ABSTRACT BOOK

Iran International Aluminium Conference

11-12 May 2016

Tehran, Iran

Conference chairperson
Prof. Mansour Soltanieh

Scientific chairperson
Prof. Mohammad Reza Aboutalebi

Preface

Following the last three successful events, the 4th Iran International Aluminium Conference (IIAC) will be held on May 11-12, 2016 in Tehran. On behalf of the organizing committee of IIAC2016, it gives us a great pleasure to welcome you to this meeting. This conference is organized and hosted by Iran Aluminium Research Centre at Iran University of Science and Technology (IUST) and Iranian Mines and Mineral Industries Development & Renovation Organization (IMIDRO).

The goal of this international conference is to present and discuss recent research and development progress in aluminium covering all aspects of production, processing, fabrication, structure/property relationship and engineering applications of aluminium. Keynote lectures, oral and poster presentations, technology sessions, and industrial exhibition are the major parts of the conference program.

Keynote lectures are dedicated to general issues of aluminium industry. Papers will cover new and innovative topics in the fields of Casting and Solidification, Corrosion and Surface Engineering, Heat Treatment, Welding and Joining, Powder Metallurgy, Metalworking and Mechanical Properties, Advanced Materials, Simulation and Automation, Smelting, Economy, Energy and environmental issues. We received more than 247 abstracts. Around 140 full-papers were subjected to the reviewing process and finally 124 papers written by both academic and industrial contributors were accepted to be presented at the conference.

Specific technology sessions are to be held with the cooperation of international and Iranian companies and organizations where they will be presenting their latest developments in aluminium technology. There is also an industrial exhibition alongside the conference where companies from various countries such as Germany, Italy, France, China, Russia, USA, Spain, Turkey, India, UK, Netherland, UAE, Switzerland, Oman, Norway, Denmark, Canada, Bahrain as well as Iran participate to present their technology, services and product dedicated to the aluminium and related industries.

We would like to express our sincerest gratitude to all the participants, authors, the keynote speakers, board of reviewers, the members of the organizing and scientific committees, various sponsors particularly Iran Aluminium Company (IRALCO), NFC, Almahdi Aluminium, SMS Group, Outotec, Danieli, Rusal, Pars Aluman Kar, Navard Aluminium, Iran Alumina, Fives, Paya Afzar for their valuable support in organizing this conference. We wish everyone a very pleasant, interesting and fruitful time throughout the conference.

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Numerical Modeling of Macrosegregation in Direct-Chill Casting of Al-Cu Billets

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Abstract

Macrosegregation has been in focus of the solidification modelling studies, more specifically in direct-chill casting of Al-Cu billets. Nonetheless, it is not straightforward yet to discuss or predict how alloying elements will distribute in a casting billet. Mathematically, an important challenge is how to keep temperature and composition fields linked together as thermodynamics suggest, while temperature and composition are separately defined through heat and solute mass transport equations. In the current work, a two-phase mathematical model of mass, momentum, energy and species transport was formulated for the mixture of liquid and solid in an axisymmetric solidifying billet in a practical scale DC caster. The fluid dynamics of the problem involved thermosolutal convections, shrinkage flow through mushy solid and floating dendrites in slurry liquid in the mathematical model to contribute to the evolution of macrosegregation in results. An already proposed model called SIMTLE was employed for three-phase eutectic Al-Cu alloy, and then implemented to link the temperature and composition fields for calculation of mass fractions and compositions of the phases. The solution methodology was based on a standard CFD routine plus the proposed algorithm of SIMTLE. Measurements were performed on an industrial scale caster and obtained experimental data were used to verify calculated macrosegregation patterns. Results have been illustrated as distributions of temperature and composition, flow patterns, relative movement of liquid/solid and macrosegregation profiles. With reasonable agreements in validations, the results have been discussed giving an insight into solidification dynamics and macrosegregation mechanisms.

Keywords: Macrosegregation, Modelling, Solidification, Direct Chill Casting, Aluminium Alloys, Phase diagram

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Modeling of Non-Equilibrium Solidification of Aluminium-Copper Alloys

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Abstract

Knowledge about the non-equilibrium phase diagram is necessary to model the microsegregation in practical situations. Therefore the aim of this research is theoretical analysis of the phase diagram and diffusion coefficient for calculation of microsegregation. In order to do this, the non-equilibrium solidification condition was simulated by increasing the vacancy content to a non-equilibrium value according to the certain cooling rates. Aluminium rich part of the Al-Cu phase diagram was recalculated and the effect of these excess vacancies was incorporated during calculations. The effect of excess vacancies on diffusion coefficient was also considered. Al-Cu alloys were solidified with different cooling rates and the concentration profiles in the primary phase were measured experimentally. These concentration profiles were also calculated by three sets of input data; i.e. equilibrium phase diagram and diffusion data, non-equilibrium phase diagram and equilibrium diffusion coefficient, and non-equilibrium phase diagram and diffusion data. The results show that by modifying the phase diagram, the calculated results have better consistency with the experimental results, but still not to a satisfactory limit. However, by correcting diffusion coefficient, the modeling results show much better correlation with the experimental results.

Keywords: Al-Cu Binary Alloys; Cooling Rate; Microsegregation; Phase Diagram; Diffusion Coefficient.

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Historical Review of Aluminium Degassing and Future Developments

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Abstract

Liquid aluminium has a very high capacity to dissolve hydrogen but loses this ability as it solidifies. This leads to the potential generation of gas porosity as hydrogen comes out of solution during soldification. This porosity has negative consequences to mechanical properties of the final product. This paper looks at the evolution of degassing techniques from using a lance to inject an inert gas, to the development of box-type degassers and inline degassers. Hydrogen measurements systems will also be discussed as this is an important component of hydrogen removal. RPT, Telegas and Alscan will be covered. The paper will then cover future developments such as ultrasonic and vacuum processing degassing as a potential means of degassing.

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Dynamic Nature of Diffusion during Solidification

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Abstract

Some of the mechanisms which determine the extent of microsegregation during solidification of metallic alloys are based on the diffusion in the solid, so deep knowledge about diffusion is essential for studying the microsegregation. The aim of this research is therefore to elucidate the nature of diffusion during the solidification. For this purpose, Al-4.8 wt% Cu alloy was selected as model alloy. Solidification tests were carried out using a differential thermal analysis (DTA) furnace capable of quenching samples during solidification. Cooling rate was selected as 5 K/min and samples were quenched from predetermined temperatures during the solidification. Copper concentration profiles in the primary phase were measured by scanning electron microscope (SEM) equipped with an energy dispersive spectroscopy (EDS) detector. The concentration profiles were also calculated by numerical modelling and compared to the experimental profiles. According to the results it concluded that the diffusion coefficient has higher values than the tabulated ones at the begging of solidification. The results were discussed according the current theory of solidification.

Keywords: Solidification; Microsegregation; Phase Diagram; Diffusion Coefficient; Vacancy.

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The Properzi Technology for the Production of Aluminium Rod and Aluminium Ingots

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Abstract

The molten aluminium produced in the pot lines of smelters worldwide is transformed into semi-finished products (rod, slabs, billets) and re-melt products (T-bars, sows, ingots). The semi-finished products and the re-melt products are identified as "commodities" and have a reference price worldwide as well as standardized shapes and characteristics. In 1949 Properzi developed the continuous casting and rolling system for the production of aluminium rod to be used mainly for the production of conductors and cables. Over the years the demand of electric energy has grown dramatically and the e cable industry has requested rod made from a broad range of complex alloys so as to maximize the A/h transmitted per kg of conductor. The production rate of the Properzi rod production plant, originally limited to 1t/h or less, has currently reached 15t/h whereas the rod is collected in superjumbo coils of 3.7 t weight. Benefiting from the experience gathered with large sized rod production plants, Properzi extended the continuous casting method to the production of alloyed aluminium ingots being such ingots the pillar for the development and innovation of the automotive industry. The author explores the current requirement of the industry for aluminium rod and ingots and the characteristics of the unique Properzi ingot casting machine and rod casting and rolling plant.

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Assessment of Optimal Conditions in Centrifugally Cast of Aluminium-Brass Bimetal Composite

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Abstract

Excellent corrosion resistance and long working life have caused bimetal composites find more usage in different fields such as marine and automotive industries. In this study, pure aluminium melt which is lighter and cheaper compared to brass, was centrifugally cast into the brass bush known as a corrosion resistance shell. To achieve acceptable component, at first, brass bushes were preheated at various temperature between 100-400 °C and then aluminium melt with 1.5 and 2.5 melt-to-solid volume ratio was cast into cylindrical bush rotating at 800, 1600, and 2000 (rpm), respectively. Obtained samples were studied using X-ray diffraction analysis (XRD), optical microscope (OM), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS) and Image J software. Metallurgical joint is probably due to particular dissolving condition that is provided by multiple mechanical forces involved and also possible solid diffusion at the end of solidification process.

Keywords: Bimetal composite, Aluminium, Brass, Centrifugal casting, Dissolution

Proceedings of Iran International Aluminium Conference (IIAC2016)
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The Effect of "Repetitive Corrugation and Straightening by Rolling" (RCSR) Process on the Semi-Solid Microstructure of A356 Aluminium Alloy

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Abstract

Semi-solid metal forming is a new developing technology that has some advantages in relation to other forming and casting techniques. This process contains three main steps; feedstock manufacturing, reheating and forming. In this study, in order to produce highly strain feedstock from A356 aluminium alloy, a new severe plastic deformation method named repetitive corrugation and straightening by rolling (RCSR) is utilized. RCSR process including corrugated and flattened rollers acquires accumulative strain in material with minimum dimensional changes. A356 alloy specimens were subjected by RCSR process for various numbers of cycles to investigate the effect of strain on the morphology and shape factor of reheated specimens. Moreover, effect of holding temperature and time were on microstructure change were investigated. According to the microstructure observations, with increasing the number of RCSR cycles, besides decreasing in spherical size of particles, sphericity was increased and took place in less reheating time. Results indicate that RCSR process followed by reheating was effective to produce plate shape material with fine globular microstructure.

Keywords: Semi-solid; RCSR; Aluminium alloy; Severe plastic deformation; Globular microstructure

Proceedings of Iran International Aluminium Conference (IIAC2016)
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Effect of Temperature and Al-5Ti-1B Grain Refiner on the Tensile Properties of Commercially Pure Aluminium

Gholamreza Marami, Mir Saman Safavi

Abstract

In the present investigation, the effect of Al-5Ti-1B grain refiner in bar and powder form with two different powder weight percent, as well as three different melting temperature on tensile properties of commercially pure Aluminium have been studied. Samples have been cast in two different gating system: From end of sample (Directional Solidification) and from middle of sample. Experimental temperatures selected as follows: 720, 760 and 800 ^{0}C. A comparative study on tensile properties of commercially pure aluminium with grain refiner and without grain refiner was carried out. The aim of this study was to evaluate the yield stress values at various casting temperatures.

Keywords: Aluminium; Grain refiner; Temperature; Tensile properties

Proceedings of Iran International Aluminium Conference (IIAC2016)
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Microstructural Assessment and Mechanical Performance of Al-6%Mg-X%Ca Alloy in As-Cast Condition

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Abstract

This study was undertaken to investigate the effect of different amount of calcium (0.01, 0.03, 0.05, 0.1, 0.3, 0.5, 1, 3, and 5 weight percent of calcium) on the microstructure and mechanical properties of Al-6%Mg alloy in as-cast condition. In current work, microstructural assessment was carried out by optical and scanning electron microscopy and also the change of mechanical properties was investigated by tensile tests. By increasing the calcium content, the ultimate tensile strength (UTS) of Al-6%Mg base alloy increases from 244 MPa to 293 MPa. And also the results showed that, increasing the calcium contents enhances the hardness values of the base alloy. Since the maximum solubility of calcium in aluminium alloys is very low, most of the calcium concentrations precipitated in the form of calcium-rich intermetallic compound such as $CaAl_2$, which is greatly brittle and excessive presence of calcium contents lead to decrement in tensile properties.

Keywords: Calcium contents; Microstructure; Al-6%Mg; $CaAl_2$

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Influence of Mg Addition on Microstructural Characteristics and Fracture Toughness of A356/SiC_p Composite Castings

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3 Assistance Professor, Faculty of Materials Science and Engineering, K. N. Toosi University of Technology, Tehran, Iran.

Abstract

This study aimed at investigating the microstructural characteristics and fracture toughness of A356/10 vol.% SiCp composite casting in the presence of Mg. Toward this end, Al-A356 alloy melted in an electrical furnace, and after that the addition of SiC particles was performed in a specific sequence. The samples were prepared via the stir casting technique. In order to increase the wettability of SiC particles to the matrix, a higher Mg loading was incorporated within the melt mixture. The results showed that the fracture toughness of the composite was significantly reduced compared to the base alloy. Microstructural examination showed that the gas holes, inclusions, cracks and clustering of particles were the reasons for the decline in the fracture toughness. Addition of 1 wt.% Mg increased the wettability of SiC particles to the matrix and it would be very effective in a good dispersion of SiC particles and enhancing the fracture toughness of resultant sample.

Keywords: A356/SiC composite; Magnesium; Fracture toughness; Microstructure

Proceedings of Iran International Aluminium Conference (IIAC2016)
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The Effect of B Elements and Cooling Rate on the Microstructure and Tensile Properties of Al-7%Si-0.5%Mg Alloy

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2 Department of Materials Engineering, Islamic Azad University, South Tehran Branch, Tehran, Iran

Abstract

This work carried out to investigate the effect of different amounts of B (0.01, 0.05, 0.1 and 0.5) and cooling rate on Al-7%Si-0.5%Mg alloy. The samples were examined by using optical microscopy (OM) and tensile testing to evaluate the modification efficiency of the alloy with different B contents. The optimum level B as Al–B grain refiners was found. Grain size and dendrite arm spacing decreased, due to increasing cooling rate and B grain refiner through reduced sections. Increasing cooling rate results in higher strength and B-refined specimens showed highest tensile strength and elongation values.

Keywords: Aluminium alloys; Casting; Grain refinement

Proceedings of Iran International Aluminium Conference (IIAC2016)
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Evaluation of Ti Addition and Cooling Rate Effects on the Microstructure and Tensile Properties of Al-4%Cu-3%Si Alloy

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2 Department of Materials Engineering, Islamic Azad University, South Tehran Branch, Tehran, Iran

Abstract

This work carried out to investigate the effect of different amounts of Ti (0.01, 0.05, 0.1 and 0.5) and cooling rate on Al-4%Cu-3%Si alloy. The samples were examined by using optical microscopy (OM) and tensile testing to evaluate the modification efficiency of the alloy with different Ti contents. The optimum level Ti as Al–5Ti–1B grain refiners was found. Decreases grain size and dendrite arm spacing due to increasing cooling rate and Ti grain refiner through reduced sections. Increasing cooling rate results in higher strength and Ti-refined specimens showed highest tensile strength and elongation values.

Keywords: Aluminium alloys; Casting; Grain refinement

Proceedings of Iran International Aluminium Conference (IIAC2016)
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Microstructural Evolution of Al-15 (Wt.%)Mg with Al-8B Grain Refiner and Cooling Rate

Mehrab Lotfpour, Masoud Emamy, Hamed Ghorban Nataj, Bita Pourbahari.

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Abstract

This work carried out to investigate the effect of different amounts of B (0.01, 0.03, 0.05, 0.1, 0.3 and 0.5) and cooling rate on Al-15(wt.%)Mg alloy. The samples were examined by using optical microscopy (OM), and XRD to evaluate the modification efficiency of the alloy with different B contents and cooling rates. The optimum level B as Al–8B grain refiners was found. Grain size and dendrite arm spacing decrease due to increasing cooling rate and B grain refiner through reduced sections.

Keywords: Aluminium alloys; Casting; Grain refinement

Proceedings of Iran International Aluminium Conference (IIAC2016)
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Microstructural Evolution of Al-4 (Wt.%)Mg with Al-8B Grain Refiner and Cooling Rate

Hossein Norouzi, Masoud Emamy, Ahmad Razaghian,

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Abstract

This work carried out to investigate the effect of different amounts of B (0.01, 0.03, 0.05, 0.1, 0.3 and 0.5) and cooling rate on Al-4(wt.%)Mg alloy. The samples were examined by using optical microscopy (OM) to evaluate the modification efficiency of the alloy with different B contents and cooling rates. The optimum level B as Al–8B grain refiners was found. Grain size decrease due to increasing cooling rate and B grain refiners through reduced sections.

Keywords: Aluminium alloys; Casting; Grain refinement

Proceedings of Iran International Aluminium Conference (IIAC2016)
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Effect of Twin-Roll Casting Parameters on Mechanical and Microstructural Properties of AA5083-H321 Sheet

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Abstract

The purpose of the present paper is to study the mechanical and microstructural properties of the twin-roll cast and cold rolled AA5083 aluminium alloy sheet in strain-hardened H321 temper. To reach this goal, first, a sound surface slab of 8.90mm thick and 1260mm wide was cast by a 15° tilt back twin roll caster at a casting speed of 490mm/min. After homogenization at 520°C, the product was cold rolled to two thicknesses of 6.30mm and 3.85mm with an intermediate annealing at 370°C and final stabilization at 180°C. Optical and scanning electron microscopy (SEM) investigations of the as-cast state depicted the segregation of intermetallic particles mainly in grain boundaries, which were the cause of grain removal observed in the fracture surface of tensile test samples. In addition, mechanical properties indicated an increase in total elongation after homogenization heat treatment due to the elimination of the grain boundary segregations. Finally, it was observed that the properties of the 3.85mm thick sheet were consistent with the H321 temper requirements according to ASTM B 290M standard due to applying sufficient cold reduction.

Keywords: AA5083 Aluminium alloy; Twin roll casting; Cold rolling; H321 strain-hardened temper

Metalworking and Mechanical Properties

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An Investigation on the Mechanical Properties of Al-Mg_2Si-SiC Hybrid Composites

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Abstract

Aluminium hybrid metal matrix composites are the field of interest of researchers because they are widely used in aerospace and automobile industries. A hybrid composite benefits the properties of two or more reinforcement materials and could contain unique physical, mechanical and tribological properties which are not achievable in other materials. In this study different amounts of SiC microsize (37 μm) particles were added to Al-Mg_2Si composite using stir casting method. Then, hot extrusion was applied to the specimens. Finally, the effect of different amounts of SiC on the mechanical properties of Al-Mg_2Si in-situ composite was investigated. The microstructure characteristics of the composite was studied using optical and scanning electron microscopy. The results showed that SiC particles had a good dispersion in the Al-Mg_2Si matrix. The hardness increased from 110 for the bas composite to 135 brinell for the composite containing 9 wt. % SiC. The amounts of YS and UTS of the Al-Mg_2Si composite was 90 and 160 MPa respectively and the addition of 9 wt. % SiC enhanced these values to 125 and 260 MPa respectively. However, the addition of SiC reduced the elongation from 6.7 % to 1 %. Moreover, the addition of 9 wt. % SiC increased the ultimate compressive strength from 280 to 430 MPa.

Keywords: Hybrid; Metal; Matrix; Composite Mg_2Si; SiC; Mechanical Properties

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The Effects of Friction Coefficient and Strain Rate on the Al5052 Sheets Fabricated by CGP Process

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Abstract

In order to produce nano-size-grained material, the severely plastic deformation (SPD) is known as a novel method in order to prepare high-strength alloys in industry. In this method, the size of the grains is fined by subjecting specimen to severe strains. The finer the grains become, the more the yield and ultimate strength would increase. The constrained groove pressing (CGP) process is one of the SPD methods which used to fabricate nano-size-grained metal sheets. In this study, the strength and hardness of the Al5052 sheets fabricated by CGP process are numerically and experimentally investigated. The process is then simulated in DEFORM 2D commercial software. The effects of the friction coefficient (between specimen and dies) and stain rate (velocity of the dies in vertical direction) on the mechanical properties of fabricated sheets are studied. The results reveal that the increase of the friction coefficient and strain rate, would lead to the increase of the strength behavior of the specimens. The results are in a good agreement with those obtained by experimental and analytical investigation.

Keywords: Constrained Groove Pressing; Aluminium 5052; Friction; Mechanical Properties; DEFORM 2D.

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Application of New Technologies in the Drawing of Aluminium Wire

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Abstract

Aluminium is a good thermal and electrical conductor, which has seen it replace copper in many electrical applications. Aluminium provides a lower weight to current-carrying ratio compared to copper. Although in use for several decades in the power distribution sector (i.e. MV and LV cables, as well as OHL and OPGW), the automotive manufacturing represents the brightest growth potential for aluminium wire and cable. As automakers and suppliers continuously look for new solutions to reduce weight, aluminium is a popular candidate for applications that require high current, such as large cables under the hood. Moreover, we may envisage other applications that in the near future will use this metal as the primary conductor core material: from the rolling stock to the off-shore (platform) cables, aeronautics and military. Basically any place where the importance of weight is crucial. The aim of this paper is to present the latest technical solutions developed by Sampsistemi for the production of round and shaped wire for power cord and the new advancements in multiwire drawing and in-line annealing technologies to guarantee a better quality of the final product.

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Nanostructured AA6063 Alloy Using Equal Channel Angular Pressing

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Abstract

By means of severe plastic deformation, acquiring nanoscale within size range of less than 500 nm has hardly been reported in the literature. In this paper, a novel approach is proposed to acquire nanostructured AA6063 alloy within a size range of less than 100 nm using equal channel angular pressing (ECAP). This includes application of a specially designed pre-deformation thermomechanical processing after initial solution treatment. The pre-deformation treatment starts with two passes deformation in ECAP followed by annealing at 500 ^{o}C for 10 sec and quenching in water. An equiaxed nanostructured AA6063 alloy within the size range of less than 100 nm is obtained after 6 passes ECAP while more than 69 % of boundaries are high angle ones.

Keywords: Nanostructure; Aluminium; Equal channel angular pressing.

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Production of Aluminium Requires High Energy Consumption Using High Quality Row Material Could Reduce Energy Consumption

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Abstract

Graphitic carbon as the anode is the one of the main row material of aluminium production. Aluminium is produced by electrolysis of Alumina powder. Pre-baked Anode technology is used in this process. Anode baking is the final step of Anode production. The effect of packing coke size on gas consumption and baked anode quality in open type furnaces were fully investigated in this thesis. For this purpose the three sizes of packing coke were tested (very coarse, coarse, and medium).Gas consumption and Anode quality parameters were tested and recorded according to ISO standard in each baking cycle by laboratory. The lowest gas consumption is related to medium size packing coke which is 12% lower than the case of usage coarse. The highest gas consumption occurred when very coarse packing coke was used which is 9% more than coarse usage and also the quality of Anode when coarse packing is used has less deviation from standard parameter finally with regards to results of the investigation done the coarse grain size is the optimum size in comparison with others and also to avoid Anode burning, usage of medium size packing coke even fine on top layer of Anode coverage in baking furnace is recommended

Keywords: Anode; Backing furnace; packing coke; Gas consumption

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A Johnson-Cook Model for Deformation Behavior of 2030 Aluminium Alloy under Elevated Temperature

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Abstract

The hot compression tests were conducted with wide strain rates (0.005-0.5s^{-1}) and forming temperature ranges (623-773K) to study the high temperature deformation behavior of 2030 aluminium alloy. The material flow behavior during hot forming process are discussed. Based on the experimental results, the Johnson-Cook model was proposed to describe the hot deformation behaviors of the studied 2030 aluminium alloy. Results show that the stress-strain values predicted by the proposed model in stain rate 0.5s^{-1} well agree with experimental, which confirmed that the Johnson-Cook model can give estimate of the flow stress for the studied 2030 aluminium alloy.

Keywords: 2030 Aluminium alloy; Hot deformation behavior; Hot compression test; Johnson-cook model

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Application of Annealing and Accumulative Roll-Bonding Processes for Enhanced Mechanical Properties of Al 1050

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Abstract

In this study, mechanical properties of bulk ultrafine-grained materials (Al 1050 alloy) produced by severe plastic deformation modified or enhanced by a mild annealing treatment. In order to put the UFG materials for structural use, they must have bulky dimensions. This method is based on Accumulative roll bonding (ARB) and appropriate annealing treatments. The ARB process up to 8 cycles was performed at ambient temperature under unlubricated conditions. Then annealing at 275ºC for 90 minute applied. Here, how annealing treatment affect the mechanical properties discussed.

Keywords: Severe plastic deformation; Accumulative roll bonding; Mechanical properties

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Effects of Zr Element and Solidification Parameters on the Microstructure and Tensile Properties of Al-7%Si-0.5%Mg Alloy

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Abstract

In this investigation, experiments were carried out to study the relationship of master alloy Al–5Zr and solidification parameters in Al-7wt%Si-0.5wt%Mg casting with various thicknesses under the same solidification condition. The optimum level of Zr as Al–5Zr grain refiner was found to be (0.03 wt.%), respectively. It was found that 0.03 wt% Zr addition could refine the microstructure significantly and modify the eutectic Si from plate-like morphology to fiber converted. The results show that the Increasing cooling rate through reduced sections, decreases grain size and dendrite arm spacing, but Zr-refined specimens showed lowest sensitivity to cooling rate. The relationships between the microstructure and cooling rate have investigated. The microstructural characterization was carried out by optical microscopy and image analysis. mechanical properties also have investigated at various thicknesses.

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Mechanical Properties of AA2024 in the Presence of Al-Cu Intermetallic Surface Layer

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Abstract

In this research, in-situ intermetallic surface layer based on Al-Cu alloying system were produced on Al2024 plate by friction stir processing (FSP). Then, microstructural and hardness properties of these specimens were investigated. To removal defects of conventional methods to produced surface layer by FSP, in this study, a new procedure was introduced for applying the reinforcement. So that at firstly, a new composite layer based on Al and Cu was produced by accumulative roll bonding (ARB). ARB composite layer were placed and fixed on Al2024 plate. Then FSP were performed by rotation and travel speed of 1000rpm and 63 mm/min. Microstructural evaluation was performed by Scanning Electron Microscopy (SEM). In order to examine the effect of FSP process on hardness behavior, hardness test were performed on base metal and intermetallic surface layer.

Keywords: Al2024; Intermetallic; Mechanical Properties; FSP; ARB

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Experimental Investigation of Microstructure and Mechanical Properties on Twist Extrusion Forming Process of AA6063 Aluminium Alloy

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Abstract

In this research the effect of twist extrusion on the mechanical properties and microstructure of AA6063 aluminium alloy was studied. Stress relief heat treatment used to relieve stresses of samples. The stress relieved specimens were extruded under twist in 3 passes. The mechanical properties treatment used to relieve stresses of samples. The mechanical properties and microstructures of samples investigated after each twist extrusion pass. The test results specified uniform distribution of precipitates in the AA6063 alloy microstructure and improvement of mechanical properties with increasing the extrusion passes from 1 to 3.

Keywords: AA6063; Twist extrusion; Mechanical Properties; Microstructure

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Analytical and Numerical Modeling of air V-bending for Al3105 Sheets

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Abstract

Air bending is one of the most common processes in sheet metal forming. Many researchers have been carried on mathematical analysis of this process. Theoretical procedures were formed based on some assumptions. These assumptions may lead the analysis to error. Mathematical approach aims to make connection between geometrical parameters, such as punch and die radius and punch stroke, and mechanical parameters, such as stress and strain, moment and curvature distributions. In present paper analytical approaches are discussed and FEM model of air bending process is performed. To evaluate mathematical strategies, results of FEM simulation will be compared to those emerged from mathematical approaches.

Keywords: Mathematical model; Air bending; FEM

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Analysis of Stiffness and Dent Resistance in Aluminium Sheets

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Abstract

Global warming crisis forces governments to act restrict rules to subside emission of greenhouse gases. Aluminium has been increasingly applied in different aeronautical and automotive industries thank to its light weight and high stiffness to weight ratio. Aluminium sheets used as outer panel of different machines like automobiles need to satisfy different standards like dent resistance. Dent resistance is a quality criterion for automotive body panels which should be considered in design. In this paper dent resistance of aluminium sheets is investigated using Finite Element Method and effective parameters are analyzed. Finally the combination of optimum parameters to maximize dent resistance is introduced.

Keywords: Dent resistance; Aluminium sheet; stiffness; FEM

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Evaluation of Mechanical Properties of High Strength 7075 & 7050 Aluminium Alloys after Single and Multi-Stage Precipitation Hardening Heat Treatments

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Abstract

In the civil transport airframe constructions parts, resistance to applied loads, providing an aerodynamic shape and protecting passengers, payload and equipment from the external environmental conditions are necessary. At present work, high strength 7075 and 7070 aluminium alloys (AA) were subjected to single and multistage precipitation hardening (known also as age-hardening) heat treatments. The extruded slab of AA7075 with the dimension of 60cm×10cm×7 cm heat treated as T6, while the rolled plate of AA7050 with the dimension of 200cm×100cm×11cm was subjected to multistage T73-651 heat treatment by the manufacturer. The over-aged T7 temper provides the best resistance to exfoliation corrosion and SCC, but significant sacrifice in tensile properties compared with the single-stageT6 temper. It also enhances resistance to fatigue crack growth and imparts dimensional and thermal stability to the part. The chemical composition of the investigated alloys were determined by atomic adsorption. The precipitates were studied using optical and scanning electron microscope. To identify grain size distribution and image analysis of the precipitates, the Clemex image analysis software was used. The specimens for hardness measurement and tensile test were extracted from the heat treated plates. The hardness of the specimens was measured in S-T, L-S and L-T planes using Brinell hardness tester. Tensile tests were conducted on the cylindrical specimens prepared only in L direction in accordance with ASTM B-577. According to results, very fine precipitates ($MgZn_2$) are evenly distributed throughout the microstructure, while the coarse precipitates (particles) are evident along the grain boundaries. Considering the SEM fractographs, it seems that the intermetallic particles act as void nucleation and damage initiation sites.

Keywords: High strength aluminium alloys; Single and multi-stage precipitation hardening; Microstructure; Mechanical properties.

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Numerical and Experimental Study of Bursting Prediction in Tube Hydroforming of Al 7020-T6

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Abstract

In this study, forming limit diagrams of tubular materials (Al 7020-T6) were determined numerically and experimentally. A set of experimental bulge tests were carried out to determine forming limit diagram under combined internal pressure and axial feeding. Also, a numerical approach which is based on the acceleration of plastic strain (i.e., the second derivation) was applied to compute the hydroforming strain limit diagram. Based on this method, the localized necking would be started when the acceleration of the major plastic strain got its maximum value. Finally, the numerical forming limit diagram was verified by experimental test results on the aluminium tube 7020-T6 and a good agreement between the proposed method and the experimental works was observed.

Keywords: Tube hydroforming; Bursting; Second derivative of strain; Forming limit diagram

Heat Treatment

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Optimization of the Heat Treatment of Rheocast Alloy A356- T6

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Abstract

In this work the optimum T6 heat treatment of Sr- modified A356 alloy obtained via cooling slope casting was investigated. This study attempts to find a better mechanical response at the optimum heat treatment process. Moreover, the effect of strontium modifier on T6 heat treatment was discussed in detail. The solution heat treatment and age hardening carried out at the temperature-time of 540 °C for 30min,1h,2h and 4h and artificial aging (160°C,180°C,200 °C) at different time at 0.5h until 12h respectively, enabled the magnesium dissolution, eutectic silicon phase spherodization and magnesium inter-metallic precipitation .The micro hardness results demonstrated that the optimum heat treatment was the solution heat treatment of 2 h at 540°C and artificial aging at 180°C for 3 h which is comparable to other reports. The possible mechanisms involved in achievement of this new short heat treatment are discussed by considering the microstructure and hardness analysis.

Keywords: Solution; Heat treatment; Rheocast; Artificial aging.

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The Effects of Quenching Media and Aging on Residual Stress and Mechanical Properties of 2024 Aluminium Alloy

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Abstract

Residual stresses developed after quenching of aluminium alloys cause distortion and has negative effect on their properties. The purpose of this study is to predict the influence of aging treatment and different concentrations of polyalkylene glycol (PAG) quenchants on minimizing residual stresses of 2024 aluminium alloy. Also mechanical properties resulting from aging treatment and PAG quenching are discussed. Quenching in 15% PAG and aging at 190°C for 12h cause 50% reduction in residual stress compare to natural aging and also the hardness decrease from 74.6 HRB to 67.3HRB.

Keywords: 2024 aluminium alloy; Residual stresses; Quenching

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Effect of Thermo-Mechanical Age Hardening on Strength, Hardness and Elongation in an Al-Cu-Mg Alloy

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Abstract

Thermo-Mechanical Processing (TMP) is defined as a combination of metal forming, heat treating and phase transformations. Thermo-Mechanical Age Hardening (TMAH) can produce new dislocation structure, small precipitates and dislocation-precipitate locks which lead to higher tensile strength, hardness and elongation simultaneously. This goal is not achievable in common strengthening operations whereas elongation normally decreases by increasing hardness and tensile strength. In this research, effect of TMAH on mechanical properties in an Al-Cu-Mg alloy is investigated. Specimens were first annealed and homogenized. Finding the optimum aging time, the specimens were 45 percent rolled in 100˚C and age hardened. Afterwards, the mechanical properties were evaluated in terms of hardness and tensile strength. The results indicate that by employing TMAH, the hardness value increases by 42 % and 39 % in accordance with the as-received and T6 specimens respectively. In addition, an increase in tensile strength and yield strength is observed in comparison to T6 specimens; 32 % and 51 %, respectively. Moreover, the average elongation for TMAHed specimen shows 2.5% increase according to T6 ones.

Keywords: TMP; Age Hardening; Cold Working; Precipitation Hardening; Aluminium Alloys.

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Heat Treatment and Evaluating the Mechanical Properties of Silicon Carbide-Aluminium Alloy Composite

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Abstract

Reducing the weight of structures is one of the industries target especially aerospace and automotive industries, so the usage of aluminium alloys is expanded dramatically in the industry. Aluminium alloys are used in more than 70% parts of aerospace constructions, military and weapons. The aluminium alloy 7075 is one of the most widely used among engineering alloys due to their high specific strength. In this study, to evaluate the mechanical properties and microstructure of aluminium alloy 7075 containing silicon carbide, a particular heat treatment was considered. To investigate mechanical properties and microstructure and distribution of deposits, Brinell hardness method and optical microscopy were utilized. Hardness results show that aging and dissolution for 8 hours and 20 minutes respectively in nitrate salt bath is the most hardness achieved.

Keywords: Aluminium; Heat Treatment; Silicon Carbide

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The Effect of Infrared Rapid Heating on Microstructure and Mechanical Properties of Al Alloy 319

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Abstract

Rapid heating process using infrared heating source is able to considerably reduce heat treatment process time of AL Alloys without reducing the mechanical properties. This has been attributed to the micro structural improvement one of which is the presence of finer grains compared to those normally observed in the samples heat treated in conventional electrical furnace. In the present work the effect of applying rapid heating using infrared heating source on the microstructure and mechanical properties of AL alloy 319 during T6 process was studied. Results showed that the process period was reduced as much as 60%. In addition, not only hardness increased about 11%, but also the tensile strength considerably increased compared to that obtained from the samples heat treated in conventional electrical furnace.

Keywords: Rapid heating; infrared heating source; T6 process; AL alloy 319.

Advanced Materials

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An Investigation of Using Sodium Nitrate as a Foaming Agent of Production Close Cell Aluminium Foam via Powder-Compact Foaming Technique

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Abstract

This article describes a method named Powder-Compact Foaming Technique to produce close cell aluminium foams. Porous Al was fabricated by decomposing of sodium nitrate powders at initial compacted precursor. At the first Al and $NaNO_3$ powders were mixed together and then compacted to initial precursor. At the final the precursor put in the sintering furnace. The gas released during sintering and also the mushy aluminium was the source of the produced pores. The effect of initial compacting pressure, heating temperature and weight ratio of powders have been investigated. Visual inspection and scanning electron microscopy (SEM) were utilized to characterize the porous samples. Analyzing the properties of the aluminium foams showed that the optimum weight fraction for blending initial powders was %2 wt. $NaNO_3$. In addition, if the initial compacting pressure of the powders was decreased to below 250MPa, the foaming process did not take place properly. The optimum time and temperature of this process were 15 min at 680◦C.

Keywords: Aluminium Foam; Close Cell; Powder-Compact Foaming Technique; Sodium Nitrate

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Open-cell Aluminium Foams Reinforced by Alumina Nanoparticles

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Abstract

In this research, the effects of Al_2O_3 nanoparticle additions on relative density, porosity, microstructure and compressive properties of aluminium foams, fabricated by powder metallurgy and $CaCO_3$ foaming agent, were investigated. To this end, aluminium, Al_2O_3 and CaCO3 powders were mixed and compacted using cold pressing with 318 MPa to dense cylindrical precursors with 77-80% relative density. The precursors were heated at 450^{o}C for 30 min and 1000oC for 10 min, both under the air atmosphere. Cooling in the air was employed to solidify the foams. In order to determine the effects of Al_2O_3 additions, the content of Al_2O_3 nanoparticles was varied between 0-15 wt.%. Finally, the heat treated samples were used for microstructure investigation and uniaxial compression test. FESEM micrographs indicated an open-cell microstructure with interconnected pores smaller than 100 micron. Measurements showed that Al_2O_3 additions didn't affect the linear expansion. In addition, agglomeration of Al_2O_3 and $CaCO_3$ particles occurred in samples with 15 wt.% Al_2O_3. Foams containing 3 wt.% Al_2O_3showed the highest relative density (65.81%), lowest porosity (34.14%), the most uniform microstructure and highest compressive properties. Increasing of $Al_2O_3$from 3-15 wt.% resulted in gradually decrease of microstructure uniformity, compressive strength (42.10-23.60 MPa) and densification strain (45.75-34.08%).

Keywords: Nano-composite aluminium foam; Alumina Nanoparticle; Powder metallurgy microstructure; Compressive properties

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Investigation of Microstructure of A319-matrix in-situ Casting Composite Reinforced with Iron Based Intermetallic Produced by Stir Casting Process

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Abstract

In the current work, the effects of stir casting process parameters on the microstructural features of an in-situ Al 319 based composite reinforced with Fe-based intermetallic phase was studied. Parameters such as stirring temperature, cooling rate, and iron content were investigated to determine how they may influence the morphology, size, and distribution of iron-based intermetallic and eutectic silicon during the process. The optimized microstructures for different Fe contents were determined to be related to those samples processed for 5 minutes stirring at 1200 rpm and at a temperature near the β nucleation temperature and solidified in permanent molds. It was found that the harmful needle-like morphology of the intermetallics was significantly modified into a compact one through melt-shearing at semi-solid region leading to the modification of morphology, aspect ratio, and distribution of Fe-based intermetallics.

Keywords: Al composites; stir casting; Fe-based intermetallic; β phase modification

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Influence of Aging Treatment on Mechanical Properties and Microstructure of Al6061-Nano Al_2O_3 Composites

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Abstract

Aluminium and its alloys have an ever growing demand in many industries such as aerospace, automotive due to their high strength to weight ratio and corrosion resistance. Aluminium−magnesium−silicon (Al−Mg−Si) denoted as 6xxx series alloys are medium strength heat treatable alloys and have good formability. Work hardening and precipitation hardening are common strengthening mechanisms of 6xxx series of aluminium alloys. The influence of combination of different designated precipitation hardening on the hardness and tensile properties of 6061 aluminium alloy was investigated. In this study, the mechanical properties and microstructure of a commercially available AA6061 alloy aged to various levels were studied. Peak-aged conditions were reached in this particular alloy after a 30 min heat treatment at 220°C. The variation of the yield stress, ultimate tensile strength, ductility with aging time is measured and discussed in relation to the microstructural changes induced by the heat treatment. In order to investigate the microstructure, specimens were electro-polished and etched by Weck reagent. The results indicate that applying single aging at 220°C for 30 min improves the elongation. T6 Al6061-nanoAl_2O_3 matrix rolled has lower UTS of 315 MPa in comparison to a higher value of 390 MPa for the non-heat treated sample. It seems that hardening induced by T6 precipitates was less than the work hardening attributed to the matrix hardening during sheet rolling.

Keywords: Al-Al_2O_3 Nano composite; Precipitation hardening; Mechanical properties; Electro-polishing; Microstructure

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Closed-Cell Aluminium Foam Manufactured by Accumulative Roll-Bonding and Friction Stir Processing

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Abstract

Two manufacturing routes of accumulative roll-bonding (ARB) and combination of friction stir processing (FSP) and ARB was compared to production of closed-cell aluminium foams. Titanium hydride powder as foaming agent was distributed inside 1100 aluminium sheets through ARB and then FSP trials were conducted. Optical microscopy and densitometry measurements, revealed different agglomeration level and distribution of titanium hydride particles in two manufacturing routes before heat treatment. As a result, different porosity was obtained in two methods after gas releasing. Moreover, it was found that FSP modified the distribution of titanium hydride powder and therefore resulted in an improved foam structure.

Keywords: Aluminium Foam; Accumulative Roll Bonding; Friction Stir Welding

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Study the Effect of Strontium Addition on Microstructure, Impact Toughness and Corrosion Behavior of Al-Mg_2Si In-Situ Composite

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Abstract

This study investigated the effects of 0.01 wt.% Sr addition on the microstructure, impact toughness and corrosion behavior of Al-20Mg_2Si in-situ composite. Size, density and aspect ratio measurements presented that addition of 0.01 wt.% Sr refined the Mg_2Si reinforcement. The results of Charpy V-notch impact tests at room temperature showed that Sr addition increased impact toughness by 75% as a result of change in Mg_2Si particle morphology. Polarization corrosion tests conducted in sodium chloride solution showed that the corrosion current density increased from 0.58 $\mu A/cm^2$ to 1.8 $\mu A/cm^2$ with the addition of 0.01 wt.% Sr due to increase of boundaries between the Al and Mg_2Si reinforcement particles.

Keywords: Aluminium; In-situ composite; Strontium; Toughness; Corrosion

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Al- CNTs Nano-Composite Produced via Double-Pressing Double-Sintering Method

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Abstract

In this study, carbon nanotubes (CNTs) reinforce aluminium composites which were synthesized by double-pressing double-sintering (DPDS) method .Hardness as well as compressive and bending strength of Al-CNTs increase with the increase of up to 8.0wt% (HV= 82.6) as compared with the pure matrix. The composites were characterized by SEM and XRD. The XRD is used to analyze the composites structure. Appearances and fracture surface morphologies of failed composite samples indicate that the composites become more and more brittle with the increase of the MWCNT content. The maximal increments of bending and compressive strength, and the hardness of the composites, compared to Al matrix, are 20%, 52% and 64%, respectively. This study shows the feasibility of manufacturing CNT reinforced metal composites by DPDS.

Keywords: Aluminium-CNTs Nano-composites; Double-pressing double-sintering method; Mechanical properties

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Influence of Temperature and Pressure on Mechanical Properties of CNTs-Reinforced Aluminium Nano-Composites Fabricated by Double-Pressing Double-Sintering Method

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Abstract

Multi-walled carbon nanotubes (MWCNTs) should be attractive for the reinforcement of metal-matrix composites, because of their high strength, high modulus and high thermal conductivity. The effects of CNTs content, temperature, pressure and secondary pressing-sintering on mechanical properties of the nano-composites were investigated. To improve density as well as mechanical properties, the double-pressing double-sintering technique was used, as increments of 2.4 to 16.14% of densification was obtained when compared with the nano-composites produced by conventional sintering route. In this study, the optimum CNTs content, temperature and pressure have been determined for the manufacture of Al-CNTs nano-composites. SEM and XRD have been used to study morphology, sintering procedure and various phases produced during synthesis of the Al-CNTs nano-composites.

Keywords: Aluminium-CNTs Nano-composites; Optimum density; Influence of temperature and pressure; Double-pressing double-sintering method; Mechanical properties

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Fabrication and Characterization of Al-Matrix Composites Reinforced with Carbon Nanotube

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Abstract

In recent years, there has been increased attention to carbon nanotube-reinforced metal matrix composites due to their high tensile strength as well as exciting thermal and electrical characteristics. In this study, aluminium matrix composite reinforced with multi-wall carbon nanotubes were fabricated by hot pressing. Mechanically milled micron-sized pure aluminium with 0.5wt%, 1wt%, and 2wt% multi wall carbon nanotubes (MWNT), are used to fabricate the samples. In order to obtain optimum pressing condition, mechanical properties (hardness and compressive strength) and densification behavior of pressed samples at different times and temperatures were measured. Mechanical properties results showed that, carbon nanotubes improve compressive strength and hardness of pure aluminium significantly.

Keywords: Carbon nanotube, Aluminium, Mechanical properties, Hot pressing

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The Effects of Rotational Speed on the Microstructure of FGM Hypereutectic Al-17wt%Si Cast via Centrifugal

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Abstract

Functionally Graded Materials (FGM) containing microstructural features intentionally varied from surface towards interior area of a component, exhibits attractive surface mechanical properties such as wear behavior. In the current work the effect of rotational speed on the distribution of primary Si in an Al-17wt%Si alloy cast via centrifugal casting method was studied. Results show that, the optimized condition from the microstructural point of view, i.e. primary Si distribution and volume fraction within the surface area, was obtained at the rotational speed of 1400 rpm. The mechanical properties such as hardness and wear behavior are also reported.

Keywords: FGM; Hypereutectic AL-Si; Centrifugal method; Primary Si

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The Effects of Process Parameters on Synthesis of Aluminium Nanoparticles Produced by Electromagnetic Levitational Melting Gas Condensation Method under Helium Atmosphere

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Abstract

As high purity Aluminium nanoparticles are widely used and attracted as fillers, active media, explosives, chemically active materials, absorbents, chemical analysis, decorative and reflective materials, a novel Electromagnetic Levitation Gas Condensation (ELMGC) method was applied to synthesis Aluminium nanoparticles. In this study high purity helium was applied as carrier gas and cooling media. Hexan was used to collect the nanoparticles in a noble environment as a liquid media. A suitable conical cylinder coil made of copper rod was used to levitate, melt and vaporize the sample. In this process, the Aluminium vapours ascending from the high temperature levitated droplet were condensed by a helium gas stream under atmospheric pressure .The effects of input power, gas flow rate were investigated. Finally the obtained Nano Aluminium particles were analysed by scanning electron microscopy (SEM) and X-ray Diffraction (XRD).The spherical Aluminium nanoparticles with average particle size 26.4nm and a narrow size distribution were synthesized by helium flow rate 15 lit/min at constant temperature of 1683 ^{0}K. It was found that increasing gas flow rate and sample temperature would result in smaller particle size.

Keywords: Aluminium; Electromagnetic Levitation; Gas condensation; Nanoparticles

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Synthesis and Structural Characterization of Nanocrystalline Al-10at.%Li Powder Prepared by Mechanical Alloying

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Abstract

The technique of mechanical alloying has been used to obtain nanocrystalline structure of Al-10 at.% Li alloy. For this purpose, pure aluminium powder was mixed with crushed lithium particles with a nominal composition Al90Li10 was subjected to intense mechanical alloying in an attrition ball mill under high purity argon gas atmosphere. Then they attrition milled for 20 hours. Morphologic evolution and variations in grain size, powder particle size, lattice parameter and phase transformations in 5 hour time interval of milling was characterized through X-ray diffraction (XRD) and scanning electron microscopy (SEM). Crystallite size, lattice strain and lattice parameter were determined by Williamson-Hall and Nilson-Reley methods. Based on the characterization results, grain size was fallen to 50 nanometers after 20 hours of milling. In primary hours of milling, system shows more tendencies to form solid solution rather than intermetallics. However, with increasing milling time, the solid solution was not stable anymore and intermetallic of AlLi established instead of solid solution. The more the lithium content in powder mixture, the more the percentage of intermetallic would be in final milled powder.

Keywords: Aluminium-Lithium alloy; Non-equilibrium processing; Mechanical alloying; Williamson-Hall; Nilson–Reley; Scanning electron microscopy; Particles size

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Improvements to the Sintering Behavior of Yttria-Stabilized Zirconia Coating by Addition of Aluminium

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Abstract

Yttria-stabilized zirconia (YSZ) is the most widely used material in thermal barrier coatings. The main difficulty in fabricating ceramic coatings on metal substrates using the electrophoretic deposition process (EPD) is problems caused by the volume shrinkage during the sintering of the green form ceramic coating. In this research, a combination of EPD and reaction bonding processes has been used for fabrication of an adherent and crack-free coating on Iron-Nickel superalloy. Aluminium particles were added to the suspension of YSZ in acetone. By using EPD of aluminium and YSZ particles, a uniform green coating formed on the substrate by applying voltage of 6 V during 3 min. After oxidation of aluminium at 660°C for 2 h and sintering at 1100°C for 2 h, an adherent and crack-free coating was obtained. Addition of aluminium to the green coating not only has reduced the sintering temperature of the YSZ coating about 200°C, but also has compensated the shrinkage of the coating by the volume expansion due to the oxidation of aluminium.

Keywords: Aluminium; Yttria-stabilized Zirconia; Electrophoretic deposition; Reaction bonding; Coating

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Investigation on the Production of an Al Matrix Composite Reinforced with Metallic Glass Particles Using Equal Channel Angular Pressing (ECAP)

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Abstract

In this study, pure Al matrix composite reinforced with $Al_{65}Cu_{20}Ti_{15}$ metallic glass particles produced, using the equal channel angular pressing (ECAP) process. Al-based metallic glass (AMG) particles were synthesized by mechanical alloying process and then blended with Al powders as the matrix material. The ECAP processing was used for consolidation of the composite. The densities of the samples were measured to evaluate the performance of the consolidation process. Microstructure and mechanical properties of AMG composites were investigated. Structural analyses showed finely distributed reinforcing particles produced through shearing deformation, imposed during ECAP. The fully dense consolidated AMG composites showed a remarkable increase in compressive yield strength and appreciable plasticity at fracture, compared to the matrix alloy.

Keywords: Aluminium-matrix composites (AMCs); Equal channel angular processing (ECAP); Metallic Glass particles; Microstructure; Mechanical properties

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Experimental Study and Characterization of Activated Alumina Adsorbent

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Abstract

This paper is devoted to specify properties of activated alumina, determine its adsorption characteristics, and calculate its adsorption rates as a significant parameter for designing adsorption process. In this regard, the most physical properties such as crush strength and particle size distribution of adsorbent were determined using modern and advanced devices. The Brunauer–Emmett–Teller (BET) test was carried out to determine the specific surface area, pore diameter and pore volume of the activated alumina which were 334.67 m^2/g, 8.096 nm, and 0.0713 cm^3/g, respectively. Additionally, chemical and morphological specifications such as pore size distribution of adsorbents assess textural properties of the activated alumina were characterized using X-ray fluorescence (XRF) and Barrett-Joyner-Halenda (BJH) analysis, respectively. Also, adsorption isotherm of the activated alumina were determined using Langmuir, Freundlich and BET models.

Keywords: Activated Alumina; Physical Characterization; Adsorption

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In Situ Synthesis of Aluminium Matrix Surface Composites by Friction Stir Processing

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Abstract

Al matrix surface composite layers reinforced with in situ synthesized Al_3Ni and TiC compounds were produced on Al 1050 sheets by friction stir processing (FSP). Effects of traverse speed, rotational speed and heat treatment on the microstructure and hardness of specimens were studied. FSP induced reaction between mechanically alloyed (MA) Ni-Ti-C powders and aluminium matrix was investigated. Microstructural evaluation of the samples was conducted by optical microscopy (OM) and scanning electron microscopy (SEM) of the cross-sections of surface composite layers fabricated by FSP. X-ray diffractometery (XRD) was used to study the structural evolutions. Hardness profiles were obtained from microhardness measurements across the cross-sections of FSPed samples. Improved distribution of Ni-Ti-C particles and smoother hardness profile observed at 1400 rpm and 40 mm min^{-1} rotational and traverse speeds, respectively. Defect-free in situ composites containing Al_3Ni and TiC reinforcements were successfully produced after two passes of FSP at optimum speed. Surface composite layers obtained from FSP showed increased hardness up to about 60 VHN.

Keywords: Al matrix composites; In situ synthesis; Friction stir processing; Microstructure

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Effect of Graphene on the Mechanical Properties of Al7075-Graphene Nanocomposite Produced by Accumulative Roll bonding

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Abstract

In this study, nanostructural Al7075 composite sheets with phase reinforced Graphene was produced by Accumulative Roll Bonding (ARB) Process and the effects of T6 aging process on their mechanical properties were studied. For this purpose, the ARB up to three cycles on samples with particles of reinforced Graphene and without Graphene was processed. Changes in mechanical properties were investigated by using Vickers Hardness and tensile test. And as well as to study the microstructure and distribution of particles used electron microscopy SEM and to trace the Graphene used Raman spectroscopy. In addition, XRD analysis was used to determine the grain size and identify the present phases in the samples Al7075-0.2% Graphene and Al7075. Results indicate the mechanical properties of AL7075-0/2 Graphene nanocomposite with T6 aging improves compared to samples without Graphene.

Keywords: Nanocomposite; Al7075-0.2% Graphene; Accumulative Roll Bonding; Mechanical properties

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Study of Tribological Properties of Microwave-Sintered CuNi-Al_2O_3 Nanocomposites

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Abstract

The work evaluates the effect of Al_2O_3 Nano powder addition on microstructure and tribological properties of CuNi-Al_2O_3 nanocomposites. The elemental powders of Ni and Cu contains 0, 5 and 10 vol. % of Al_2O_3 Nano powder were mixed in a high-energy ball mill. Phase transformation of the alloyed powders obtained was characterized by X-ray diffraction (XRD). Mechanically alloyed powders compacted under cold pressure at 350 MPa and were sintered in microwave furnaces (2.45 GHz). The microstructural analysis of the cross section of the sintered samples was made using scanning electron microscopy (SEM). The sintered sample show fully dense microstructure without any radial cracks. Tribological properties of sintered nanocomposites were evaluated by ball-on-disk wear test. Increasing the Al_2O_3 content in the nanocomposite decreased the wear rate and coefficient of friction. These results showed that the addition of Al_2O_3 Nano powder in the CuNi matrix caused improves its wear behavior.

Keywords: Microwave sintering; Nanocomposite; Wear; Nanoparticle.

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Studying Enhancement of Buckling of Composite 2D-FG Cylindrical Shells Produced by Alumina and Aluminium Elements

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Abstract

This paper has been proposed to investigate enhancement in Buckling of two-dimensional functionally graded (2D-FG) cylindrical composite shells using Alumina and Aluminium elements under combined loads based on first-order shear deformation theory (FSDT). Features of this composite are changing in both radial and axial directions. The material properties composite are graded in two directional (radial and axial). The Euler's equation is employed to derive the stability equations which have been solved by numerical method. In the following, the effects of shell geometry, the mechanical properties and elements distribution in radial and axial directions on the mechanical critical buckling loads of cylindrical shell are studied and it is compared with a cylindrical composite shell made of one-dimensional functionally graded material (1D-FGM). The numerical results reveal that the composite materials (2D-FGM) in which Alumina and Aluminium elements are used in have a significant and crucial effect on improvement of the critical buckling load.

Keywords: Composite; Mechanical Buckling; 2D-FG cylindrical shell; Combined Loads; Classical Shell Theory

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Glassy State Formation in $(Al_{90}Ni_8Zr_2)_{100-X}$ Mm_x Melt Spun Ribbons

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Abstract

$(Al_{90}$-Ni_8-$Zr_2)_{(100-x)}Mm_x$ alloys were rapidly solidified by using melt-spinning technique to examine the effect of Misch metal content on microstructure, thermal and mechanical properties. The resulting melt-spun ribbons were characterized by X-ray diffraction, scanning electron microscopy, energy dispersive spectroscopy, differential scanning calorimetry, and Vickers microhardness tester. $Al_{90}Ni_8Zr_2$ alloy consists of amorphous and nano-crystalline α-Al with 30nm size phases. Other ribbons were completely amorphous, so glass forming ability increased by adding Mm. The change in microhardness is discussed and concluded that the higher the Misch-metal content, the higher the hardness of the ribbons.

Keywords: Amorphous Ribbon; Melt spinning; Glass Forming Ability; Hardness

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Effect of Graphite Content on Characteristics Al/40SiC/Gr Hybrid Composites Processed by In Situ Powder Metallurgy (IPM) Method

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Abstract

Aluminium matrix composites reinforced with SiC and Gr particulates are a unique class of advanced engineered materials that have been developed for use in tribological applications. Conventional liquid phase techniques and powder metallurgy (P/M) used for producing these composites have some drawbacks, such as poor wettability of the reinforcement particles with the matrix alloy, inhomogeneous distribution of particles, presence of Al_4C_3 compound and requiring a relatively long mixing time for obtaining a uniform distribution of reinforcing particles in the matrix. In the present study a relatively new method, namely "in situ powder metallurgy (IPM)" was applied for consolidating the Al/40SiC/Gr hybrid composites. In this method, stir casting and P/M synthesizing processes were combined into an integrated net shape forming process. In this work, the effect of graphite content (0-13 Vol.%) on characteristics of the resultant powder, green density of the Al/40SiC/graphite compacts as well as the microstructure and hardness of the consolidated hybrid composites was investigated. It was concluded that the increased graphite content was accompanied with finer aluminium particles and improved densification of the powder compacts. Hardness of all the composites were higher than the base alloy. However, hardness was decreased by enhancing graphite content of the composites.

Keywords: Al/SiC/Gr hybrid composites; IPM method; Graphite content; Hardness

Welding and Joining

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Thermo-Mechanical Analysis of Tool used in FSW Process of Al 1100 Alloy

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Abstract

The ability of friction stir welding (FSW) to create a solid state bond makes it a proper candidate for materials that are difficult to join using traditional arc welding techniques. In this research, a three-dimensional model based on finite element analysis was used to study thermo-mechanical characteristics of tool used for FSW process of aluminium 1100. This research considered tool regarding the gradient of stress and temperature developed in it. Additionally, wear of tool was studied. The results showed that maximum rate of wear for tool happened at plunging step which tool initially contacts the workpiece and pin wears more than other points of tool. Additionally, the temperature distribution around the weld region, during the FSW, was investigated using finite element method (FEM). FE-results were verified by experimental results. The comparisons revealed a good compatibility between the results. Additionally, it was concluded that temperature in advancing side is higher than that in retreating side.

Keywords: Friction stir welding; Tool; Thermo-mechanical analysis; Simulation

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Investigation of Using Filler Metal in Friction Stir Welding of Aluminium Foam Sandwich Panels

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Abstract

Appropriate combination of mechanical properties of aluminium foam sandwich panels (AFS) make them ideal materials for applications in automotive, shipbuilding and aerospace industries. The main problems in fusion welding of AFS are core's low density and its cell structure that without taking special measures, the cellular structure will be lost. The lack of metallic material in friction stir welding of AFS causes a poor joint and defect in welds. Adding filler metal by casting method or placing a solid aluminium bar is recommended as a solution. In this study, both procedures were used to apply fillers with different thicknesses to the joint. In order to evaluate the effect of different thicknesses on mechanical properties and defects, all samples friction stir welded with the same rotational and advancing speeds. Due to the results of three-point bending test, the joint between two AFS panels does not represent the weak point of the whole component and failures occur from discontinuities. Also, investigations showed that generally the casted fillers have better mechanical properties. The advantages of this method include absence of liquid phase which reduces the destruction of cell structure and creating sound joints.

Keywords: Aluminium foam sandwich panel; Friction stir welding; Bending test; Infiltration process; Filler metal

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Effect of Tool Rotational Speed on the Microstructure and Mechanical Properties of Projection Friction Stir Spot Welding of 2024 Aluminium Alloy

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Abstract

Friction Stir Spot Welding (FSSW) is a solid state joining process which utilizes a rotating tool consisting of a shoulder and/or a probe. FSSW has a strong interest related to the welding of aluminium alloys and dissimilar materials. The main disadvantage of this technique is the keyhole which remains in the stir zone and corrosion could take place preferentially in this region. Different techniques have been used for eliminating of this keyhole. In this study, a novel technique has been successfully applied to prevent the formation of the keyhole by using a cylindrical pinless tool and a projection on the beneath anvil. The effect of tool rotational speed on the microstructure and mechanical properties of projection friction stir spot welding of 2024 aluminium alloy is studied. This process was carried out in three different tool rotational speeds (1000, 1600 and 2000 rpm). By using this new method significant improvement was observed in mechanical properties, grain size and microstructure.

Keywords: Friction stir spot welding; Aluminium; Projection height; Rotational speed; Mechanical properties

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Effect of Tool Dwell Time on the Microstructure and Mechanical Properties of Projection Friction Stir Spot Welded 2024 Aluminium alloy

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Abstract

Automotive industry has developed a variant of the Friction Stir Welding named Friction Stir Spot Welding (FSSW), having a strong influence on welding of thin sheets of aluminium alloys. However, one of the disadvantages of FSSW technique is that a keyhole generally remains at the center of the stir zone. Keyhole defect can reduce the mechanical properties of FSSW joints. A novel friction stir spot welding technique was developed with the purpose to improve the mechanical property of the joints by removing the keyhole. This novel FSSW method was applied to 2024 Al alloy sheets, 1 mm in thickness, under different dwell times. The effect of this welding parameters on the microstructural and mechanical properties of the spot joints has been. The final joints have a smooth surface without keyhole and show improved mechanical properties. The welding parameters variations change the length of metallurgical bonding zone and mechanical properties of the welds in terms of peak load and energy absorption.

Keywords: Friction stir spot welding; 2024Aluminium alloy; Microstructure; Mechanical properties

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Experimental Filling Friction Stir Welding of Exit Hole and Numerical Simulation– A Modified Technique to Apply Practically for Pipe AA5456

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Abstract

Filling Friction Stir Welding (FFSW) is a solid state joining process which uses a rotating tool consisting of a shoulder and a semi-consumable pin. One of its applications is preventing from forming an exit hole at the end of the Friction Stir Welded samples. It is important to choose the appropriate tool design and welding parameters in order to fill exit hole for a given situation. A tree dimensional (3D) model is developed using finite element (FE) commercial code DEFORM 3D/Implicit. In the present study, 7.5mm thick AA5456 rolled plates and pipes were successfully welded by FFSW without Exit-Hole using a semi-consumable similar pin (5456) and semi-consumable dissimilar pins (7075 & 2024) on lap joint specimens. The influences of the pin material, pin geometry, rotation speed (rpm) and plunge velocity (Z axis speed) on the mechanical properties of the joints were investigated. Microstructure of the joints, especially at the interface, was examined by SEM and optical microscopy. The optimized process parameter for AA5456 was obtained by tool rotation speed of 800 rpm, plunge velocity of 50 mm/min, similar cone angle pin of 8^{o}. The hardness profile of the welds exhibited a W-shaped appearance in processes and the minimum hardness was measured in the HAZ. Radiographic, Pneumatic and Hydraulic tests was done in order to verify the ability of being used in the industrial applications. Results showed that the strength of filled Exit hole is 7% higher than the strength of the joint with the non-filled exit hole.

Keywords: Filling Friction stir welding; Consumable pin; Exit hole; Lap joint; AA5456

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Effect of FSSW Parameters on Grain Size and Hardness of 6061-T6 Al in Dissimilar Joining to DP590 Dual Phase Steel

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Abstract

Dissimilar 6061Al alloy/DP590 dual phase steel joints were fabricated using friction stir spot welding (FSSW). Microstructural examinations by optical and scanning electron microscopy exhibited the occurrence of dynamic recrystallization in the stir zone of aluminium and steel sides that lead to refined grains. Five distinct regions in the stir zone of aluminium (having different mean grain size from ~ 1.5 to 12 μm) were found as a function of process parameters. The grain size of these distinct regions was found to increase with increasing of tool rotation speed. In addition, the grain size of these distinct regions decreased with increasing plunge and retraction rates. However, with increasing dwell time, the mean grain size showed increasing; this was associated with near homogenous grain size distribution. The process parameters were found to have relatively less effect on variation in hardness values of the aluminium side.

Keywords: Friction stir spot welding; Dissimilar joint; Aluminium alloy; Grain size; Micro-indentation hardness

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Influences of Tool Pin Profile on Microstructure, Mechanical and Defects of Friction Stir Welded 7075 Aluminium Alloy

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Abstract

In this study, effect of geometry of the pin profile on microstructure, mechanical and defects of FSWed 7075 alloy was investigated. Three pins with cylindrical, square and triangle geometry were used for welding. Microstructure of the welding zone showed that the tunnel hole produced by triangle pin has smaller dimensions compared to cylindrical pin. On the other hand, results of optical microscope indicated that the size of grains resulted from square pin is smaller than the other kinds of tools. Also, the results showed that when the pin is cylindrical, tunnel, kissing bond, and zigzag line defects are formed. On the other hand, when the pin is triangle, original joint line with severe plastic deformation and crack defects are created. After welding with the square pin, tensile strength and the hardness were acquired 490 MPa and 160 HV respectively that were the maximum values compared to other pins.

Keywords: 7075 Al alloy; Friction stir welding; Pin profiles; Microstructure; Mechanical properties

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The Influence of Nd:YAG Laser Welding Parameters and Surface Modification on Hot Cracking Behavior of 5456 Al Alloy

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Abstract

Samples of 5456 Al alloy were welded using a 80 W Nd:YAG pulsed laser. The influence of laser power and surface preparation on hot cracking behavior of 5456 Al alloy were investigated. In order to determine the microstructure and hot crack growth paths, scanning electron microscopy (SEM) and optical microscopy (OM) were used. It has been found that the penetration of welds and hot cracks increased with laser power enhancement. Also, results show that weld width does not increase significantly with laser power increment. The penetration of welds and welding quality of 5456 Al alloy sheets were improved when the surface modification was performed before laser welding. It was demonstrated that the penetration of the welds can be remarkably increased when the heat input of the laser is increased. The modification of surface lead to more penetration and decrease in the total number of the cracks. The microstructural investigations revealed that the solidification cracking would occur due to microsegregation of Mg into the interdendritic regions.

Keywords: Nd:YAG pulsed laser; 5456 Al alloy; Hot cracking; Surface modification

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Influence of Pulsed Nd: YAG Welding Parameter on Hot Crack in Aluminium Alloy 5083

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Abstract

Aluminium alloy 5083 belongs to the family of high strength light alloys and in this respect is widely used in high performance engineering structures. However, aluminium–magnesium alloys are known to be susceptible to hot cracking in fusion welding. The objective of this study is the investigation of occurrence of hot cracking i.e. solidification cracking in the weld metal and liquation cracking in the HAZ in Nd: YAG pulsed laser welding of a 5mm-thick 5083 –H321 aluminium alloy. The effects of peak power and frequency were studied. The cross section of welds were studied by metallographic techniques and the crack length were measured. It has been found out that with increasing peak both the weld penetration and hot cracking susceptibility increase. However, increasing the laser pulse frequency had reduced the occurrence of solidification cracking in 5083-H321 alloy.

Keywords: Aluminium alloy 5083-H321; Hot crack; Laser welding; Solidification cracking; Liquation cracking

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Investigation of Friction Stir Welded Joints of 1050 Aluminum Alloy by Inserting Cu Foils

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Abstract

Aluminum alloys are used in many industries because of its high strength to weight ratio. Due to many problems of fusion welding of aluminum alloys, in the past decade, much attention of scientists and craftsman has been directed towards friction stir welding (FSW) as a solid-state welding process. In this study, microstructural evolution and mechanical properties of butt friction stir welded wrought 1050 aluminium alloy by inserting pure copper foil has been studied. Friction stir welding was conducted at a tool traverse speed of 25 mmmin−1 and a rotational speed of 1200, 1600 and 2000 rpm. The mechanical properties in forms of tensile tests showed that the strength of base metal (initial = 137MPa) diminished about 45% to 73MPa during friction stir welding without Cu foil in the stir zone after friction stir welding. Formation of intermetallic compound particles such as Cu_9Al_4 and Al_2Cu, between aluminium matrix and Cu foil, increased strength of the stir zone. Furthermore, fractography characterization revealed that, Fracture place of weld joints without foil and with foil occurred at advancing side and retreating side in the stir zone respectively. This is related to aggregation of intermetallic compound particles in retreating side. Finally, the maximum UTS of joint increased to 98MPa (about 25%) that achieved in specimen with Cu foil with rotational speed of 2000 rpm.

Keywords: "Friction Stir Welding"; "1050 Aluminum Alloy"; "Copper Foil"; "intermetallic compound";

Corrosion and Surface Treatment

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Base Metal Microstructural Considerations for Anodizing Aluminium

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Abstract

Producing the anodic aluminium oxide is a multidisciplinary process that combines basic chemistry and electrochemistry with the physical metallurgy of the substrate. Therefore, the process of anodizing comprises engineering issues and procedures, not only in the anodizing plant, but also prior to anodizing, during substrate manufacturing. Defects that compromise the clarity, color, wear and corrosion resistance of the anodic oxide are often not visible in the as-manufactured condition, but are developed by the anodizing process. Consequently, the root cause for such defects can often be found in the substrate microstructure, which can point to critical variations in the manufacturing process. This paper presents data from unrelated studies that target components representative of different manufacturing processes and different alloys and tempers. These data illustrate how differences in manufacturing process parameters produce differences in microstructure, which are in turn developed by anodizing. By understanding the impact of these critical factors, alloy selection, manufacturing, and surface finishing can be optimized to yield design performance and appearance.

Keywords: Anodizing Aluminium; Microstructure; Manufacturing Process; Surface Defects

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How to Obtain High Performance in Anodizing with Low Operational Costs, Sludge Reduction and Zero Liquid Discharge

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Abstract

Nowadays, high quality and low operational cost are the keys to success in any type of industry. In particular an anodizing plant can now adopt innovative technologies, which allow the plant to obtain very high performance, resulting in very uniform anodizing layers in many colours that are resistant to strong UV light. These anodic layers are highly corrosion resistant not only to acid, but also to alkaline corrosion, which is requested especially by the automotive industry. Operational costs can be kept much lower than in conventional plants due to specific electronic devices, which can monitor all the energy and chemical wastes. As regards water savings and waste water treatment, it is possible to reduce water consumption to zero or almost zero. Zero Liquid Discharge plants are now available with an affordable investment and with low operational costs. The innovative patented zero discharge system is a "revolution" compared to conventional physical chemical systems, and has been particularly designed for the treatment of liquid wastes derived from anodizing plants and powder coating pre-treatment. All of the above technologies are described in detail in this paper, with pictures and practical examples of industrial applications.

Keywords: High-Efficiency Anodizing

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Passive Behavior of AA6061 Aluminium Alloy in Borate Buffer Solutions

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Abstract

Passive behavior of AA6061 Al alloy in borate buffer solutions of various pH values ranging from 8.25 to 6.57 have been studied by using potentiodynamic polarization and electrochemical impedance spectroscopy (EIS). Potentiodynamic polarization curves showed that AA6061 Al alloy show excellent passive behavior in borate buffer solutions of various pH values ranging from 8.25 to 6.57. EIS results showed that the changes in the pH lead to one distinct behavior in the EIS plots. Moreover, it can be concluded that the passive film formed on AA6061 Al alloy shows its best protective behavior when pH interval is 6.81, and if the pH is higher or lower than this interval the protective properties of passive film will decrease.

Keywords: AA6061 Al alloy; Potentiodynamic polarization; EIS; Borate buffer solution

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The Effect of Hot Extrusion Conditions on Nanostructure and Corrosion Properties of Anodized AA6063 Alloy

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Abstract

Samples of AA6063 alloy were extruded at different extrusion temperatures and velocities and anodized using sulfuric acid. Salt spray test was used to measure the resistance of the coating against corrosion. Results demonstrated the formation of a network of beehive cell nanostructure on the surface of all samples. Samples extruded at higher velocity and lower temperature indicated finer recrystallized grain structure and finer beehive cell nanostructure and higher corrosion resistance. In these samples, the surface fraction of the nanocavities was smaller and a smaller fraction of the surface was left unprotected which caused higher corrosion resistant.

Keywords: AA6063; hot extrusion; Anodizing; Nanostructure; Corrosion properties

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Investigation Properties Aluminium Coated by Active Screen Plasma Nitriding

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Abstract

Nitriding has been shown to improve the poor tribological properties of Aluminium and Aluminium alloys. However, nitriding Aluminium alloys is difficult because of the high affinity of oxygen to Aluminium in a surface, Aluminium oxide layer that acts as a diffusion barrier and precludes nitriding even at high pressure. Active screen plasma nitriding (ASPN) is an emerging surface engineering technology that offers many advantages over the conventional DC plasma nitriding (PN). In this research plasma nitriding of pure aluminium 1050, using iron active screen was investigated. At first the rectangular cube-shaped samples with dimensions, 20 × 20 × 5 mm^3 prepared. Then under atmosphere %20 H_2-%80 N_2, at 450, 500 and 550 ° C, 80% duty cycle and the frequency of 10 kHz for 10 hours were plasma nitrided. The coatings were characterized using X-ray diffraction, scanning electron microscopy. Results showed that the coatings were mainly consist of $Fe_{2-3}N$ particles whose size particles increased by increasing temperature. The surface of samples coated with the method of active screen plasma nitriding, to form hexagonal nitride particles covered with uniform distribution.

Keywords: Active Screen Plasma Nitriding; Aluminium; Iron nitride; Aluminium nitride

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Eight Continuous Annealing and Pre-Treatment lines in Operation

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Abstract

In the last few years Tenova experienced a boom of sales in continuous annealing and surface heat treatment lines (so called cash lines) from noted aluminium producers to cover automotive, aircraft, architectural and various others market demands. Among the 10 continuous annealing lines sold by Tenova in the last few years, 8 of them are now under production, while the remaining 2 are in the erection phase. Commissioning of these last two lines is foreseen to be on 2016. With this article Tenova would like to show this booming of orders showing the overall installed technological equipment and the results of operation of these lines. The results are given to show the continuous improvements of its own technology taking into consideration the development of new equipment able to reduce maintenance downtimes and loss of production.

Keywords: Continuous Annealing; Floating Process; Pre-Treatment; Strip handling; Passivation

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Effect of Chloride Ions Concentration on the Passive Behavior of AA6061 Aluminium Alloy

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Abstract

The effect of chloride ions concentration on the passive behavior of AA6061 aluminium alloy in a borate buffer solution (0.3 M H_3BO_3 + 0.01 M $Na_2B_4O_7$, pH=7.15) has been investigated by using potentiodynamic polarization and electrochemical impedance spectroscopy (EIS). Potentiodynamic polarization curves indicate that chloride ions concentration narrowed passivation region for AA6061 aluminium alloy. Also, these polarization curves revealed that increasing chloride ions concentration leads to decrease the pitting potential of AA6061 aluminium alloy. EIS tests showed that the passive films formed in chloride-free solution are most stable, and that formed in chloride-containing solution are unstable. Also, EIS tests demonstrated that the charge transfer resistance of AA6061 aluminium alloy decreases by increasing the concentration of chloride ions.

Keywords: AA6061 aluminium alloy; Potentiodynamic polarization; EIS; NaCl

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Factors Effect on Aluminium Extrusion Streaking Defect

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Abstract

Usually in anodizing industry the extruded raw profile surface is very shiny and flat, and there is no streaking defect appearance on the surface. However, after anodizing, few streaking defects appear on the surface which reduce the quality of anodized profile surface. These defects are related to the accumulation of impurities that are not visually seen on raw profile surface. This study shows that the selective corrosion of etching solution cause streaking defect appears on the surface. The factors effect on accumulation of impurities on extrusion section surface includes: alloy elements, extrusion dye, surface conditions and dye temperature. In this article we study and control the effect of each variables on aluminium extrusion streaking defect appearance to achieve the desired anodized surface. We also discuss the effects of alloying elements in 6063 alloy, extrusion dye surface and Billet temperature on the extrusion streaking defect in etching process.

Keywords: Etching; Alloy elements; Alloy impurities; Billet temperature; Dye surface

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Mechanism Study and Parameter Optimization of A356 Aluminium Alloy Electrochemical Polishing

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Abstract

The aim of the present study was to find a good method for electropolishing A356 Aluminium alloy. Consideration of the fundamental current density-voltage relation and limiting current density has made it possible to identify an optimum applied voltage for good electropolishing through variation of different parameters (electrolyte, bath temperature, electrode distance, surface roughness before polishing, cathode material, etc.). A mixture of water, perchloric acid and ethanol with different ratio were used as the electropolishing solutions. The electropolished surfaces have been investigated by various electrochemical and morphological techniques, including scanning electron microscope (SEM), atomic force microscope (AFM), roughness measurement and potentiostatic polarization test. The significant findings of the present study are that electropolishing can also improve the corrosion resistance as well as the smoothness.

Keywords: electropolishing; Smoothness; Corrosion resistance

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Effect of Voltaren Drug and Voltaren Expired Drug as a Corrosion Inhibitor for Aluminium in Acid Solutions

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Abstract

In different industries organic compounds are used as corrosion inhibitor in acid solution. Organic compounds are highly cost and it may not be economical to use .organic inhibitors make a thin layer on the metal's surface that may absorb on the cathode or anode surface or both. Decrease corrosion rate. This article discuss about some organic drug that has been used as an inhibitor of corrosion. These drug compounds has been used in two types: drug and expired drug. This method decrease the cost in corrosion field. In this experiment EIS test has been used to major the polarization resistance and the capacity of electrical double layer. The drug has been used with these concentrations 500-100-1500ppm. Drug voltaren with the concentration of 1500 ppm was the best inhibitor among other compounds. And it has been observed that the active type of the drug works better as an inhibitor than another type.

Keywords: Inhibitor of corrosion; Voltaren; Aluminium; Drug; Expired drug

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Study on the Kinetics of the Growth of Intermetallic Layer on the Surface of CK45 Steel During Hot Dipping Process in Molten Aluminium

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Abstract

Aluminizing is one of the processes that increases the resistance to corrosion and oxidation of the steels at high temperatures. During this process, the intermetallic compounds that formed on the steel surface, causes desirable properties. Among the various methods of aluminizing, hot dipping is more economical and feasible. In this work, aluminizing of CK45 steel was carried out via hot dipping process at three immersion temperatures of 730 °C, 770 °C and 830 °C and for different immersion times in molten pure aluminium. By using EDS analysis, the phase formed on the surface of steel was detected as Fe_2Al_5. The thickness of this phase was measured by optical microscope for the different temperatures and times. The plots of intermetallic layer thickness versus the square root of time indicated a linear behavior that means the growth of this intermetallic layer obeys the diffiusion-controlled kinetics. By plotting the graph of logarithm of slops as a function of reciprocal temperature, the activation energy of the growth of the Fe_2Al_5 was calculated as 121 kJ/mol.

Keywords: Aluminizing; Corrosion resistance; Hot dipping; Activation energy; Intermetallic layer

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Evaluation Aluminium Alloy1050 a Corrosion in a Simulated Environment Heller Tower by Polarization Method and Determine the Optimum Conditions for Maintenance

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Abstract

The polarization technique has applied to investigate the factors affecting aluminium alloy**1050A** corrosion used in cooling towers. In addition, the storage conditions were optimized using the statistical method central composite design (CCD). The primary goal of this study was to identify factors influencing corrosion of aluminium alloys used in dry heat transfer towers in Yazd combined cycle power plants, which was the result of experimental design. The cross-sections studied were performed using SEM imaging and EDS analysis. The results showed that three factors including pH, temperature, and the amount of available iron ions (ш) in environment, are effective on alloy corrosion during towers operation (Heller Type). In conclusion, increase of pH, water temperature, and the amount of iron ions (ш) in the environment, have led to increase in the corrosion of applied aluminium alloys in heler towers of the combined cycle plants . The results show that corrosion was the pH of the solution exponentially effective. In addition to maintaining optimum conditions mentioned alloy to minimize corrosion rates in this study were extracted.

Keywords: Heller; Corrosion; Aluminium Alloy; CCD

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Effect of Grain Size and Oxidation on the Contact Angle of Water with Pure Aluminium

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Abstract

Hydrophobic surfaces are of great interest to many industries. Such surfaces tend to repel and minimize their contact with water. This may improve corrosion and wear resistance, prevent icing and minimize fouling and spotting of the surfaces. Surface tension and surface roughness are the main parameters that have been shown to affect the hydrophobicity. Metallic materials have high surface energy and are intrinsically hydrophilic. The most common way to increase the water contact angle on metallic surfaces is through application of hydrophobic coatings. Stabilization of such coatings in industrial environment is a great challenge for scientists. In this work an attempt is made to evaluate the effect of grain size and oxidation on the surface contact angle of pure aluminium. For this purpose a chill test specimen was cast from commercially pure aluminium and the water contact angle at different cross sections of the specimen, with and without oxidation treatment, was measured. The results showed that water contact angle of aluminium surface was affected by grain size and oxidation treatment. The contact angel increased from 50 to 86 degrees by increasing the grain size and to a maximum of 117 degrees by oxidation in air.

Keywords: Aluminium; Grain size; Hydrophobicity; Contact angle; Surface Energy

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Electrochemical Corrosion Behavior of Friction Stir Welded AA6061 in NaCl Solution

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Abstract

In the present study, electrochemical corrosion behavior of FSW welding investigated for 6061 aluminium alloy in different area such as HAZ, TMAZ and STIR in 3.5% NaCl solution. Corrosion behavior of weld areas is evaluated by polarization and electrochemical impedance tests. According to the polarization curves, corrosion current density in HAZ area is lower than TMAZ, STIR and base metal and the corrosion potential moved to the more noble values. The corrosion current density and corrosion potential for HAZ area is 60nA/cm^2 and -0.680V respectively. Electrochemical impedance test confirm polarization test. Based on Nyquist curves, there is a time constant for the double layer at the interface of the solution and the substrate. The EIS values obtained that HAZ area has highest charge transfer resistance (5.64E+5).

Keywords: AA6061; Corrosion; Friction Stir welding; Polarization; EIS

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Corrosion Resistance of 6063 Aluminium Alloy by Anodizing Treatment in a Phosphoric Acid, Boric Acid and Oxalic Acid Baths with SEM and TAFEL Study

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Abstract

Corrosion resistance specimens of 6063 aluminium alloy were investigated during anodizing in sulfuric acid, sulfuric acid/ boric acid and sulfuric acid/ boric acid/ oxalic acid baths using electrochemical impedance (EIS) techniques, Tafel extrapolation, SEM micrographs and optical microscopy images. After anodizing that by changing of the time during the anodizing different thicknesses of aluminium oxide Nano-layer was formed on the aluminium surface. The corrosion resistance behavior of the 6063 aluminium alloy showed by increasing the thickness of the Nano-oxide layer in each of the three supports reduces the corrosion rate, increasing the load transfer resistance and thus reduce the influence of attacker ions into the aluminium. The obtained results indicated that the corrosion resistance increased in the order of sulfuric acid/ oxalic acid/ boric acid> sulfuric acid/ oxalic acid> sulfuric acid for anodized piece.

Keywords :6063 aluminium alloy; Electrochemical impedance; Tafel extrapolation method; Nano-layer

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An Investigation on the Effect of Crystal Orientation on Corrosion Behavior of ECAP Processed Aluminium 7075 Alloy

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Abstract

In recent years, Equal Channel Angular Pressing (ECAP) has attracted a lot of attention as a novel method in implementing strain. In this study, the effect of crystallographic orientations on corrosion behavior of aluminium 7075 alloy was studied. ECAP was used to provide samples with a textural microstructure form. The samples were cut in 0°, 22.5°, 45°, 67.5° and 90° angles to obtain the corrosion characteristics of varying surfaces. Polarization and EIS tests were performed to study the corrosion behavior of the samples. XRD TEXTURE analysis was performed to verify crystallographic orientations of the samples along with the relation between the crystallographic orientations and the corrosion characteristics. Results showed that the structure was greatly influenced by the ECAP process. Corrosion verifications demonstrated that, when the surface were created at 0° cutting angle, corrosion potential for two pass pressed sample was more positive than the sample which was pressed once. However, in case of surfaces created by cutting angles of 22.5°, 45°, 67.5° and 90°, the corrosion potential of one pass pressed samples was more than two pass pressed counterparts. The dependence of the corrosion behavior of samples on different cutting angles was explained by the XRD TEXTURE analysis results.

Keywords: ECAP; Aluminium 7075; Corrosion

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Improvement of 6061 Aluminium Alloys Wear Resistance by Electrodposited Nickel Coating

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Abstract

To improve the wear resistance of a 6061 aluminium alloy, a 20 µm nickel layer was electrodeposited from a modified Watts bath. The characteristic of nickel coating was identified by means of SEM and XRD. The nickel coating had a regular pyramid structure. Furthermore, the preferred crystallographic orientation of the coating was (200). Wear tests were performed on a pin-on disk tribometer under normal load of 2 N at a sliding distance of 300m. The nickel coated sample with higher hardness showed better wear behavior in comparison with the aluminium substrate. This was mainly attributed to the higher hardness of nickel coating and formation of tribological layer on this coating.

Keywords: Aluminium alloys; Nickel coating; Electrodeposition; Wear

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Cube® Trevisan: the Smart, Efficient Coating Solution

Andrea Trevisan

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Abstract

The revolution in the aluminium profiles powder coating market took place in 2013: during March 2013, SAT (Surface Aluminium Technologies) introduced the Cube Trevisan, the first compact vertical powder coating line with the following characteristics: small space required (only 150 square meters, excluding loading and unloading areas), low operational costs (low fuel-water-electricity consumption, with no need of skilled painters to run the entire line) and a competitive price. This product target is, on one side, the small to medium size companies aiming to increase productivity in a very short time and with a modest investment. With the Cube system, they can get very high quality and lower production cost comparing with traditional systems, which makes them immediately competitive in the market. On the other side, the product also targets towards big company, willing not to concentrate the production in one single headquarter, but bringing the coating service closer to their end-customers, with a coating line in every single warehouse.

Keywords: Vertical powder coating line; Compact line; Quick-process line; Reduced space; Low operating costs

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Analyses increase thickness Aluminium profiles dies or die wear in the direct extrusion (Die life) And How to preserve it

Behrooz Khatami

Felez Sazeh Arak Co

Abstract

The major factors the die life are: temperature and extrusion process, tribology and nitration. Excessive die wear during extrusion and removal of **WHITE LAYER** and stop extrusion before we get to Diffusion Zone (contains nitrides). Nitration depth should be max. 150µm. White layer thickness should be Max 10µm. Die wear is one of the tribology aspects and as the destroying of continuous material of the die surface is defined. Wear have the harmful effects , because of the flow , product shape and contact surface the die change it , also on the process, size, shape and quality the flow of material from in the die have effect . Wear can lead to serious damage and change the topography and shape in the surface the hollow of dies (mandrel and matrix), particular mandrel of die.

Keywords: Extrusion, Thickness, Dies, Wear, Bearing, Temperature, Nitration

Raw Materials and Reduction Technology

Proceedings of Iran International Aluminium Conference (IIAC2016)
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The Processing of Alumino Silicates for the Purpose of Producing Alumina

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Abstract

Alumino silicates were once the dominant source of aluminium for the purpose of producing alumina prior to the 2nd world war. The technique was widely used, firstly in the western hemisphere in the first half of the 20th century and later by the Soviet and Chinese manufacturing plants. Since then the development of Bayer process together with the change in geopolitical landscapes has resulted in bauxite being the primary raw material for aluminium production resulting in slow technical progress for the production of alumina from alumino silicates. The naturally high content of silica in the raw material makes direct use of alumino silicates problematic in the Bayer process as it will result in an uncompetitive outcome. The simplest way of processing is to sinter the alumino silicate material at elevated temperatures in the presence of limestone. However, certain chemical and physical requirements (e.g. temperature) need to be met. Several techniques have been tested on an industrial scale. The purpose of this paper is to explain these industrial techniques and to present the new options that have been developed through investigative efforts.

Keywords: Alumina; Aluminosilicates; Nepheline; Sinter

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Measuring the Effectiveness of Circuit Grinding Coke of Anode Plant at Almahdi-Hormozal Aluminium Complex

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Abstract

Anode reacted as a positive pole in recover cells with aluminium and since of two main roles of transforming electric flow and cooperation in the electrochemical process of changing alumina to aluminium is so important. Since the quality of the produced aluminium is related with quality of anode directly so in this study deal to measuring the quality of aluminium industry , in this study we discuss on producing micro seeds of coke that is as one of the most important producing parameters of anode with suitable quality. So the process of studies of producing fine in one stage of feeding involved coke mix and green with the considered sizes and before feeding set the size of classifier size and changed the speed of any circulation, and deal for sampling the product. In some of the speeds of classifier sizes, the quality of the product was suitable and good for producing anode, and in some speeds of the sizes it was unsuitable and without quality.

Keywords: aluminium; Anode; Fine; Classifier; Coke; Blaine

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Current Performance Achievements and Future Improvement Orientation of 68 kA Modernization Project in Arak Aluminium Smelter, Iran

Liu Siren, Zhao Xinliang, Xu Lusheng

China Nonferrous Metal Industry's Foreign Engineering and Construction Co., Ltd

Abstract

Arak 68KA aluminium refinery in Iran was accomplished in 1960s with high current density, unscientifically designed busbar arrangement, unapplied pot controlling system, high working voltage, high energy consumption, low current efficiency and serious pollution. Preliminarily modernized by NFC, the aforementioned problems are solved thoroughly, and all variety of indicators are satisfying.

Keywords: 68kA, Pot, Modification, Energy Saving and Emission Reduction Energy consumption.

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Choice for Structure of Pre-baked Anode Assembly in 430 kA Aluminium Pot

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Abstract

430kA Aluminium pot technology is used in the Phase2 of SALCO Aluminium Smelter Plant. It was disputed whether single-block anode and double-block anode is chosen in the structure of pre-baked anode assembly. In this text, the effect of technical and economical indexes of aluminium production was compared between single-block and double-block anode. It can decrease the voltage drop, consumption of anode block and increase the running rate of Anode rodding shop when the single-block anode is used.

Keywords：Structure, Pre-baked anode assembly, 430 Aluminium pot.

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The Roll of Bauxite and Alumina in Iran's Primary Aluminium Business

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Abstract

Aluminium industry has found its place in Iran, a country with huge reserves of natural gas, a reliable source for primary aluminium production as the most energy-intensive industry based on per tonne of the production and the big volume produced globally, around 58 million tonnes per year (2015). Nevertheless, the low availability and quality of Iran's local bauxite reserves as the main mineral ore for primary production of aluminium has always been a cause for concern for this section's development decision-makers. Iran regional climatic characteristics are not considered appropriate to bear high-quality sufficient bauxite resources for being processed viably and economically into alumina, a white powder extracted from bauxite in refineries and fed into aluminium smelting reduction pots directly. In the current paper, this challenge with bauxite is more explicitly explained to see its real impression on Iranian primary aluminium industry and the future development projects considering the country's 2025 Vision plan to rise the current 487-ktonne primary metal capacity to 1500 ktonnes, more than three times of augmentation. IMIDRO

as Iran's biggest mining and mineral industries state holding organization and as the body in charge of capital-intensive industries development, like aluminium smelters with more than 1 billion dollars of investment, has defined solutions for the aluminium industry raw mateprials' supply. In this paper, it will be discussed why today's aluminium smelting development is not anymore dependant on proximity to bauxite mines. Furthermore, the change in the aluminium business structure globally since 40 years ago till now has been investigated from bauxite and alumina perspective and the repercussions of such an evolution on Iranian aluminium industry as well as our future development plans are being explained.

Keywords: Primary aluminium; Bauxite; Alumina refinery; IMIDRO

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Improve the Performance of Bag Filter on Preheating and Calculate the Amount of Fine and Heat Transferred (Case Study: Almahdi-Hormozal Alminium Smelter)

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Abstract

The project has been tried that bag filter "J" performance improve on pre-heated in unit green anodes and Redirection can prevent the frequent stoppages. The difficulties is intensifying in Bandar Abbas climatic conditions (high humidity).For better efficiency production of the Anodes Green, anode unit should be production continuous otherwise , Batch production will be prevented from standard anode production. Non-discharge of bag filter j is one of the constraints in the production. This bagfilter suck Fine and fumes caused by the pre-heating equipment But because of high pah and high humidity environment, the output is stuck and stopping production.

Keywords: Bagfilter; Pre-heating; Pitch vapour treatment; Green anode production

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Qualitative Investigation of Petroleum Coke Production Condition

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Abstract

Petroleum coke is produced by thermal cracking of vacuum distillation residue is in the form of raw and calcined coke. Most of calcined coke consumed in aluminium industry. Feed properties such as conradson carbon residue and operating conditions such as pressure and temperature is affected the quality and quantity of petroleum cokes. In this paper, one of the Iranian refinery vacuum distillation residue was performed under delayed coking conditions in the pressures of 1 and 4 bar and temperatures of 420$_o$C and 520$_o$C to investigate the effect of operating conditions on the yield and sulfur content of coke. Increasing the reaction temperature at a given reaction pressure led to decrease the yield and sulfur content of coke. Increasing the reaction pressure at a given reaction temperature led to higher yields of coke and as well as a decrease in the sulfur content of coke. So, the high pressure and optimum temperature will be good to production of petroleum cokes.

Keywords: Petroleum Coke; Aluminium; Delayed Coking; Operating Condition; Calcined Coke

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Fives, a Global Technology Provider in the Carbon Sector

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Abstract

This paper will highlight Fives' latest solutions for modern Anode Rodding Shops and Bath Processing Plants. With considerable experience in industrial engineering and project management, Fives proposes ultimate solutions for the aluminium industry from equipment supply to full EPC. In the Carbon Sector, Green Anode plants, anode handling, Firing & Control Systems, Fume Treatment Centers on Anode Baking furnace, Furnace Tending Assembly and Anode Rodding Shops are part of Fives 'expertise.

Keywords: Carbon; Rodding; Recycling; Bath; Grinding

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Fives' Sustainable Solutions to Reduce Emissions in the Reduction Sector

Bassam Hureiki, Philippe Martineau, Jean-Nicolas Maltais, Vincent Vérin, Mathieu Frainais, Alain Periers, Antoine de Gromard, Chin. Lim, G. Dobra, M. Cilianu

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Abstract

This paper will highlight Fives' most valuable solutions for treating pot gas and potroom emissions. With considerable experience in industrial engineering and project management, Fives proposes ultimate solutions for the aluminium industry from equipment supply to full EPC. In the Reduction Sector, Gas Treatment Centers, Pot Tending Machines, potroom cranes and various pot equipment are parts of Fives 'expertise. Today, in the electrolysis building of modern aluminium smelters, pot gas emissions are very efficiently treated by the latest generation of dry scrubbing technologies such as Ozeos, with rates close to 99.8%. But stack emissions only represent a very small amount of the total Fluorides emitted. Indeed, HF is mostly originated from potrooms where in many smelters no specific treatment is provided to limit pollutants. Fives proposes also solutions to eliminate emissions coming from open pots thanks to its boosted suction systems, Yprios, and from anode butts stored in potroom thanks to an Anode Inert Tray which confines butts.

Keywords: GTC; Ozeos; Fluorides emission; Boosted suction; Dual suction; Anode butts

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The Impact Coke Granulation on Pitch Consumption on Carbon Anode

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Abstract

All aluminium smelters use carbon anode in their electrolysis cells. Anode is a good electrical conductor. The granulation of coke plays signification role in anode structure. Most of the smelters classify the granulation of coke as follow:

Coarse 2- medium 3- inter medium 4- fine

H.S.P coal tar pitch use as binder of coke particles. Above classifications have special impacts on pitch consumption optimization of pitch consumption (financially& quality) is one of aluminium smelter challenge.

This article is to explain about impact of dimension of coke particle on pitch consumption rate.

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The Impact of Butts on Density of Green Anode and Pitch Consumption Rate

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Abstract

A prebaked anode is made from mixture of petroleum coke, coal tar pitch and butts, it act as positive pole in reduction cells. An anode butts is the rest of the used anode (residual anode) removed from the cells during the anode changing. The butts content in the new anodes can be varied but normally it is between 15% and 25%. Smelters reused butts due to economic & quality aspect. Butts converted to coke have different characteristics such as chemical & density which has impact on pitch consumption, density of anode. For optimization of consumable pitch suitable for reused butts in anode, the amount of the pitch must be modified.

This article reviews the impact of butts on consumption of pitch and green anode density.

Keywords: Coke; Anode quality; Optimization; Pitch consumption; Anode density

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Increasing Aluminium Production Purity in Reduction Cells

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Abstract

Aluminium is extracted from alumina through an electrolytic reduction process. The purity of raw materials are crucial and effective on purity of reduction cells. The main raw material for aluminium production is as follow:

Alumina, anode, cryolite , aluminium fluoride , additives and modifiers. Typically the purity of aluminium production in reduction cells in aluminium metal, the impurity of Fe 0.09% and Si 0.04% is visible. By performing simple equation we can see the impurity of metal is higher than raw material impurity in the process. As result, the impurities from other sources are most effective in the quality of the metal. This article is studied the ways of impurities in pot and the ways of controlling them.

Keywords: Max purity of raw materials; Reduction process; Aluminium production purity; Additives

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Preheating Anodes without Consumption Energy in Aluminium Reduction Cell

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Abstract

Anode breakage in the cell is usually either from “thermal shock” as the anode is set, or late Rota (i.e. anode cycle) cracking. The large carbon pieces that fall into the cell from anode breakage Create major problems: they are hazardous to remove, but if not removed, spikes can form if anodes are set on the carbon pieces, and they degrade over time in the cell to form dust. Appling anode in cold weather, waste many energy and makes some problems for the reduction cells .For saving energy and preheating anode without energy, there is method which this article is to explain about. For this purpose applied a new method which in that, is measured the difference temperature between the anodes (new anode and anode butts) by thermovison (IR-Thermometer) at all levels of anode In 3 stages and compare their temperatures

Keyword: Preheating anode; Saving energy; Aluminium reduction cells; Fluctuations of pot setting anodes

Simulation and Automation

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The Cost-Benefit Analysis of AlPSim and Two other Project for Optimization Consumption Energy (Almahdi Hormozal Aluiminium smelter Case Study)

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[3,4]*Almahdi-Hormozal Aluminium Smelter, Bandar abass, P.O. Box:79171-7-6385, Iran*

Abstract

AlPSim is a Simulating model which is used for calculation of aluminium electrolysis properties (same as Electrical Conductivity, Electrolyte Viscosity, Electrolyte Density, Aluminium Density, Max Alumina Solubility in Electrolyte, Max aluminium Solubility in Electrolyte and Liquids Temperature) in order to optimize operational parameter in aluminium production systems. And the other project 3-D thermo-electrical model for an aluminium reduction cell is developed and the effect of operational parameters on the thermo-electrical characteristics of the cell is studied. And to another project Due to the need to collect daily data from pots, the design and construction of Vm (and Thermocouple) with high accuracy is proposed. The purpose of this study is to propose a Plans of Management Energy In the aluminium industry, and explore the possibility of the project is financially. In this paper the construction period of a year, a 16 percent discount rate, net present value and rate of return on plan net Internal. According to the results based on costs and revenues, this plan is quite justified financially.

Keywords: Aluminium smelter; Optimization Consumption energy; The Cost-Benefit Analysis

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The Cost-Benefit Analysis of Implementing Level3 Automation and Two Other Project for Optimization Consumption energy (Almahdi Hormozal Aluiminium smelter Case Study)

Maryam Gobadi[1], Alireza Naseri[2], Borzu Bahrvand[3], Mohsen Ameri Siahooei[4]

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Abstract

First project sample Standard Level3 Automation implementation for improvement an Aluminium factory and the second project we will present an attempt which was made in order to retrofit a so-called center break cell to point feeder cell. The results show that this project has decreased the energy consumption and anode effect frequency. Furthermore, there has been a significant increase in current efficiency. The purpose of this study is to propose a Plans of Management Energy In the aluminium industry, and explore the possibility of the project is financially. In this study the construction period of a year, a 16 percent discount rate, net present value and rate of return on plan net Internal. According to the results based on costs and revenues, this plan is quite justified financially.

Keywords: Aluminium smelter; Optimization Consumption energy; The Cost-Benefit Analysis

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Simulation of Aluminium Ingot Pot by Neural Network for Temperature Control

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Abstract

One of the difficulties of aluminium ingot pots is its temperature control. Due to the fact that several factors influence the operation and the temperature of the pot, it's very difficult to analyse it with mathematic functions. This article attempts to simulate an aluminium ingot pot by neural networks and control its temperature according to environmental parameters. In this process, first, pot's input data like aluminium fluoride, voltage, abdomen size and … are gathered in various work shifts and simulated by radius networks and the results are compared with a view of error, training speed, amount of training, and etc. This article can determine the measure of influence of each output in the parameter of temperature and present the anticipated temperature for different inputs while doing this experimentally take a lot of time and is expensive.

Keywords: Neural networks; Aluminium pot; Radius networks; Training theory; Modelling

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Green Aluminium Extrusions - Breakthrough Development in Sustainability from UAE to the World

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2 Assistant Division Head, Gulf Extrusions, Dubai
3 Business Development Manager, Gulf Extrusions, Dubai

Abstract

In this paper we would like to showcase our journey with Masdar Green City, Abu Dhabi UAE, where we embarked together to actively develop sustainable building materials and processes which considerably reduce the total carbon footprint and provide a replicable commercial resource. We will show in the paper how we worked with the Supply Chain team of Masdar to analyze the entire product life cycle of aluminium extrusions in particular. This involved extensive studies on where carbon savings can be made, analysis of more efficient production processes, logistic plans, producing locally wherever possible and by introducing more recycled material and renewable energy into the production process. The objective was clear - to find a sustainable material of choice which will have low carbon emissions and less embodied energy consumed for production. But, the Middle East region poised a very interesting challenge for us to embark on this journey - Low energy costs which supported extraction and production of aluminium in the region and lack of available aluminium scrap segregation centres to secure post-consumer/end of life aluminium. In this abstract, we would like to showcase the process, supply chain strategy, alloy strength study of recycled aluminium and the meticulous steps taken by our Research team to identify the right production strategy for green aluminium extrusions. Furthermore, we would like to highlight the life cycle analysis study we conducted using third party agency to verify the methodology used by us and validate the efforts put into developing green aluminium extrusions.

Keywords: Green aluminium extrusions; Post-consumer recycled aluminium; CO_2 Emissions

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Innovative Product Design - Twisted Aluminium Profile at KAIA Airport Saudi Arabia

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2 Laboratory Manager, Gulf Extrusions, Dubai
3 Business Development Manager, Gulf Extrusions, Dubai

ABSTRACT

International Airport, Jeddah, Kingdom of Saudi Arabia is one of the most prestigious projects in the Middle East and is known for its unique design and innovative 2 km façade. The façade was designed to meet the climatic nature of the region. It is designed to be energy efficient and is targeting to achieve LEED Gold status. The façade was designed to accommodate harsh conditions such as – heat, dust, sandstorms, absence of rain, cleaning. The facade system was intelligently designed with an incorporated façade maintenance system. The architect of the project wanted to incorporate a 'twisted' rain screen façade in order to serve as a protection from the harsh dusty weather conditions and provide shading for ambient internal thermal comfort ability. The challenge however was to find a supplier who can provide 60₀ twisted aluminium section and also needed to be PVDF coated. After many exhaustive searches conducted by the contractor and architect, the challenge was finally poised to Gulf Extrusions. Gulf Extrusions studied this challenge carefully, designed a special extrusion and a machine to achieve this almost impossible feat.

The key challenges were:

1. Design, Extrusion and Fabrication of Twisted profile

2. Required twisting of 430 mm wide and 6m long Aluminium profile from 0 degrees to 60 degrees in a consistent pattern.

In this paper we will share our systematic planning and challenges faced for this special project. We will present a detailed walk through of this project from choosing the right Al alloy, countering the spring effect of Aluminium extrusions to developing a bespoke machine for twisting the profile to a tune of 60 degrees and finally conducting a special PVDF finish to the profile.

Keywords: twisted façade, rain screen, LEED Gold, smart ribs.The King Abdul Aziz

Proceedings of Iran International Aluminium Conference (IIAC2016)
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A Study of Plastic Deformation Behavior of AA1050 Aluminium Alloy during Pure Shear Extrusion with Back Pressure

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3 Department of Materials Science and Engineering, Golpayegan University of Technology

Abstract

In the present study, the effect of back pressure on the filling fraction of dies during pure shear extrusion, a novel severe plastic deformation process, is investigated by finite element analysis. The applied load predicted by simulation during the pure shear extrusion process is verified and a good agreement between the predicted results at a Coulomb friction factor of 0.12 and experiments is found. Next, various amounts of back pressure are applied to a plunger at the exit channel of the dies, and their influence on the filling fraction of the die are studied.

Keywords: Pure shear extrusion; Finite element method; Back pressure; Aluminium

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The effect of porosity and pore shape on the mechanical properties Of Nanoporous Aluminium Single Crystal, Using molecular dynamics simulations

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Abstract

In this research, the effect of porosity and pore shape on mechanical behaviour Of nanoporous aluminium single crystal (open and close cell) were studied. In fact, by combining molecular dynamics simulations with house codes, the mechanical behaviour of the foams were measured. The results showed that by increasing the porosity, the Young's modulus, yield strength and ultimate tensile strength were decreased. Also by changing the pore shape from spherical to cylindrical Young's modulus, yield strength and ultimate tensile strength were decreased with fixed relative mass density. Also, the results indicated that the nanoporous deformation was accompanied by nucleation and growth of cracks near the void surface along the loading.

Keywords: Nanoporous Aluminium; mechanical properties; molecular dynamics simulations

Powder Metallurgy

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Preparation and Characterization of Al- 4.5 Mg Alloy by Mechanical Alloying

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Abstract

An aluminium alloy composition corresponding to Al-4.5Mg-0.5Mn was prepared by powder metallurgy route and mechanical alloying. The powder mixture was subjected to high energy ball milling at constant milling speed and constant ball to powder ratio of 20:1, but varying milling time for 5-20 hours. Effect of milling time on particle size, morphology, lattice parameter, and crystallite size and lattice strain were studied by using scanning electron microscope and X-Ray diffraction patterns. It was found that magnesium completely dissolved in aluminium matrix after 20 hour milling and the crystallite size reduced to 16.8 nm.

Keywords: Mechanical Alloying; Al-Mg alloy; Milling time; Crystallite size

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Investigation of the Optimum Ratio of Raw Material Stoichiometry to Produce Fe-TiC/Al_2O_3 Composite

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Abstract

Ilmenite, aluminium and graphite can be used to produce in-situ Al_2O_3/TiC–Fe composites. Al_2O_3/TiC-Fe composites are used as cutting tools for machining gray cast iron and steels. Very few publications can be found in the literature that discuss the effect of molar ratio of aluminium and graphite in foresaid system. Therefore, the present research is designed to determine the effect of aluminium and graphite molar ratio in the raw materials. In addition, optimum ratio of raw material stoichiometry will be discussed here.

In this research, the milled and pressed samples, from synthesized ilmenite, aluminium and graphite powder mixture with different molar ratios were prepared. Then, the samples were heat treated at 1300°C. The final products were analyzed with XRD and SEM. It was found that the optimum molar ratio of ilmenite, aluminium and graphite mixture is 1:2:1 which leads to the desired product of Al_2O_3/TiC-Fe composite. Increasing the amount of aluminium causes the $TiAl_3$ formation. Insufficient proportion of the aluminium also doesn't allow the reactions to be completed. In comparison with the optimum stoichiometry ratio of 1:2:1, using more graphite, leads to form the Fe-C compounds while less amount of graphite, causes incomplete reactions.

Keywords: Ilmenite; Aluminium and Graphite; Fe-TiC/Al_2O_3 composites; Molar ratio

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The Effect of Aluminium on the Structure and Electrochemical Performance of Li $Ni_{0.5}Mn_{0.3}CO_{0.2}O_2$ Positive Electrode Materials for Li-Ion Batteries

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3 School of Chemical Engineering, Malekashtar University of Tehran, Lavizan, Tehran, Iran

Abstract

Single phase Li $Ni_{0.5}Mn_{0.3}Co_{0.2}O_2$ ($0 \leq x \leq 0.2$) compounds were prepared via acid citric-nitrate combustion method and investigated the effect of substitution of aluminium for cobalt on the structural and electrochemical properties. The structural evolution was assessed by thermo gravimetric analysis/simultaneous differential thermal analysis, X-ray diffraction and scanning electron microscopy experiments. The electrochemical performance was evaluated by analyzing the charge/discharge profiles, cycling stability and rate-capability performances. The cycling stability and rate-capability performance of aluminium bearing materials were superior to the parent material. Partial replacement of aluminium leads to structural changes that affect electrochemical performance. The improved electrochemical behavior is closely connected to the stabilization of the layered structure and the reduction of the cation mixing after metal substitution.

Keywords: Aluminium; Cathode material; Li-ion batteries; Electrochemical erformance

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Metallurgical and Structural Characterization of Novel Al/ β-Al_3Mg_2 Nanocomposite Synthesized via Powder Metallurgy

Morteza Ghadimi, Mohammad Ali Sourani, Mehdi Vanda

Young Researchers and Elites Club, Science and Research Branch, Islamic Azad University, Tehran, Iran,

Abstract

Complex metallic alloys (CMAs) are new possible candidates for reinforcing agents with excellent technological potential. The β-Al_3Mg_2 belongs to this new category of intermetallics. β-Al_3Mg_2 nano particles were synthesized by mechanical milling (MM) of Pre-alloyed CMA intermetallic ingot in attritor ball mill. Then different amount of CMAs nanoparticles varied from 0 to 20% (by weight) were added to Aluminium matrix powder. Consolidated samples were prepared by hot pressing of blended composite powder. Phase and Microstructural characterization were performed applying X-ray diffractometer (XRD), optical microscope (OM) and scanning electron microscope (SEM) equipped with energy dispersive X-ray (EDX). The results confirmed the formation of uniform distributed reinforcement in nanocomposites with finer microstructure by addition of CMA reinforcement.

Keywords: Nanocomposite; Al/ β-Al_3Mg_2; Powder Metallurgy; Mechanical Alloying

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The Effect of Process Parameters on the Combustion Synthesis of Ti-Al/TiC Composite Materials

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Abstract

The synthesis of titanium aluminide/titanium carbide composite via the thermal explosion mode of combustion synthesis was studied. Powder mixtures of Ti+Al/Ti+C were pressed to form cylindrical preforms. The samples were heated with a high heating rate in a tube furnace. The occurrence of highly exothermic reactions between Ti and Al as well as Ti and C resulted in the formation of a matrix of titanium aluminides with dispersed particles of TiC. The product was characterized by performing analyses such as XRD and SEM. The effect of Ti+Al:Ti+C ratio on the process behavior was investigated.

Keywords: TiAl/TiC composite; Combustion Synthesis; Thermal Explosion

Miscellaneous

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The Effect of Inferior and Superior Aluminium Industries on the Economy of Iran (Case Stud: Kaveh Khuzestan Aluminium)

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CEO Kaveh Khuzestan Aluminium

Abstract

One of the principles of economics is the optimal allocation of limited resources. Thus, in less developed regions that we are facing a shortage of production facilities; unbalanced growth strategy should be defined and applied. The first step in the development of this strategy is to identify priority sectors and activities in the area. Aluminium industry as a strategic industry in the country lies in the Group of Production of Basic Metals based on ISIC categorization. The group has about 23% of the value added in the country's industry section. Using the Input-Output table, this paper attempts to evaluate the importance of aluminium industry in the superior and inferior industries and the impact it can have on the economic growth in the country, particularly in the deprived area of Masjid Soleiman.

Keywords: Aluminium industry; Input-output table; Economic growth; Kaveh Khuzestan Aluminium

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Investigation of gallium extraction from Bayer solution using Strongly Basic Anionic Exchange Resins

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Abstract

In the present study, the extraction of gallium from Bayer solution containing 164.90 g/l of Na2O, 86.70 g/l of Al2O3 and 105 ppm of gallium was investigated using strongly basic anionic exchange resins such as Dowex 21k XLT, Varian AP and Amberlite IRA-410 in a continuous process under conditions of ambient temperature, 2g resin in 100ml of Bayer solution and contact time of 130 min. The amounts of gallium adsorbed on Dowex 21k, Varian AP and Amberlite IRA-410 resins were 98(93.33%), 90(85.7%) and 65(61.9%) ppm, respectively. It has been concluded that the gallium adsorption capacity and its kinetics by Dowex 21k were higher than that of two other resins. The adsorption capacity of Dowex 21k resin for gallium was obtained 30.5 mg per gram of resin which is roughly equal to that of chelating resins (31 mg gallium per gram of resin).

Keywords: Gallium; Bayer solution; Anionic exchange resins

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Breakthrough Sustainable Innovation: the Journey behind the Development of 90 Minute Fire Rated Door

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ABSTRACT

Globally around 6 million people get seriously injured in fire accidents per annum and over 500,000 die. Approximately, 80- 85% of deaths are mainly due to smoke inhalation and not by burns. The smoke kills faster than fire. Studies from recent fire incidents have shown than 57 % of people killed in fires are not even in the room of the fire's origin. There has also been an increase in the fire incidents in the GCC region where the entire façade had been burnt down. We had to address this problem and decided to engineer a solution which can be sustainable, locally available and easily sourced. The challenges were obvious, Aluminium is conventionally understood as a metal which deforms at about 600 degrees Celsius and the air temperature during a fire can go up to 900 degrees Celsius in a room. However Aluminium has significant properties such as lightweight, recyclable and high strength to weight ratio. These properties cannot be achievable in any other metal. So we had to design a system which had to be innovative and had to maintain the integrity for at least a 60 minutes. In the paper, we would like to show how we had to maintain the integrity of the door in such blazing temperatures of 900 degrees Celsius by designing two special barriers – internal and external. Both needed to be highly insulated in order to prevent the heat and smoke to transfer from inside to outside. The design had to function as an entire system and maintain its integrity for more than one hour under conditions of extreme fire and smoke. Further in the paper, we would like to explain the process we went through in conducting the fire test and the results which had come through as per the British EN Standards. The system eventually passed a fire rating of 90 minutes flawlessly. This is indeed a breakthrough development as now we are able to present aluminium door as a sustainable fire rated material of choice and replace the use of non-sustainable fire rated material such as stainless steel and wood.

Keywords: Fire insulation; External barrier; Internal barrier; Integrity; Insulation

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A Review on Recent Advances on Aluminium for Automotive Applications Focusing on Passenger Cars

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Abstract

Aluminium is remarkable for its low density, relatively low cost, light weight and high ability to resist corrosion. This material has many applications in industries. One of the common application of this material is in automotive industry. Recent development and advanced use of aluminium in passenger cars, focusing on 5xxx and 6xxx aluminium alloys has been discussed in the present paper. 5xxx and 6xxx aluminium alloys are characterized by their high strength and good formability, resulting in a mass reduction and improved crash worthiness.

Keywords: Super-light-car; Aluminium; Automotive; Alloy

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Identify the Challenges of Risk of Investing in the Aluminium Industry's Supply Chain Performance after the End of International Sanctions

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Abstract

After the end of international sanctions and exit from the recession and investment growth, an opportunity is created to apply a comprehensive and strategic program in the aluminium industry flourished. The elegance of all opportunities must be exploited to the best results were available. One of the main uses of the correct functioning of the supply chain. A supply chain includes all processes that directly or indirectly, to meet the demands of all its customers. Supply chain logistics network covers all issues, including suppliers, manufacturing centers, warehouses, distribution centers, retail market of raw materials and products as well as the final. All these things are interrelated hierarchy and importance than any other gender so that override any of which could lead to the risk. In this study, the criteria for determining the risk of supply chain also checked the effect of each other. The end of sanctions against Iran Aluminium Company (Iralco) in the supply of raw materials needed and create an opportunity to start billet export their production to other countries, we can create new opportunities for the growth of foreign investment and the potential risks will also be managed. Some of the highlights include external events and non-controllable risks, natural disasters, extreme changes in demand and it is recommended that the aluminium industry's senior managers should focus on ways to control these risks.

Keywords: Aluminium industry; Strategic program; Supply Chain; Investment growth

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The Continuous Development of SAMI's Alumina Technology and Equipment

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Abstract

SAMI of Chalieco has a long history, dedicated to alumina system technology and key equipment research and development. SAMI of Chalieco has different process schemes for different source of aluminium containing raw materials, also can provide solutions to the whole process of construction, expansion, optimization, the design or construction of the alumina plant with advanced technology, process simplification, excellent index, has a strong competitive advantage, SAMI of Chalieco is a trusted provider of alumina technology and equipment.

Keywords: SAMI of Chalieco; Alumina; Single line capacity; ϕ 16m precipitator; 3500t/d calciner

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Development and Application of SY Pot Technology in the Last 30 Years

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Abstract

In this paper SY pot technology is summarized on its development and application. SAMI of Chalieco did innovative solutions to improve pot stability based on advanced models, industrial trial platforms and energy saving technologies. SY pot technology is the dominant for high amperage pot technologies in China and is also adopted by abroad owners. Automatic control technology and dry scrubbing technology are also presented.

Keywords: SY pot technology; Energy-saving; Pot control; MES; Dry scrubbing.

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The Research and Application of Calcination Technology for the Vertical Shaft Furnace

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Abstract

The calcination technology for the vertical shaft furnace was developed and applied in plant successfully to adapt the change market. The new construction was designed by simulation optimizing; the special new brick for resisting sulphur corrosion was invented, and its capacity of resisting sulphur is three times than the common brick; the manual operation was replaced by automatic combustion control system, which make it come sure that the vertical shaft furnace is operated automatically. The residual heat utilization can achieve 1.2 ton steam per ton CPC or generate 220-260kWh per ton CPC, which is 1.5 times than the average level in whole industry. The efficiency of desulfurizing is above 95%, and the efficiency of dedust is more than 85%. The comprehensive technology is widely applied, and proved that it is friendly to environment and highly automatic, and is the first choice for production quality, investment and operation.

Keywords: Vertical shaft furnace; Simulation optimization; CPC quality control technology; Automatic control system; Resisting sulphur corrosion new brick

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Current Situation and Development Trend of China's Aluminium Fabrication Industry

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Abstract

The paper describes the current production capacity, product output and export amount of China's aluminium fabrication industry, and gives introduction to famous domestic enterprises for different product. In accordance with the industry development of China-Made passenger airplane, automobile, rail train and others, analysis is made for the development trend of China's aluminium fabrication industry.

Keywords: Aluminium fabrication industry; Product output; Aerospace application; ABS; High strength profile

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China's Technology and Equipment for Aluminium Plate/Strip/Foil Production

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Abstract

The paper introduces the production technology of China's aluminium fabrication industry, and gives the analysis on comparison of hot rolling process and continuous casting process. Accompanied with the rapid development of China's aluminium fabrication industry, a number of China-Made rolling facilities for aluminium plate/strip/foil production are designed and manufactured by ourselves. Among these, CHALIECO-CNPT's equipment is widely applied in global aluminium flat rolling industry with advantages of standout property, reliable quality and competitive price.

Keywords: Hot rolling mill; Continuous caster; Cold rolling mill; Foil rolling mill; Core technology

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Strong Winds of Growth for the Aluminium Industry in India

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Abstract

Production of primary aluminium in India crossed the 2.0 million tonne mark in 2014 and the demand has been growing at a healthy pace over the last decade. With the Indian economy forecast to expand at 7 to 7.5% per annum over the next five years, the prospects for the aluminium industry in India are promising. End use sectors that are likely to expand rapidly include transportation, building & construction, packaging and electrical sectors. Several new applications have emerged over the last decade and there is a much higher degree of product sophistication in the user segments. Recycling rates have to improve significantly in India with formal scrap collection systems and regulations that need to be put in place by the Government. Export of aluminium downstream products from India has picked up well and the country is well poised, from the skill and cost perspectives, to take advantage of the export market opportunities.

Keywords: Aluminium; India; Electrical & electronics; Transportation; Building & construction; Packaging; Wire rods; Flat rolled products (FRP); Extrusions; Castings; Recycled aluminium

Recycling

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Recycling of Aluminium Alloy ADC12 Turning Chips via Mechanical Stirrer

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Abstract

Recycling of the aluminium is considered to be a sustainable process, as it requires significantly less energy than extracting mined bauxite ore from its natural resources. Aluminium chips collected from machining operations are specifically suitable for this process, as their high surface area to weight ratio allows for more rapid oxidation and increases the value of the recycling.

In the present study, recyclability of aluminium alloy ADC12 which is commonly used in die-casting industry, has been experimentally investigated using a mechanical stirrer in molten aluminium method. The implemented mechanical stirrer included a motor, a gearbox, and two plates for generating turbulence in molten aluminium and the aluminium chips were added to the melt during stirring process. The efficiency of the recycling has been measured by calculating the percent of weight loss. Also, the chemical composition of the samples were compared with the reference one that was obtained from melting.

The results showed that the proposed method is able to recycle up to 94 percent of the Chips and to recover all of the main elements. Also the achieved mechanical properties of the recycled aluminium were shown to be very to those of the aluminium ADC12 alloy ingot

Keywords: Aluminium chips; Recycling; Mechanical stirrer; Melting; Die casting

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Recovery of High Pure Alumina from Aluminium Hazardous Waste Using Facile and Inexpensive Method

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Abstract

To avoid environmental problems and to recovery the aluminium, a processing method was developed and aluminium was recovered as an added value product such as alumina from hazardous aluminium solid waste (HAW) as raw material. Different methods were performed to get high purity of alumina in an inexpensive way in order to being useful for industrial scales. All methods refer to a process at relatively low temperature, in more stages: acid or base leaching, purification, precipitation and calcination. At the end of this process aluminium was extracted, first as Al^{3+} soluble ions and final as alumina product. The composition of the aluminium dross and alumina powder was measured by using Energy-dispersive X-ray spectroscopy (EDX). The method presented in this work allows the use of hazardous aluminium solid waste as raw material to recover an important fraction from soluble aluminium content as an added value product, alumina, with high grade purity (99.5%).

Keywords: Alumina; Hazardous Aluminium Solid Waste; Acid Leaching

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The State-of-the-Art and Development of Sidewall Materials for Al Reduction Cells in China

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Abstract

The type of sidewall materials for Al reduction cells, manufacture, material properties, key performance, the application as well as research hotspots were introduced in the paper. From author's point of view, integral sidewall with a combination of Si3N4-SiC block and carbon block will be the main application in Al reduction cell in China, in the meantime, the research on long service-life Si3N4-SiC based insulating sidewall is an important task towards energy-saving Al reduction cells at current stage in China.

Keywords: Aluminium reduction cells; Sidewall materials; Si_3N_4-bonded SiC material