OPTIMIZATION AND SELECTION OF WELDING PROCESS VARIABLES: DUPLEX STAINLESS STEEL

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ABSTRACT Gas Tungsten Arc Welding, Shielded Metal Arc Welding and Submerged Arc Welding were used to weld a 25 mm thick plate of a duplex stainless steel. Heat input vas varied for each test sample by changing the values of current, voltage and travel speed. For Shielded Metal Arc Welding the heat input was varied from 0.46 to 0.63 kJ/mm, for Submerged Arc Welding from 1.20 to 1.92 kJ/mm and travel speed from 1.1 to 1.44 kJ/mm. Non destructive and destructive testing was carried out to evaluate quality of weld metal. Optical Metallography was employed to study the phases in the weld metal, heat affected zone and base metal. It was observed that a root pass of Gas Tungsten Arc Welding does not affect mechanical properties of the weld in case of removal of the root pass for second side welding of butt joints. Welding parameters of 100 Amps and 120 mm/min can be used to restrict the heat input to 1kJ/mm in case of Gas Tungsten Arc Welding. An electrode of 3.15 mm diameter with a limiting current of 100 Amps can be used with a travel speed of 300 mm/min in case of Shielded Metal Arc Welding. Welding parameters of 300 Amps, 28 Volts and 420 mm/min should be used to limit the heat input to 1.2 kJ/mm in case of Submerged Arc Welding. The austenite percentage in the weld metal can be stabilized by selecting highly alloyed nickel consumables. This stabilizes the phase balance even though lower heat inputs of 1.2 kJ/mm and faster cooling rates are employed. Tensile strength of the order of 759.93 N/mm^2 has been obtained for the heat input of 1.2 kJ/mm and the heat input should be less than 1.5 kJ/mm in case of welding of duplex stainless steel.

“Precipitation hardening of A356 alloy cylinder head for property optimization”

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ABSTRACT

Aluminium-silicon alloys are widely used for automotive and aerospace applications due to their high strength to weight ratio. A356 (Al-7Si-0.3Mg) this alloy is commonly used for automotive application because this alloy can achieve the optimum strength and ductility. Cylinder head is one of the most critical component which is supposed to be brain of the engine. The higher strength and life of the cylinder head can improve the efficiency of the engine. Jaya Hind Industries Pvt. Ltd. is one of the pioneer organization in manufacturing of cylinder head. This project work was carried out under the development of A356 cylinder head. So in this thesis we have studied about the effect of precipitation hardening heat treatment of T6 temper on microstructural behaviour and mechanical properties of A356 alloy. Basically T6 heat treatment consist of solutionization at 540 $^{\circ}$C for 5 hrs followed by water quenching at 70 °C for 30 minutes followed by artificial ageing at higher temperature of 200 °C for 5 hrs. In this thesis we have also studied about the effect of various ageing time and temperature combinations on microstructural behaviour and mechanical properties of A356 alloy to find out the optimum ageing parameter. After comparing the effect of various ageing parameter 230 °C/3hrs has been found out as an optimum parameter which can replace the present ageing parameter i.e. 200 °C /5 hrs. This optimum ageing parameter not only saves the energy but also increases the productivity.

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Title of Dissertation: "The Effect of Shielding Gases on Mechanical Properties of Austenitic Stainless Steel Welds"

ABSTRACT

Austenitic stainless steels are widely used in various offshore and onshore industries including oil, gas, petrochemical, chemical, pharmaceutical and number of food processing industries. The principal attribute of austenitic stainless steels is their corrosion resistance but also excellent properties in extreme temperature range. The welding of stainless steels, especially the austenitic grades, is important in all these applications. These joints must meet severe service conditions with good mechanical properties and corrosion resistance. However, previous research shows several problems which are encountered in welded joints such as discontinuities produced in welds, solidification cracking and presence of porosity. Nevertheless, in recent years ceiling cost of shielding is another bane for the GMAW process because of which GMAW has became expensive. In this research AISI 304L type of austenitic stainless steel plates were welded using 308L consumable electrodes by gas metal arc welding (GMAW). The aim of the research is to investigate effects of shielding gas compositions on mechanical properties and microstructure of AISI 304 L weldments. Welding was carried out under different shielding media including mixtures of argon with CO_2 and hydrogen. Welded samples were characterized by means of estimating mechanical properties like tensile strength, hardness and impact toughness followed by metallographic analysis by using scanning electron microscopy to find a correlation between microstructure and mechanical properties The study conducted revealed that shielding gas proportions have great influence on mechanical properties and weld composition. Observation of this investigation indicate that increase in CO_2 percentage in argon shielding resulted in higher tensile strength and hardness in weld metal than base metal. Shielding gas proportion also have an influence on impact toughness, this variation of impact toughness values is attributable with δ-ferrite content in weld metal. This δ-ferrite content is found to be dependent upon weld chemistry which in turn depends upon shielding gas composition.

High Temperature Heat Resistant and Electrochemical Corrosion Behavior Of Powder Coating And Paint Coating Of Automotive Exhaust Mufflers.

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ABSTRACT

Corrosion is the main problem due to which automotive exhaust components have limited life particularly the exhaust mufflers. A large variety of designs of exhaust silencers having different characteristics and designs are available which are made up of aluminized mild steel, stainless steel, ferritic stainless steel etc. But stainless steel does not provide adequate corrosion resistance in aggressive operating conditions. The major cause for premature failure of muffler is corrosion, fatigue or a combination of the both. Some of the other causes are internal corrosion, external corrosion, material sensitization on hot spots (500^0 C- 600^0 C), static loads, internal stresses, thermal expansion due to the heating and cooling cycles and vibration from the engine. Powder coating is more efficient because it has higher quality finish, no drying time and over spray recovery. It shows significant durability and resistance to abrasion, corrosion, scratching and chemicals with high and low gloss. After powder and paint are coated on the substrate the annealing treatment is carried at 400^0 C and 500^0 C and the corrosion rate is studied. The corrosion rate is increased in both the powder and paint coated samples. In powder coated sample the corrosion rate is increased due to the formation of cracks and in paint coated samples the paint layer is burnt and the organic compounds are evaporated which results in the decrease in adhesion strength of paint coated sample. The salt spray test, heat cycle test and were investigated. The adhesion test, impact test, pencil hardness test, gloss test, are also carried out to check the coatings stability. SEM and XRD tests were also carried out to check the surface morphology and to identify the phases respectively after annealing and heat cycle test.

Process optimization of MgO compound coated powder for soft magnetic composite (SMC)

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ABSTRACT

Soft magnetic composite (SMC) is the internationally recognized name for pressed and heat-treated powder components with three-dimensional magnetic properties. In the present work SMC are produced by insulating the pure electrolytic iron powder (99.9%) with a coating of magnesium compound in a specially fabricated set up. Process optimization gave rise to 98% yield of the coated powder. Powder metallurgy process was used to compact Magnesium compound coated powder (M-SMC) into green pellets (Ø16mmx3mm) at varying pressure (600 MPa to 900 MPa). These pellets were cured at varying temperatures (600^{o}C to 1000^{o}C) and time (30 min to 90 min) in order to understand their impact on electrical and magnetic properties. It was noted that electrical resistivity and saturation magnetization of cured M-SMC has gone up by 97% and 66 % with reference to silicon steel. A governing mechanism has been proposed to illustrate improvement in magnetic properties.

Keywords- SMC, Saturation magnetization, permeability, magnesium compound

Preparation of Polyphenylene sulfide/Copper micro- and nanocomposites by planetary ball milling and their properties

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ABSTRACT

High performance polymer matrix composites based on poly(phenylene sulphide) (PPS) as matrix andmicro- / nano copper (Cu)as reinforcements were studied for the electronic applications. The micro- and nanocomposites were fabricated using planetary ball milling/hand mixing methods followed by hot pressing. The content of micro- and nano Cu was 30 wt%, 40 wt%, 50 wt% and 60 wt% in the PPS matrix. The microhardness was increased by more than 25% compared to pure PPS matrix. Electrical conductivity of the hand mixed microcomposites showed an increment of 13 orders of magnitude while those prepared by ball milling showed an increment of 2 orders of magnitude for the samewt% (60 wt%). This huge difference in the conductivity of composites prepared by different techniques is attributed to the dispersion of Cu particles in the PPS matrix.The conductivity of the 60 wt% Cu filled nanocomposite prepared by hand mixing showed 3 orders of magnitude increment while that prepared by ball milling showed just 1 order of magnitude increment. Low conductivity of the nanocomposites was due to the presence of cuprous oxide layer on nano Cu particles. Surface resistance and AC conductivity were also studied for the micro- and nanocomposites prepared by both methods, which showed the similar trend as the DC conductivity.

Dielectric constant of the microcomposites prepared by hand mixing showed a sharp rise after 40 wt%. In contrast, micro- and nanocomposites prepared by ball milling didn't show sharp increment. This is due to the excellent dispersion of Cu in the PPS matrix. Coefficient of thermal expansion (CTE) of microcomposites prepared by hand mixing, decreased significantly before and after glass transition temperature compared to pure PPS. Owing to better dimensional stability and good electrical properties, these micro- and nanocomposites may be promising candidates for electronic applications like electrostatic dissipation (ESD) and electromagnetic interference (EMI) shielding.

“To develop ZnO containing duplex coating to enhance corrosion resistance”

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Abstract

Galvanized steels are widely used in applications where high corrosion resistance anticipated. But still it is prone to corrode in a chloride & SO_2containing environment. Thus in order to isolate the component from such an environment and to improve its life paints are applied on galvanized steel. The nanocomposite is prepared by adding ZnO particles in epoxy mastic mechanically & painted on galvanized steel.The barrier property of a paint film largely depends on the morphology of the ZnO particles mixed in the composite. Flake like crystalline nano ZnO particles are synthesized by thermal plasma technique. The nanocomposite coated on galvanized steelimproves water ingress resistance & corrosion resistance. Corrosion resistanceof the composites film was studied by an electrochemical impedance spectroscopy (EIS) in 3.5 % NaCl electrolyte solution& salt spray test. The water ingress capacity of the coating is studied by long term immersion test along with EIS. It was found that the epoxy coating resistance& water ingress against corrosive electrolyte (3.5% NaCl) was significantly improved using flakey ZnO nano particles in a coating on HDG.Different analytical techniques including scanning electron microscope(SEM), Optical microscopy, transfer electronmicroscopy (TEM), Energy-dispersive X-ray spectroscopy (EDS) &X-ray diffraction (XRD) for characterization of synthesized nano ZnO & paint surface morphology. Paint film adhesion is an important mechanical property was studied by a pull off adhesion test on universal testing machine (UTM).

"STUDY ON INJECTION MOLDED POLYPROPYLENE / COPPER COMPOSITES"

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ABSTRACT

Polymer matrix composites filled with metals are widely studied for the applications in electrostatic dissipation (ESD) and electromagnetic interference (EMI) shielding. In view of this, composites based on Polypropylene (PP) as matrix and copper (Cu) particles as reinforcement were prepared using mechanical mixing followed by injection molding.PP and Cu powders were mixed under dry condition at room temperature for 4 h at 60 rpm and then, the blended powders were injected at 215 °C and 15 MPa. Cu content was varied from 0 to 40 wt. % in the matrix. Optical microscopy showed almost uniform dispersion of Cu particles in the composite prepared by horizontal ball mill at lower loadingwhereas agglomerates were observed in the composites containing higher Cu loading. Mechanical and electrical properties of the injection molded samples were studied systematically. The electrical conductivity and the microhardness of the composites increased with increasing Cu content in the matrix. The significant increase in the impact energy and impact strength was found for the composites compared to pure PP. This was attributed to the better and uniform dispersion of the Cu particles in the matrix. The tensile strength and % elongation were found to decrease with increasing Cu content in the matrix, as the Cu act as stress arising points under deformation as compared to pure PP.

Conducting polyaniline -2 wt% MMT Clay paint coating on low carbon steel

ABSTRACT

Conducting polyaniline -2 wt% MMT Clay paint coating are obtained on low carbon steel. Low carbon steel can be protected for long time and it can be considered as a potential material for replacement of toxic and environmentally hazardous pigments such as chromates in the inhibitive coatings. The coating is characterized by Fourier transform infrared spectroscopy and UV-vis absorption spectroscopy. The existence of Al-O and Si-O bond in the FT-IR spectrum confirms presence of MMT in synthesized paint. The corrosion protection aspects of polyaniline – 2 wt% MMT Clay coatings, in both – intact and damaged form, on low carbon steel were investigated in aqueous 3.5% NaCl solution by potentiodynamic polarization studies, open circuit potential measurements, electrochemical impedance spectroscopy, alternate immersion testing and salt spray testing. Corrosion rate of conducting polyaniline - 2 wt% MMT Clay paint coating in 3.5 % NaCl is found to be 1.2mpy which is about 4.3 times lower than that of unpainted low carbon steel in same medium. The coating resistance of PANI- 2 wt% MMT Clay coated low carbon steel in intact and in damaged condition just after immersion is 16710 ohm/cm^2 and 1700 ohm/cm^2.After 24 hrs this is increased to 30150 ohm/cm^2 3500 ohm/cm^2. At the end of 96 hrs the coating resistance of intact and damaged coatings was decreased to 2800 ohm/cm^2 and 816 ohm/cm^2. Increment in the coating resistance of Intact coating and damaged coating value indicates the dissolution of iron but subsequent possible formation of passive Fe_2O_3 layer this reveals that PANI-2 wt% MMT Clay coating is better for long term corrosion protection even in intact and in damaged condition. Conducting polyaniline - 2 wt% MMT Clay based paint protects low carbon steel significantly in drying and wetting cycles in atmosphere. Conducting polyaniline - 2 wt% MMT based paint controls corrosion of low carbon steel in neutral medium by anodic protection. The addition of the nano fillers enhance the corrosion protection offered by conducting polyaniline coating due to increased surface area of conducting polyaniline around MMT.

Effect of rolling textures of nitriding behavior of AISI 1020 mild steel

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ABSTRACT

Cold rolling is well known process by virtue of which the material is deformed at room temperature. In the present work the AISI 1020 plates (5 mm thickness) was cold rolled different routes and rolling passes (5 rolling passes) constant true strain (= 0.3) to generate crystallographic textures in the given material. The experiment was carried out in order to understand the effect of rolling textures on nitriding behavior of AISI 1020. The nitriding of rolled samples was performed at 550 ˚C and at different process cycle time (i.e. 1, 2, 3, 4, 5, and 6 hours). In the present work an attempt has been made to investigate the effects of rolling textures on nitriding behaviour of AISI 1020 mild steel. It was found that unidirectional rolling (UDR) samples exhibits symmetrical textures and that with cross rolling it gives un-symmetrical textures. The symmetrical unidirectional rolling texture component (100)[011] shows higher polar density at an inclination of 40higher polar density at an inclination of 40˚ from centre axis. The symmetrical textures of component {100}<011> obtained by unidirectional rolling gives higher nitriding rate for same nitriding conditions than cross rolled sample textures of same kind under same nitriding conditions.. From experiment results it was noticed that with unidirectional rolling the samples can be nitrided at lower temperatures.

Keywords- Preferred orientations (crystallographic textures), unidirectional rolling (UDR), multi-step cross-rolling (MSCR), nitriding.

Fabrication of Polyphenylene Sulfide/Clay Nanocomposites and study of their Properties

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ABSTRACT

Clay is an inorganic material which is freely available in the nature. It requires necessary modification to make it compatible with the polymer matrices.

In present study, the modified clay (C-15A) was incorporated in high performance poly (phenylene sulfide) (PPS), using planetary ball mill followed by hot pressing technique. The clay content was varied from 0 to 10 wt%. These nanocomposites were fabricated at 295 °C and 45 MPa. Nanocomposites were characterized by scanning electron microscopy (SEM), Vickers hardness tester, high resistivity meter, pin on disk wear tester, and impedance analyzer. The experimental density was very close to that of theoretical density. SEM showed almost uniform dispersion of clay particles in the PPS matrix. TEM revealed that the modified clay has layered structure. Vickers microhardness was increased approximately 13.5 % at 2 wt% clay content. Water absorption was found to increase with increasing clay content in the matrix. Dielectric constant of the nanocomposites was decreased slightly with increasing frequency. However, it was increased slightly with increasing clay content. Electrical conductivity is also increased with increased clay content up to 5 wt%. The specific wear rate of the PPS/clay nanocomposite with 1 wt% clay was found lowest. SEM images of the worn surface of pure PPS showed adhesive wear mechanism, whereas nanocomposites with 1 wt% and 5 wt% clay showed mild abrasive wear and sign of microploughing, respectively.

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Title of Dissertation: "Dissimilar Stainless Steel Joining By Flux Core Arc Welding"

ABSTRACT

Dissimilar stainless steel weld joints are widely used for various industrial applications. In industries dissimilar stainless steels are welded by using various welding processes such as shielded metal arc welding, gas tungsten arc welding, and submerged arc welding. The use of SMAW and GTAW have low welding speed and low deposition rate. Submerged arc welding process has no flexibility and can be used only in down hand position. These drawbacks are recently overcome by using flux core arc welding process. Flux core arc welding process has advantages like deep penetration, high deposition rate and high welding speed. Moreover; this welding process can be used in all welding positions. In this work austenitic stainless steel (AISI316L) and duplex stainless steels (SAF2205) were welded by flux cored arc welding process. Two different flux core wires E2209T1-1 & E309LMoT1-1 were used for welding test plates. For shielding purpose three different gas mixtures such as 80%Ar + 20% CO_2, 50%Ar + 50% CO_2, 100%CO_2 were used during welding. To study mechanical properties of weld by two different flux core wire & effect of shielding gas mixture on weld was done by conducting following test a) Dye penetrant test b) Radiography test c) Tensile test d) Bend test d) Charpy impact test e) Hardness test .Study of microstructures in weld and Heat affected zone were done using Scanning electron microscope. Ferrite content in weld was first calculated by Schaeffler diagram and then predicted value was confirmed with actual measured values by ferrite-scope meter. Salt spray test were conducted on weld samples to study effect of corrosion on welding according to ASTM B117 standard. Among six welded samples by using three different shielding gas compositions mixture, 80%Ar+20% CO_2 mixture gives good mechanical properties in dissimilar weld.