Study of Microstructure and Mechanical properties of Welded mild steel fabricated by FCAW and Compare with GMAW Process

N. Khodabandehloo*[1] , H. Sabet[2]

Abstract

In this study, samples of carbon steel St37 was junction with thickness of 4 and 8 mm by two process GMAW and FCAW welding methods. The samples was junction by using solid wires and flux cored for welding GMAW and FCAW respectively, to near the chemical composition connected. Evaluation of microstructure was performed by optical microscopy and scanning electron microscopy (SEM) with EDS analysis. The results showed that, with increasing the thickness of the Ferrite circulators content reduced in the Weld zone and the amount Weidman Ashton ferrite and grain boundary ferrite phases increased. Also in the FCAW process due to potential areas for nucleation sites and the formation of Ferrite circulators than the process GMAW, better mechanical properties was observed. The results of the tensile test showed the highest the amount of tensile properties in the sample thickness of 4 mm and obtained in welded by FCAW method. Hardness test results showed, highest the amount of hardness in welding and heat affected zone related to sample with thickness 4 mm and is welded by FCAW method. SEM images were showed, the amount of inclusions and cavities weld metal was FCAW more of GMAW method. Images SEM showed that the impact test samples with the increase in thickness in both welding methods the fracture surfaces, fracture but also show evidence of brittle behavior as well.

Keywords: Thickness, Ferrite Circulators, Steel St37, GMAW, FCAW.

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Investigation on the effect of Al addition on synthesis of Ti3SiC2 nanostructure by Mechanical alloying – heat treatment method

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Abstract

In this study, the effect of Al addition in synthesis of Ti_3SiC_2 nanostrucure has been studied by mechanical alloying - heat treatment method and using the mixture of Ti, Si, C powders. The composition of 3Ti: 1.3Si: 2C: xAl (x= 0%, 0.5%, 1% and 1.5%) were used in order to evaluate the molar percent of aluminum in synthesis of Ti_3SiC_2 MAX phase. First the initial powders were weighed. Then, the powder mixtures were milled at the ball to powder ratio of 30:1 for 40 hours under argon atmosphere. After that they have been formed in pills under 200 MPa pressure. After the heat treatment of the samples at 1200 °C for 1 hour, an X-ray diffraction analysis was used to examine phase composition while a field emission scattering electron microscope equipped with an EDS spectrometer was utilized to observe the microstructure. The results indicate that the maximum amount of the synthesized Ti_3SiC_2 MAX phase is totally equal to 75wt.% and it is related to the sample of 3Ti:1.3Si:2C:xAl (x= 1%) which heat treated at the temperature of 1200°C. It was also observed that the weight percentage of the Ti_3SiC_2 MAX phase has decreased in the reaction products by increasing of the molar percent of aluminum from 1 to 1.5 %.

Keywords: MAX phase, Ti_3SiC_2, mechanical alloying - heat treatment, molar percent of aluminum.

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Investigating on effect of heat treatment on microstructure and metallurgical properties of three layers explosively bonded Cu/Al/Cu plates

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Abstract

In this study, the microstructure and mechanical properties of Cu/Al/Cu explosively bonded plates interface after heat treatment were discussed. To illustrate the effect of temperature and time, welded samples at temperatures 300°C and 400 °C in times of 30 minutes and 20 hours heat treated. With the heat treatment for 30 minutes At temperature of 300°C, 30 minutes At temperature of 400°C and 20 hours At temperature of 300°C, respectively average thickness of the the interfacial layer in upper interface was increased from 37/144, 27/232 and 82/33 microns to 39/285, 33/987 and 95/834 microns and at the lower interface, thickness was increased from 20/967, 16/992 and 43/979 microns to 22/12, 22/76 and 52 microns.The micro-hardness of diffusion layer at the upper interface was decreased respectively from 508/8, 436/2 and 393/9 Vickers to 258/9, 296/7 and 293/9 Vickers and at the Lower interface was decreased from 321/3,321 and 248/7 Vickers to 2213/, 185/8 and 162/3 Vickers. The results showed that the thickness of the interfacial layer had a direct relationship to the temperature and duration of heat treatment. So that by applying heat treatment on the samples, the thickness of intermetallic compounds is increased compared to pre-heat treatment and this increase was higher in the upper joint.

Keywords: Heat treatment, explosion welding, microhardness, tensile-shear strength, temperature, time.

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Production of composite coating of hard chrome – nano alumina by electroplating from the bath of hexa valence chrome and the study of the hardness and abrasive properties

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Abstract

This research paper aimed at study of the effect of two critical parameters on the electroplating of nano composite coatings that are, the weight percent of alumina nanoparticles dispersed on the electroplating bath and the density of electrical current. The amount of distributed nanoparticles influences the resistance to abrasion, coating microstructure and adhesion to substrate The hard chrome coating and nano composite coating of chrome – alumina by using of direct current and electroplating bath of hexavlence chrome. optical microscope images, SEM/EDS, XRD, micro vikers hardness test and the abrasion test of pin on the disc. The results of these examinations showed that the maximum amount of nano alumina, distributes into the nano composite coatings when electroplating conditions set on 25 grams of nano alumina per liter of bath, and the current density was 50 amps on square decimeters .SEM images were resolved the presence of nano-alumina particles that distributed into volume of coated layer XRD reveals that the size of grain in coated layer with nano-alumina was reduced noticeably and with increasing the volume density of nano particle in coated layer the grain size of coating structure reduces. Comparison between hard chrome coating and the nano-composite coating of chrome-alumina showed that the coating containing of nano-alumina particles is 46% harder and enjoys 179 times more abrasion resistance as compared to hard chrome.

Keywords: nanocomposite coating, electroplating, hexavalence chrome bath, alumina nano particles.

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Synthesis of Microspheres Cr_2O_3/C by Changing the Synthesis' Parameters and Evaluation of Electrochemical Properties of Microspheres

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Abstract

Nanostructured transition metal oxides have received Special role in the production of the anode electrode in the lithium-ion batteries. In this research, a one stage method to synthesize Cr_2O_3/Chybrid microspheres via solvothermal method was reported. The XRD and SEM methods were used for characterization of products. The Carbon content of synthesized samples were measured by TGA method. The results showed that only Cr_2O_3 peaks could be observed XRD patterns, and this indicated that the carbon in the composite was amorphous. The average crystallite size is calculated by using Williamson-Hall, 36 nm. The content of carbon in the composite was 63 wt%. The SEM images showed that the surfaces of prepared spheres were relatively smooth and Carbon microspheres had an average diameter of about 2 μm. The morphologies and sizes of the microspheres change with controlled by reaction conditions Solvothermaland in the size range of 0.7-3/5 microns changes. Electrochemical impedance in KOH solution for Cr_2O_3/C indicates a good behavior Capacitive to materials. Cr_2O_3. Improve the electrochemical properties of the composite can be attributed to amorphous carbon.

Keywords: Electrochemical, Solvothermal, Carbon, Microspheres, Cr_2O_3.

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Effects of severe plastic deformation on mechanical properties, electrical conductivity and microstructure of Al-7075 alloy

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Abstract

The aim of current research was to examine the microstructure, mechanical properties and electrical conductivity of Al-7075 alloy that develops during Equal Channel Angular Pressing (ECAP) and Multi Directional Forging (MDF). The Annealed Al-7075 alloy was subjected up to 3 and 4 passes of MDF and ECAP deformation at room temperature, respectively. Followed by ECAP, Vickers microhardness and shear punch test were performed and microstructural observations were undertaken using transmission electron microscopy (TEM). The electrical conductivity was also measured by eddy current method. Microstructural investigations show that after 4 passes of ECAP very fine grains with average grain size of about 350 nm appear and most of the grains evolve into arrays of high angle boundaries. On the other hand, 3 passes of MDF leads to higher grain size (950 nm) and lower fraction of high angle boundaries compared with 4 pass of ECAP. Mechanical properties of specimens increase about 100 and 50 percent after 3 passes of MDF and 4 passes of ECAP, respectively. So, it can be concluded that the ECAP process is more effective than the MDF process in grain refinement and improvement of mechanical properties. The electrical conductivity measurement at room temperature showed that there was no significant change in the conductivity of the processed samples compared with the initial specimen. Finally, it can be deduced that grain refinement during ECAP and MDF processes can be considered as a strategy to improve mechanical strength of pure metals without sacrifice of their electrical conductivity.

Keywords: ECAP and MDF processes; Al-7075 alloy; Mechanical properties; Microstructure; Electrical conductivity.

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Investigation of structure and tribological behavior of nanostructured DLC coating, deposited by PACVD and Arc-PVD processes

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Abstract

In this Study, PACVD (plasma assistant chemical vapor deposition) and Arc-PVD (cathodic arc physical vapor deposition) methods were used to deposit of DLC (diamond like carbon) on St37 steel. Then, an interlayer was performed before applying the main DLC coating using arc-PVD. Field emission scanning electron microscopy, x-ray diffraction, Raman spectroscopy, energy dispersive spectroscopy, adhesion and tribological tests were performed to characterize and evaluate of coatings. Many factors are responsible for the excellent wear and mechanical behaviors of the DLC PVD coating including the presence of TiCrAlN interlayer, the fine grains (30-40 nm), hardness gradient as well as Ti and Cr carbides. These factors, also led to reach the high adhesion for this coating. The grain size of DLC PACVD coating was measured approximately 70-110 nm. In addition the thickness of arc-PVD coating was less than that of the PACVD coating which caused lower internal stress and subsequently appropriate adhesion to the substrate. The results revealed that this coating had lower hardness and adhesion to the substrate than that of the DLC PVD.

Keywords: PACVD, Arc-PVD, diamond like carbon, Nanostructured coating and St37 steel.

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The effect of titanium interlayer on the mechanical and structural properties of steel- tungsten diffusion bonding

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Abstract

In this study the diffusion bonding of steel– tungsten using a pure titanium interlayer was investigated. Samples were heated in a special fixture under 5 MPa pressure and at the different times and temperatures in the argon furnace. The images of optical and scanning electron microscopes indicated that a detectable diffused region was formed at the Ti- W, while no detectable diffused region was formed at the Steel- Ti interface. Also with increasing the time and or temperature of the process, the thickness of diffused region was increased. Results of the energy dispersive x- ray spectroscopy (EDX) approved the diffusion of Ti and W and little diffusion of steel and Ti. The results of x- ray diffraction (XRD) approved the presence of FeTi and Fe_2Ti phases at the welded region. The results of microhardness indicated that the maximum hardness is related to the 1000T1H sample and spatially in its steel- Ti interface. This maximum hardness was due to the presence of intermetallic compounds (FeTi and Fe_2Ti). Regarding to the results of shear test, 950T1H had the maximum shear strength and with increasing the time and temperature of welding, the strength was decreased due to the more intermetallic formation. Regarding all the results, temperature of 900 C and time of 1 hr, were found the optimum time and temperature for steel- tungsten diffusion bonding.

Keywords: Wolfram, Steel, Titanium interlayer, Diffusion bonding, Intermetallic compound.

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Studying mechanical behavior of non-wrinkled phosphorene nanotubes under uniaxial loading

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Abstract

Recently, phosphorene nanotubes like carbon nanotubes have been attracted much interest due to their superior mechanical, thermal, and electrical properties. Studying the mechanical behavior and material properties of such nano-structures is highly significant. Thus, in this research, the tensile and compressive behavior of phosphorene nanotubes is firstly simulated using molecular dynamics method and the effects of geometrical parameters on the mechanical behavior are studied. The impacts of diameter change on the tensile behavior and the influences of aspect ratio on the buckling behavior of the flat phosphorene nanotubes exhibit that the tensile strength increases for the larger diameters while the compressive strength decreases with increase of the aspect ratio. Subsequently, as a pioneering work in this field, the effects of defects on the tensile and compressive behavior of the nanotubes are investigated. The results demonstrate that the defects considerably decrease the tensile and buckling strength of the nanotubes. Also, it is seen that the buckling behavior is more sensitive to existing defects in comparison to the tensile behavior, such that 13.5 and 4.3 percentages drop of the compressive and tensile strengths are observed by removing mono-atom and a group of 2% atoms, respectively.

Keywords: Non-wrinkled phosphorene nanotubes; Tensile and buckling behavior; Effects of Defect; Molecular dynamics.

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Influence of filler metal on the microstructure of dissimilar welds between UNS S32205 duplex stainless steel and ASTM A517 Quench and tempered steel

A.R. Foroughi[1]*, M. Shamanian[2], M. Kasiri[3]

Abstract

In this study, the microstructure in different regions of dissimilar welding sections of type 2205 duplex stainless steel (DSS) to type A517 high-strength quenched and tempered (QTLA) steel was investigated using optical microscopy (OM) and scanning electron microscopy (SEM). The joints were fabricated using gas tungsten arc welding by two types of filler metals including ER309LMo and ER2209. The metallographic analysis and X-ray diffraction (XRD) revealed that the weld metals were completely free of common destructive phases and no trace of sigma phase and chromium nitride was found. The ER309LMo weld metal has austenitic with lathy ferrite microstructure and ER2209 weld metal sample has an austenitic continues networks in the matrix of primary ferrite. The studies by SEM from joint interface of A517 side revealed, in both welding samples, the unmixed zone formed and in the case of ER309LMo addition to this zone, a decarburization layer is also visible. HAZ of 2205 steel is non-width and with coarse primary ferrite grains and this region in A517 steel side has been width and with not-tempered martensite microstructure. The ER309LMo and ER2209 weld metal's hardness respectively were about 240 and 300 vickers.

Keywords: Duplex stainless steel; Low alloy quench and tempered steel; Gas tungsten arc welding; scanning electron microscopy.

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Dielectric Properties of Multiferroic Composite Consisting Lithium Ferrite and Bismuth Titanate Synthesized by Combustion Method

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Abstract

In this work, lithium ferrite and bismuth titanate have been synthesized to fabricate a multiferroic composite by microwave-induced combustion method. Multiferroic composites with the formula $(x)[Li_{0.5}Fe_{2.5}O_4]+(1-x)[Bi_4Ti_3O_{12}]$ (where x=0, 0.1, 0.3, 0.5, 0.7, 0.9, 1) were prepared. X-ray diffraction patterns showed that perovskite structure of bismuth titanate and spinel structure of lithium ferrite have been formed successfully in the as-synthesized nanostructured powders. Dielectric properties were examined by a LCR meter. Multiferroic composites containing the higher content of Li ferrite (70 wt % and 90 wt% Li ferrite), in comparison to the pure bismuth titanate and Li ferrite, indicate higher values of dielectric constant. In bismuth titanate and the composite with 10 wt% Li ferrite, dielectric constant remains constant as the frequency changes; in contrast, this character decreases significantly with frequency for Li ferrites and the other composites in such a way in Li ferrite, dielectric constant decreases from 8500 at 100 Hz to 180 at 1 MHz. Some dielectric peaks are observed in the dielectric constant vs. temperature plots which more or less shift to the higher temperatures as the bismuth titanate increases. For instance, the maximum dielectric constant of 2250 is observed at 25 ºC for Li ferrite; nevertheless, the maximum value of 5990 is found at 400 ºC for sample containing 70 wt% bismuth titanate.

Keywords: bismuth titanate; lithium ferrite; combustion reaction; dielectric constant; AC conductivity.

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Influence of Process Parameters on Hot Backward Extrusion of Al 6061 alloy

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Abstract

Backward extrusion is one of the metal forming processes which has been widely used for the production of hollow parts in recent years. In this study, the effect of process parameters such as reduction of area and temperature and friction conditions on the hot backward extrusion process of aluminum 6061 alloy was investigated for both experiment and finite element analysis. For this purpose, the backward extrusion carried out under three different temperatures (390, 420 and 450 °C) and different friction conditions(with or without lubricant) and then their results were compared to finite element software (DEFORM-3D) result. To perform experiments, a full set of backward extrusion die including chamber, punch, extrusion die, holder and ejector parts were designed and built. Grease-resistant was used as a lubricant. In the finite element analysis, the conventional constant friction factor was used for the simulation of hot forming condition (m=0.1, 0.2, 0.3). In conclusion the analysis and paper results are useful to develop a special hot extrusion technology for aluminum 6061 alloy.

Keywords: Backward Extrusion, Al 6061 alloy, Finite Element Method, DEFORM-3D.

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Synthesis and Characterization of Nanoparticles of Magnesium-Copper Oxide with Paramagnetic Properties

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Abstract

In the article, first a trinuclear complex under formula [Mn(phen)2(H2O) (μ-NCS)Cu (NCS)4(μ-NCS)Mn (phen)2(H2O)] that (phen= 1,10- phenanthroline) has been synthesized. This complex characterized by FT-IR, UV-Vis spectroscopirs. The electrochemical behavior of the complex was investigated by cyclic voltammeteric method. Crystal of complex was placed in the furnace at 950°C for 5h to become oxide particle of CuMn2O4. Nano oxide particle was carried out using FT-IR, X-ray powder diffraction (XRD), scanning electron microscopy (SEM) and energy dispersive X-ray analysis (EDX). Magnetic behavior of nanoparticle characterized using VSM. SEM images show that the particles have same morphology with less than 100 nm size. XRD show nanoparticles have single phase with cubic symmetry. The particle size of about 18 nm is formed. SEM images showed that the morphology of the particles obtained are almost identical with globular form.

Keywords: Electrochemical behavior, Nano oxide particle, Scanning electron microscopy, Single phase- morphology.

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An investigation of vanadium concentration on the optical and electrical properties of TiO2 sol-gel derived thin films

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Abstract

Doped Titanium dioxide thin film with different concentrations of Vanadium (0.5, 1 and 5 % weight) , was deposited by sol-gel method on glass substrate. Structural, electrical, optical and surface roughness of thin films, were studied by XRD, EDS, LCR meter, UV-Vis spectroscopy and AFM methods, respectively. The XRD results indicated that thin film has an only anatase phase. It is observed that the crystallite sizes of the thin films decreased from 17 nm for pure TO2 to 7 nm for V doped TiO2. In addition, No phases of vanadium oxide formed because the V substituted in the titanium position in the TiO2 crystal structure. The FE-SEM cross section image of the VTO thin film shows that thin film thickness is about 536 nm. The RMS of the pure TiO2 and V doped TiO2 thin films are 3.14 and 0.78 nm, respectively. The resistivity of the thin films of pure TiO2 and doped with 0.5, 1 and 5 wt. % V were 16.7 × 107 Ω cm, 7.7 × 107 Ω cm, 1.7 × 107 Ω cm and 12.8 × 107 Ω cm, respectively. Band gap energy of the samples reduced by adding Vanadium to Titanium dioxide from 3.71 to 3.44 eV and therefore absorption edge Titanium dioxide shifted towards longer wavelengths.

Keywords: Titanium dioxide, Vanadium, optical properties, thin film, electrical resistance.

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