray diffraction etc. The results show that a solid, almost non-layer shape microstructure coating is available with subsonic speed plasma spray, the atom diffusing nearby interface would speed up metallurgical bonding, and affect titanium alloy microstructure nearby interface in certain degree.

Key words: titanium alloy; thermal spraying; interface; coating interface

Effect of TiO_2 on microstructure of laser cladding of nickel-based hardfacing alloy   CHAO Ming-ju[1], LIANG Er-jun[1], YUAN Bin[1], YAO Jian-quan[2](1. Physical Science & Engineering College, Zhengzhou University, Zhengzhou 450052, China; 2. College of Precision Instrument and Opticelectronic Engineering, Tianjin University, Tianjin 300072, China). p28~32

Abstract: The experiments of laser cladding of Ni-base hardfacing alloy powder added with and without TiO_2 were carried out. Microstructure of the clad layers was analyzed using scanning electron microscopy, X— ray diffraction and electron probe, and microhardness of the coatings was also measured. It is shown that microstructure of the G112+ (mass fraction, %) $4TiO_2$ laser clad layer on 45 steel substrate consists of the fine in-situ formed phases of TiC, TiB_2, M_7C_3 and $M_{23}C_6$, which are distributed in the matrix of γ (NiFe) dendrites, and that the addition of TiO_2 can enhance the toughness of coatings, refine the microstructure of

clad layer, suppress the formation of block phase in the laser clad layer and reduce the cracking susceptibility obviously. The microhardness distribution of G112+(mass fraction, %)4TiO$_2$ laser clad layer is uniform, and its average microhardness is 750 HV0. 3.

Key words: laser cladding; TiO$_2$; nickel hardfacing alloy; microstructure

Forming process analysis of equiaxed grain in weld nugget zone during friction-stir welding of aluminum alloy   WANG Da-yong, FENG Ji-cai, DI Ou, LIU Hui-jie(National Key Laboratory of Advanced Welding Production Technology, Harbin Institute of Technology, Harbin 150001, China). p33~35

Abstract: A physical model of the forming process of equiaxed grain in weld nugget zone during friction stir welding of aluminum alloy was established. Experimental results showed that thermal cycle caused material softening near rotation tool. Softening material flowed as plastic state under the mechanical stir of rotation tool. The speed of different flowing layer in softening material was different, resulting in speed gradients and sticking friction shear stress at the interface between adjacent layers. Under the shear stress, the banded structures of parent material were highly elongated and bended. When the degree of bend exceeded the limit of grain boundary, the original banded structures boundary began to degrade, and the equiaxed grains forming in banded structures were arrayed by the energy principle, resulting in no order and direction pattern of equiaxed grains.

Key words: weld nugget; friction-stir welding; forming process analysis

Strength and fracture behavior of Si$_3$N$_4$ ceramic/Inconel 600 alloy liquid phase inductive diffusion bonding joint   YANG Min, ZOU Zeng-da, LIU Xiu-zhong, WANG Yu-fu, CUI Feng-you(School of Material Science and Engineering, Shandong University, Jinan 250061, China). p36~38, 42

Abstract: Bonding of Si$_3$N$_4$ ceramic to Inconel 600 alloy was carried out by liquid phase inductive diffusion bonding(LPIDB) method with Nb/Cu/Ni multi-interlayer. Effect of bonding condition on joint strength and fracture behavior was investigated in the paper. Joint strength was evaluated by shear test, shear fracture surface of the joint was observed by SEM. It was shown that the parabolic relationship among the shear strength of the joint and bonding temperature(when bonding time is 3 000 s and bonding pressure is 5 MPa), bonding pressure(when bonding temperature is 1 130 ℃ and bonding pressure is 10 MPa) was observed.

Key word: liquid phase inductive; diffusion bonding; Si$_3$N$_4$ ceramic; Inconel 600

Study on contacting line of two intersecting pipes in welding assembly

LI Xiao-gang, Lü Bi-feng, YAO Wei-wei, XUE Ji-ren(Material Science and Engineering Department, Dalian Railway Institute, Liaoning Dalian 116028, China). p39~42

Abstract: In the welding engineering of large-scale pipe structures, the assembly precision and the branch pipe cutting curve of two intersecting pipes haven't been settled for a long time. Based on the engineering practices of pipe structures, a mathematical model used for hemetially sealed intersecting assembly between radially cut branch pipe and uncut main pipe is established. By the solution of the model, a calculating formula of the local dihedral angel of intersecting line and a parametric equation of contacting line are given. At the same time, the mathematical essence is expounded. A branch pipe, practically cut, can be assembled with a main pipe accurately.

Key words: intersecting pipes; contacting line; parametric equation

A system of welding parameter collection and analysis based on LabView VI   ZHANG Yong[1], XU Xin[1], CAI Yan[1], HUA Xue-ming[1], WU Yi-xiong[1], YU Qian-bo[2](1. Welding engineering Institute, Shanghai Jiaotong University, Shanghai 200030; 2. Nantong SanJiu Welding Equipment CO. LTD, Jiangsu Nantong 226006). p43~46, 50

Abstract: A welding parameter collection and analysis system which is based on NI Virtual Instrument is described. A welding current and welding voltage signal collection circuit is designed. For farther research demarcated signals are added to represent different welding period. This article introduces software flow chart of the system in detail. The system can collect and display signals in real-time, and use the statistical analyzing method to transfer current and voltage signals into accessible format. By this means, the welding process' characteristic parameters can be extracted out and shown in the probability density distributing diagrams. Experimentations prove that this system works in stabilization, satisfy the CO$_2$ arc welding process, and the collected data is full and credible.

Key words: LabView; Virtual Instrument(VI); welding parameter; welding process; signal collection

Study in GTAW of fuzzy neural controller based genetic algorithm LEI YU-cheng, ZHANG Cheng, CHENG Xiao-nong, CHEN Xi-zhang (School of Materials Science and Engineering, Jiangsu University, Jiangsu Zhenjiang 212013, China). p47~50

Abstract: GTAW is that controls linear energy easily and has high quality welding of sheet metal. It is difficult to realize real time and effective control. Welding process is a strong nonlinear system of complexity and multi-parameter. Fuzzy control has characteristic of human experiential thought. Neural network is of self-control and self-study for information. The genetic algorithm is a new method of global optimal searching

that has character of simpleness, catholicity, parallel processing and wide application. This paper designs a new fuzzy controller harmonizing using three methods' advantages. The result of simulation in pulsed GTAW indicates the new fuzzy neural controller is better than traditional fuzzy controller.

Key word: GTAW; fuzzy neural network; genetic algorithm

Integrated intelligent system for welding seam error and penetration depth identification   ZHANG Hua, HU Jing, ZOU Chun-hua, PENG Shao-bin (Robot & Welding Automation, Nanchang University, Nanchang 330029, China). p51~54

Abstract: In this paper a integrated intelligent system for seam tracking and penetration controlling is introdmed, which receives information of welding seam error and penetration depth from only one sensor, and realizes seam tracking and penetration controlling simultaneously. This paper introduces the constitution of the system, methods of information recognition, the design of the neural-fuzzy controller and the practical application.

Key Words: seam tracking; penetration depth identification; neural network; fuzzy control

Principal component analysis based artificial neural networks for arc welding quality control   Yang Hai-lan, Cai Yan, Chen Geng-jun, Wu Yi-xiong (Welding Engineering Institute, Shanghai Jiaotong University, Shanghai 200030, China). p55~58, 64

Abstract: In this paper, the application of principal component analysis (PCA) and artificial neural networks (ANN) to the multivariate statistical analysis and quality control was introduced. The pool width control of MAG weld with high current was taken as an example. Through the PCA of 6 welding parameters, 4 main factors were extracted. The relationship between main factors and original parameters was discussed. The PCA values were taken as the new training sample set and the output results indicated both the convergent speed and the training accuracy of PCA—based ANN were much better than those of basic BP ANN.

Key Words: principal component analysis; artificial neural networks; BP algorithm; quality control

Real—time control system of digital welding machine based on communication between DSP and MCU   HE Jian—ping[1], ZHANG Chunbo[1], WU Yi—xiong[1], JIAO Fu—jie[2] (1. Shanghai Jiaotong University, Shanghai 200030, China; 2. Shanghai University of Engineering and Technology Science, Shanghai 200336, China). p59~64

Abstract: The problem of time distribution of multitask control system in digital TIG welding machine is solved by using two-CPU system of TMS320F240 digital signal processor and AT89C2051 single-chip controller. The main points of this two-CPU control system are the of tasks distribution to two CPUs, velocity matching of tasks and efficient communication between two CPUs. Communication model of this two-CPU system is analyzed in this paper. The software agreement of asynchronous communication suitable to the occasion of control system in welding machine is come up. The paper comes up with multitask control system from almost every aspects according to author's research on digital TIG welding machine, analyzes the principles of software and hardware, points out the superiority of this real-time control system centered by DSP (Digital Signal Processor) for the implementation of digitalization and information welding machine.

Key words: communication; real-time control system; digital signal processor; digital welding machine

Study on pulsed AC TIG welding technology of thin sheet of aluminium alloy   LIAO Ping[1], CHEN Shu-jie[1], YANG Wen-jie[2] (1. Jianmusi University, Heilongjiang Jiamusi 154007, China; 2. Hegang Generating Limited Liability Company, Heilongjiang Hegang 154109, China). p65~67

Abstract: The welding technology of thin sheet of aluminium alloy is studied by using the double inverter pulsed AC TIG welding power source in this paper. The influences of pulsed current peak value, EP time and pulsed current frequency on the welding technology are studied. The pulsed current peak value and EP time have a important effect on removal of the surface oxide, the lower frequency should be adopted for thin sheet of aluminium alloy. With rational welding parameters, the welding appearance can be easily controled, and the good welding quality can be acquired.

Key words: aluminium; pulsed AC; TIG welding

Research on simulation for surface tension transformation in CO_2 arc welding   ZHANG Guang-xian, ZHOU Zeng-da, CHEN Ren-fu, YIN Hai, LIU Ming-zhi (Shandong University, Jinan 250061, China). p68~72

Abstract: Based on the study of droplet transfeormation and inverter arc welding power surface tension transformation (STT) in CO_2 arc welding which has very low spatter has been used in pipe root-welding. In this paper, a simulation model is presented for STT in CO_2 arc welding which integrates current inverter welding power and arc model, and is designed to simulate the effect of droplet to arc length in arc phase and the effect of conductor to the current decrease rate in short circuit phase. The result of simulation is almost same as experiment, and shows the conductor in output loop is a key to realize low spatter

Mathematical model of hydrogen escaping from deposited metal

ZHANG Jing-hai, WEI Jin-shan, WANG Xiao-dong (Luoyang Ship Materials Institute, Henan Luoyang 471039, China). p73 ~ 78

Abstrct: Based on fick's first and second law and introduced surface hydrogen transmission coefficient " h ", the mathematical modle of hydrogen escaping from deposited metal at a unsteady diffusion condition is founded in alcohol hydrogen test. The escape hydrogen-time function is caculated by the modle with the parameters of the initial hydrogen concentration, diffusion coefficient, surface hydrogen transmission coefficient and radius of the specimen. The results show that the surface condition of the deposited metal has great effect on the hydrongen escaping from the metal, which is a vital facter to be taken into account in the research of the hydrogen diffusion and accumulation in welded joint. The practicability of the modle is proved by succeeding in fiffing measured escape hydrongen-time curves and explaining some experimental phenomena.

Influence of environment condition on cracking-resistance of 10CrNi3MoV steel

WEI Jin-shan[1], FANG Hong-yuan[2] (1. Luoyang Ship Material Research Institute, Henan Luoyang 471039, China; 2. Harbin Institute of Technology, Harbin 150001, China). p79 ~ 82

Abstract: In this paper, the influence of environment condition (temperature and relatively humidity) on diffusible hydrogen content of electrode deposited metal, H_D escape characteristic and the cracking-resistance are studied by cracking test and H_D escape characteristic of 590 MPa high strength ship structure steel (10CrNi3MoV steel) and special electrode. The research demonstrated that different H_D content and H_D escape characteristic depending on environment condition can produce different result during various cracking test. It is discussed that the slow diffusible hydrogen escaping of later period (H_{D_s}) is the key factor to effect multi-pass weld cracking test.

Numerical analysis of a method for relieving welding stresses of girth-weld pipes with small diameters

LÍ Jian-min, CHEN Huai-ning, LIN Quan-hong. (Institute of Metal Research, Chinese Academy of Sciences, Shenyang 110016, China). p83 ~ 86

Abstract: The stress corrosion crack of small diameter steel pipe girth welds has been an engineering puzzle for a long time. This paper presents a new method for relieving stresses - deformation method by temperature difference. By using general-purpose nonlinear finite element analysis software MSC. Marc, finite element modeling of original residual stress distributions in small diameter steel pipe girth welds and the relief of residual stresses by temperature difference are discussed in this. A serial of numerical analysis data and related rules about heating position, heating band width and heating time, are showed here. It shows that, by using this new method, residual stresses are decreased nearly to zero both on the inner surface and the outer surface of weld.

A new type of cathode of high-power electron gun

HE Cheng-dan[1], LI He-qi[1], XU Qi-jin[2] (1. Gansu University of Technology, Lanzhou 730050; 2. Lanzhou Institute of Physics, Lanzhou 730000, China). p87 ~ 91

Abstract: The bombarded LaB_6 cathode is a new type of cathode applied in the electron gun. It has not only a good structure in optics system, but also the powerful ability of emission and has a great important significance in developing and researching the high-power electron gun. The principle of the work, the significance of the study, the selection of the material of the cathode was dealt with in this paper. This task based on investigation has completed the design and calculation of bombarded cathode, it has designed and completed the experiment equipment of the bombarded LaB_6 cathode. By the experiment, we found that the bombarded LaB_6 cathode could get the maximum of emission current that is 450 mA, when the cathode temperature got to 1 843 K. Moreover, by analyzing the datum of the experiment, we got the constant A of LaB_6 emission that is 21. 33 and the function Φ_s of it that is 2. 6 eV, which are quite similar with the theoretic value, and proved the experiment had veracity and reliability.

Latest advances of brazing & soldering technology

GAO Feng[1], SEKULIC. Dusan. P.[2], QIAN Yi-yu (1. National Key Laboratory of Advanced Welding Production Technology, Harbin Institute of Technology, Harbin 150001, China; 2. Center for Robotics and Manufacturing Systems, University of Rentuclcy, Lexington K Y, U. S. A. 40506). p92 ~ 96

Abstract: In this paper, based on the 2002 AWS Welding Show in Chicago, IL, USA which represents the latest technology and tendency in the brazing & soldering field around the world, the novel projects of brazing study are analyzed with the understanding of the recent literatures. At the same time, it is found that the study on brazing technology has been developed to numerical and simulating period. The key research issues come to focus on the precise control and essential mechanism of brazing. Thus this report may provide some suggestions to keep up with the development of the brazing study.