In the Name of God

Abstract book of

Iran International Aluminium Conference

15-16 May 2012
Arak, Iran

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Prof. Mohammad Reza Aboutalebi

Scientific chairman
Dr. Mansour Soltanieh
Preface

Following the successful Iran International Conference of aluminum (IIAC) held in 2009, it is our great pleasure to welcome you on behalf of the organizing committee to IIAC 2012. This is the second triennial conference in IIAC series which are jointly organized by Iranian Aluminum Research Centre at IUST and Iranian Mines and Mineral Industries Development & Renovation Organization (IMIDRO). This event is held in Arak City in Central Province in which the Iran Aluminum Company (IRALCO) was established as the first primary aluminum producer in the Middle East. Keynote lectures are dedicated to general problems of aluminum industry. The contributed papers (oral and poster presentations) which form the major part of the conference program are organized into 10 sessions, and are intended to include innovative and application-driven topics in the following fields:

- Casting and solidification
- Corrosion and surface technology
- Heat treatment
- Welding and joining
- Metal working and mechanical properties
- Advanced materials
- Smelting, Reduction and synthesis
- Economics and Energy

The Program includes about 39 presentations from different countries such as China, Australia, Ireland, New Zealand, Turkey, Italy, Germany, Ghana, and Nigeria as well as Iran. The conference will be accompanied by an industrial exhibition of products and technologies.

Our objective is to make IIAC 2012 a place where academics, researchers and experts from related industries gather to present their latest achievements, update their information and scientific knowledge, and look for opportunities to collaborate on various topics.

We would like to express our sincere gratitude to all the participants, the members of the organizing and scientific committee, the keynote speakers, various sponsors particularly IRALCO, the main contributor, for their valuable times and efforts for this conference. We wish you a very pleasant, interesting and fruitful time throughout the conference.

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CASTING
Grain Refining Aluminium Foundry Alloys

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Abstract

Grain refinement of aluminium alloys avoids hot tearing and porosity, allows a marked increase in casting speed and imparts to a casting high toughness, high yield strength, excellent formability, good surface finish and improved machinability. Master alloys are added to molten aluminum in order to achieve fine, equiaxed grains after solidification, which otherwise tend to be coarse and columnar. At present, there is a variety of grain refiners from the Al-Ti-B ternary system, AlTi5B1 being the most popular. Al-Ti-B grain refiners, which are indispensable for wrought alloys, fail to perform as well with aluminium foundry alloys. The latter contain substantial levels of Si to improve castability. Si, however, reacts with Ti to form Ti-Si binary phases and impairs the grain refinement efficiency. The grains of the Ti-free aluminium foundry alloys are very small and nearly globular for the entire range of holding times when inoculated with B additions, implying not only a remarkable grain refining capacity but also a strong resistance to fading of the grain refinement effect. Aluminium castings can enjoy grain sizes well below 200 μm, with an addition of 0.02 wt% B, provided that their Ti content is controlled below 50 ppm.

Keywords: Casting; Aluminium Foundry Alloys; Grain Refinement
Effects of Zr on Grain Refinement, Microstructure and Tensile Properties of an Al–20Mg Alloy

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Abstract

In the present study, microstructure and tensile properties of an Al–20Mg alloy with Al-20Mg-xZr alloys were investigated and compared. As-cast microstructure analysis of Al-20Mg alloy contains the dendrites of primary α-phase solid solution within the eutectic matrix which consists of β-Al$_3$Mg$_2$ intermetallic and α solid solution phase. In order to produce Al-20Mg-xZr alloy, Zr added to the molten Al-20Mg alloy in form of Al-15Zr master alloy during the melting process. Scanning electron microscopy (SEM) and Energy Dispersive X-ray (EDX) analysis were utilized to study the microstructure and fracture surfaces of samples. The result indicates that adding Zr made significant raise in the Ultimate Tensile Strength (UTS) and elongation values of the alloy. These properties in Al-20Mg alloys prepared without using additives are 163 MPa (average) and 1.2%, respectively. However, an Al-20Mg-0.5Zr alloy showed the greatest values of 240 MPa and 1.75%, respectively. The main reason for the observed increase would be the reduction of Al (α) grain size and also the fragmentation of Al (α) interconnected coarse dendrites.

Keywords: Aluminium Alloys; Grain Refinement; Microstructure; Tensile properties; Zr
Effect of Ni on Microstructure and Hardness of Al-15%Mg$_2$Si Metal Matrix Composite

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Abstract

The excellent properties of Al-Mg$_2$Si composites can be seriously affected by the coarse Mg$_2$Si particles and brittle eutectic matrix. Undesired structure of the composite, specially the presence of large Mg$_2$Si particles in as-cast condition, will lead to undesirable characteristics of the composites. In this work effort was made to study the effect of Ni on microstructure and hardness of Al-15%Mg$_2$Si composite which was produced by an in-situ casting method. Microstructural studies were done by optical and scanning electron microscopy. The results showed that with increasing Ni content, Al-Mg$_2$Si binary eutectic structure gradually evolves into Al-Mg$_2$Si-NiAl$_3$ ternary eutectic. The addition of 0.1–5 wt% Ni to the composite also increased its hardness from 101 HB to 136 HB, which is equivalent to 35% enhancement in hardness results.

Keywords: Al-Mg$_2$Si Composite; Ni addition; Microstructure; Mechanical Properties
Effect of Nickel Coating on Steel Wire Reinforcement on Mechanical Properties of Aluminum Matrix Composites Produced via Lost Foam Casting

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Abstract

In this study, an aluminum alloy, A356, was reinforced with the interconnected, two-dimensional, steel wire preforms. Steel wires were coated with nickel by electroless deposition method. The composites were produced by lost foam casting process. Three different wire volume fractions were used (5.77, 10.90 and 17.66 percent). Hardness test and tension test were conducted on aluminum alloy and composite specimens, and the microstructure of the specimens was examined with optical and scanning electron microscopes. Micro structural characterization conducted on the composite samples showed good interfacial integrity. Hardness and strength of composites increased as compared to matrix alloy. The mechanical properties of these composites were measured and the results were correlated with the microstructure observation. It was found that nickel-coated steel wire reinforced composites show considerable improvement in strength with good ductility because nickel form a good interface between Al matrix and steel wire. Uncoated steel wire reinforced composites showed improvement in strength to a lower extent possibly because of formation of brittle intermetallic compound at the interface. Fracture surface of tensile specimen was examined under SEM. Nickel coating on steel wire improved the strength properties while retaining a high level of ductility due to better interface bonding.

Keywords: Aluminum Matrix Composite; Nickel Coating; Mechanical Properties; Lost Foam Casting; Steel Wires
The Effects of Oxide Film Characteristics on the Bubble Damage Defect in Al$_5$Mg and Al$_7$SiMg Alloys

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Abstract

There is a general agreement among the researchers that the surface oxide film of film forming alloy may have serious effects, on the soundness of castings, when they are entrained, as a result of surface turbulence. It has been suggested that the thickness of the surface oxide films is different alloys may varies an order of magnitude. In this work the effects of the surface oxide film thickness of two Al alloys, Al$_5$Mg and Al$_7$SiMg, and the velocity of molten metal, during mold filling, are reported. In order to investigate the effects these two variables, plates with thickness of 10 mm from Al$_5$Mg and Al$_7$SiMg alloys were cast, via a bottom-filling system, having the mold entry velocity of 0.5, 1, 1.5, 2, 2.5, and 3 m/s, respectively. The amount of entrapped bubbles was measured in the samples, using X-ray test. Then, three point bending test was carried out on plates. Finally, the fracture surface of samples was studied with electron microscope. Experiments showed that in the velocities higher than critical velocity (0.5 m/s), the amount of entrapped bubble is increasing while the volume percent of residual bubble in Al$_5$Mg alloy is 5 to 10 times more than Al$_7$SiMg alloy. The results show that there is, possibly, a connection between the thickness of surface oxide film and the quantity of bubble entrapment in the castings. Examining the fracture surface of samples indicate the presence of oxide films in residual bubble.

Keywords: Double Oxide Film; Bubble Damage; Critical Velocity; Bubble Entrapment.
Investigation of Grain Refining in Aluminum Casting Alloys by Thermal Analysis

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Abstract

Grain refinement plays a crucial role in improving the properties of cast and wrought aluminum alloys. Generally, the Al–Ti and Al–Ti–B master alloys are added to Al alloys for their grain refinements. Mechanism of grain refinement is of considerable controversy in the scientific literatures and has been the subject of intensive research. There is a common question for all producers of cast Al alloys of how can be sure about the nucleation quality. Thermal analysis is an important tool to answer this question. In this research, different types of the inoculants were used to investigate nucleation in A356 Al alloy. The cooling curve of each sample was recorded and with the help of a special computer program, the first derivative was calculated. By calculating the zero curve, and analyzing the cooling curve, it was possible to predict the nucleation quality and calculate the solid fractions, latent heats and other information. Results from this research showed that if the maximum under-cooling nucleation was approximately at 3.8 C, quality of the nucleation process becomes more reliable.

Keywords: Thermal Analysis; Grain Refining; Nucleation; A-356 Aluminum
Comparison of Microstructure and Mechanical Properties of A356 Aluminum Alloy/Al₂O₃ Composites Fabricated by Stir and Compo-Casting Processes

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Abstract

Metal-matrix composites (MMCs), as light and strong materials, are very attractive for application in different industries. In the present work, nano and micro composites (A356/Al₂O₃) with different weight percent of particles are fabricated by two melt techniques such as stir-casting and compo-casting. Microstructural characterization was investigated by Optical (OP) and Scanning Electron microscopy (SEM). Tensile, hardness and compression tests were carried out in order to identify mechanical properties of the composites. The results of microstructural study revealed uniform distribution, grain refinement and low porosity in micro and nano-composite specimens. The mechanical results showed that the addition of alumina (micro and nano) led to the improvement in yield strength, ultimate tensile strength, compression strength and hardness. It was indicated that type of fabrication process and particle size were the effective factors influencing on the mechanical properties. Decreasing alumina particle size and using compo-casting process obtained the best mechanical properties.

Keyword: A356/Al₂O₃ Composite; Mechanical Properties; Microstructure; Stir-Casting; Compo-casting.
Effects of the Addition of Sr Modifier and Al-5Ti-1B Grain Refiner and the Combined Addition on the Microstructure of Hypoeutectic Al-Si Alloys

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Abstract

Different grain refiners and modifiers have been used to improve the microstructure and mechanical properties of hypoeutectic Al-Si alloys. In this study the effect of Al-5Ti-1B grain refiner on the α-Al Phase has been discussed in this paper, which showed decrease in the size of α-Al grains; and the impact of Sr has been observed as the silicon modifier. Besides this the effect combine addition of Al-5Ti-1B grain refiner and Sr on the microstructure has been discussed in this paper. It has been observed that by increasing the level of grain refiner addition, a negative interaction took place between Al-5Ti-1B and Sr that had a negative impact on the microstructure.

Keywords: Hypoeutectic Al–Si Foundry Alloys; Eutectic Modification; Grain Refinement
Fabrication of Mg$_2$Si/Al In-Situ Composite in A Hyper-Eutectic Al-Si Alloy with Rheocasting Method

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Abstract

A hyper eutectic Al-Si alloy is known by its high wear and corrosion resistance and also low thermal expansion coefficient; hence, it used in the automotive industry. Those reasonable advantages are attributed to the primary silicon phase. Therefore, the primary phase morphology plays an important role on the mechanical properties of the final product. On the other hand, the attached coarse silicon primary phase impedes the achievement of significant mechanical properties. Some studies indicate that the addition of Mg element to Al-Si alloy makes the Si primary phase matrix weak and fragile. In this study Mg was added to an A390 hyper eutectic Al-Si alloy. Then, the melt was stirred at 256 and 512 rpm. Results show that a new Mg$_2$Si phase is produced in the melt and applying rheocasting methods makes both the Mg$_2$Si morphology and the primary Si phase finer and non-dendritic.

Keywords: Semi-Solid; In-Situ Composite; Rheocasting; Mg$_2$Si; Mechanical Stirring
Investigation of Ni Effect on the Microstructure and Tensile Properties of Al-12Zn-2.5Mg-2.5Cu Aluminum Alloy

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Abstract

In this study, the effect of Ni on the microstructure and tensile properties of Al-12Zn-2.5Mg-2.5Cu-0.05Ti aluminum alloy has been investigated. Microstructural examinations were conducted by optical and scanning electron microscopy, coupled with energy dispersive spectrometry. Microstructural studies showed that by adding Ni (from 0 to 5 wt. %) to the alloy, the volume fraction of precipitates increases. Also, increasing Ni content up to 3 wt. % showed an increase in ultimate tensile strength (UTS) values and marginal effect on ductility (% El.). The optimum amount of Ni was selected as 3 wt. %. SEM fractography of several fractured surfaces showed an overall brittle appearance with cracking along the grains.

Keywords: Aluminum Alloys; Casting; Microstructure; Fractography
Investigations on the Effects of Be and Li on the Microstructure and Tensile Properties of Al319 Alloy

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Abstract

In this work, the effects of Be and Li on the microstructure and tensile properties of Type 319 aluminium casting alloy containing 1wt.% Fe have been examined. An addition of Be and Li are able to decrease length of beta phase and improve tensile properties. Moreover Be changes the Fe compound from the β into the Chinese script α-Al8Fe2Si compound. But with comparison of tensile properties, it is concluded that Li is more effective element.

Keywords: Aluminium Alloy A319; Beta Phase; Tensile Properties; Modifying; Quality Index
Fading of Inoculant Particles in 8011 Aluminum Melt in a Twin Roll Casting Production Line

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Abstract

Fading of grain refiner particles and its role in refinement level in a Twin Roll Casting (TRC) production line has been investigated. An industrial grain refiner of Al-Ti-B was applied to the aluminum melt, at different addition rates. Then, samples from different points of line were taken. Two samples just before and after the filter were taken to evaluate effect of filter on refinement. Effect of agitation in line also investigated. The grain structures obtained, show coarsening grain structure by increasing sampling point distance from addition point (before degassing unit). Increasing addition rate leads to finer grain structure. Stirring has considerable influence on grains becoming finer and filter has inverse effect on refinement.

Keywords: Grain Refiner; Twin Roll Casting; Grain Structure
The Effect of Manganese and Cooling Rate on the Microstructure of Piston`s Alloy in the Excess Percentage of Iron

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Abstract

Adding of Fe to the alloy of piston for 0.7, 1.2 and 1.8% will create needle-like β intermetallic compounds and deteriorate mechanical properties. On the other hand, introduction of Sr and Mn will transform β intermetallic compounds to α in addition to modification of eutectic structure which can improve wear resistance and hardness. Results of this research have revealed that modification of the intermetallic compounds in the eutectic of Al-Si alloy by Mn (50% that of Fe) is possible just up to 1.2% of Fe. In contrast to previous expectation, the sample containing 1.8% Fe could not transform β intermetallics to α using 0.9% Mn. Increased rate of cooling from 3 to 15°C/s has decreased the eutectic structure and refined the intermetallic compounds.

Keywords: Al-Si Eutectic Alloy; Additional Iron; Manganese; Strontium; Cooling Rate
Refinement Effects of Strontium on Structure of Aluminium-10Magnesium (A520) Alloy

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Abstract

The effects of strontium on the macrostructure and microstructure of Al-10Mg alloy (A520) have been studied. In this work, different amounts of Sr have been used to study its effects on the grain size and microstructural evolution of the alloy. Microstructural data were assessed by the use of optical microscope, scanning electron microscope (SEM) and x-ray diffractometry (XRD). The results showed that the optimum amount of Sr as a grain refiner was 0.01 wt.%. The grain size of unrefined A520 alloy was reduced from 387 μm to 161 μm after adding Sr. Microstructural studies also showed that Sr changes the microstructural feature from dendritic to rosette-like morphology and reduces the measured dendrite arm space (DAS) value slightly. It is believed that Sr increases growth restriction factor (GRF) which results in grain size decrement.

Keywords: Al-10Mg Alloy; Grain Refiners; Microstructure; Grain Size.
Mechanical (Tensile, Hardness and Fatigue) Behavior of the Al-Al$_2$O$_3$ p Composites Fabricated by Stir Casting Method

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Abstract

Aluminum–alumina particulate composites are a class of metal matrix composites which have high strength-to-weight ratio and low density. The most important mechanical property in industries is the fatigue behaviour. Hence, it is important to know more about mechanical properties of these composites. In this study, composite samples containing of different weight percent of 1%, 2%, 3% Al$_2$O$_3$ particles in size of 20µm were fabricated by stir casting method, extruded by reduction area of 1:20 and heat treated by T6 condition. Microstructure of these composite materials was characterized by using scanning electron microscopy (SEM). Then Hardness, tensile and fatigue properties of these composites were investigated. It is observed that by increasing in weight percent of Al$_2$O$_3$, the hardness, tensile strength and fatigue strength more increased.

Keywords: Al-Al$_2$O$_3$ Composite; Hardness; Low Cycle Fatigue Properties; Microstructure; Tensile Strength.
Characterization the graded distribution of primary particles in A390 Alloy with Mg variable content fabricated by centrifugal casting

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Abstract

Three kind of functionally graded material tubes using Al-15Si alloys containing 0, 5 and 10wt% magnesium were prepared by centrifugal casting and their microstructure have been investigated. It is demonstrated that A390 alloy without Mg that reinforced with primary Si particles takes a characteristic of particles distribution both in the inner and outer layers. However Al alloy with 5wt% Mg reinforced with Si/Mg2Si particles had a different performance with particles distribution only in the inner layer. But alloy with 10wt% Mg had a performance as same as A390 alloy, whereas, it has an only primary Mg2Si as a reinforced particle in its microstructure.

Keyword: functionally graded material, A390 alloy, centrifugal casting.
Extruding of Al-Al₂O₃ Composites Fabricated by Stir-Casting Process

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Abstract

Aluminum matrix composites (AMCs) reinforced with Al₂O₃ particles are widely used for high performance applications such as automotive, military, aerospace and electricity industries because of their improved physical and mechanical properties. In this study, in order to improve the wettability and distribution of reinforcement particles within the matrix, a novel two step mixing method was used. The process included injection of particles within the molten aluminum by inert argon gas and stirring the melt at fixed speed. Different weight fractions of micro (3, 5 and 7 wt. %) alumina particles were injected by argon gas into the melt aluminum and stirred by a mechanical stirrer with a speed of 300 rpm. Then fabricated samples were extruded. The microstructure of the composite samples was investigated by Optical Microscopy (OM). Also, density, hardness, yield and Ultimate stress variations of micro composites were measured. The microstructure study results revealed that application of the injection and extrusion processes led to a uniform distribution of particles in the matrix. The density measurements showed that the amount of porosity in the composites increased with increasing weight fraction and speed of stirring and decreased by extrusion process. The hardness and tensile test results indicated that the hardness and strength of the composites increased with increasing weight fraction of particles and extrusion process.

Keywords: Al/Al₂O₃ Composite; Stir-Casting; Extrusion; Microstructure; Mechanical Properties.
METALWORKING AND
MECHANICAL PROPERTIES
Fabrication of Hybrid Composites of Aluminum/Alumina/Silicon Carbide by Accumulative Roll Bonding and Evaluation of their Microstructure and Mechanical Properties

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Abstract

A new kind of metal matrix composite with a matrix of pure aluminum (99.9%) and hybrid reinforcement of Al₂O₃ and SiC particulates was fabricated by accumulative roll bonding (ARB) process. This is the first study that manufactures high-strength and high-uniform hybrid composite by ARB process due to its ability in the industry. Anodizing process was used to grow alumina layer on the substrate of aluminum strips. The mechanical properties and microstructure of the ARB-processed composites have been investigated within different stage of ARB process by mechanical testing and optical microscopy. With the cycles of ARB, the alumina layers necked and fractured and so a homogenous distribution of Al₂O₃ particles in the aluminum matrix achieved. Also hybrid composite showed an improving in distribution of SiC particles and a decreasing in porosity between particles and matrix by increasing the cycles’ number. It was observed that the tensile strength of composites improved by increasing the ARB passes so that the tensile strength of the Al/0.5 vol.% Al₂O₃/4 vol.% SiC composite became 2.4 times higher than as-received material, while the changes in elongation value were various. Also tensile strength improved by increasing volume fraction of SiC particles.

Keywords: Hybrid Metal Matrix Composite (HMMC); Accumulative Roll Bonding (ARB); Microstructure; Mechanical Properties.
Manufacturing Al/Cuₚ Composites Produced by Accumulative Roll-Bonding (ARB) process

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Abstract

In the present work, accumulative roll bonding (ARB) process was used to produce Al/Cuₚ composite. Nanostructured Al/Cu composites with high-strength, finely dispersed and highly uniform were successfully produced in the form of sheets, through ARB process. Structural and mechanical properties of these composites were studied during various ARB cycles by scanning electron microscopy (SEM) and the tensile test, respectively. Vickers microhardness test was done on samples. The microstructure of the composites revealed properly distributed Cu particles in the aluminum matrix. It was found that by increasing the numbers of cycles, the yield and tensile strength of these composites increase, but their elongation decrease at the first cycle and then increase. It should be noted that enhancement of the strength is higher than the tensile strength of Al strips produced by ARB process without the Cu particles.

Keywords: Nanostructured Composites; Accumulative Roll Bonding; Mechanical properties.
Investigation of structure and mechanical properties of multi-layer Al/AlN composite produced by accumulative roll bonding (ARB) process using nano-sized AlN particles

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Abstract

Accumulative roll bonding (ARB) is one of the most applicable methods at the industrial production of ultrafine grained (UFG) materials with sheet form. In this work, by the accumulative roll bonding process at room temperature, Al/AlN substrates is produced successfully for the first time using Al strips and AlN nano-sized particles up to 6 cycles with different content of AlN. After optimum milling of the AlN particles by using of pearl-mill, Particle size analyzer and transmission electron microscopy (TEM) were utilized for evaluating powders. The bonding strength of multilayered substrate, which is tested by a mechanic testing equipment for all samples, reached more than 350 MPa for ARB products with 2% the nano-sized AlN particle. The microstructure of the production is investigated by scanning electron microscopy (SEM) and optical microscope. There is no reaction product in the interface of Al/AlN.

Keywords: Accumulative Roll Bonding; Transmission Electron Microscopy; Particle Size Analyzer; Pearl-Mill
Microstructure and Hot Deformation Behavior of AlMg$_6$ Alloy Produced by Equal-Channel Angular Pressing

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Abstract

Experimental work carried out to assess the strain rate and temperature affected deformation behavior of equal-channel angular pressed (ECAPed) AlMg$_6$ alloy. Elevated temperature compression test performed at temperatures ranged from 360 to 520 $^\circ$C, four strain rate of 0.001, 0.01, 0.1 and 1s$^{-1}$. The flow stress curves are displayed two kind of different behavior, which, at low temperatures or high strain rates, during the initial stage of deformation there is an increase in the flow stress, whereas, at high temperatures or low strain rates, flow curve decrease continuously from yield point due to occurrence of dynamic recrystallization phenomena. Activation energy of deformation is calculated 185.5 KJmol$^{-1}$ for the alloy. Steady state strain rate sensitivity (SRS) parameters were calculated (m=dln$\sigma$/ln$\dot{\varepsilon}$) for the strain rate ratios of $\dot{\varepsilon}$$_1$/\dot{\varepsilon}$$_2$(1:10), $\dot{\varepsilon}$$_2$/\dot{\varepsilon}$$_3$(10/100). The increasing of the m values from 0.1 to 0.4 for the applied strain rate ratios of $\dot{\varepsilon}$$_2$/\dot{\varepsilon}$$_3$ (10/100) and $\dot{\varepsilon}$$_1$/\dot{\varepsilon}$$_2$ (1:10), respectively, is assumed to be the result of changing the deformation mechanism from recovery to recrystallization. The effects of number of passes and strain path have been studied on the mechanical and microstructural characteristics of this alloy.

Keywords: Hot Deformation; ECAP; Dynamic Recrystallization; Almg$_6$ Alloy
An Investigation on Bauschinger Effect of Yielding Behaviour of Aluminium Alloy 7XXX Using Instrumented Indentation

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Abstract

In the current research, an attempt was made to use the capability of instrumented sharp indentation experiment in a multi-cycle loading on Zinc containing aluminium alloy (7XXX). The Bauschinger effect on yielding behaviour of samples was investigated by indentation using Vickers indenter. Subsequently, a comparison step was performed utilizing the uniaxial tension test. Assuming constant values for work hardening exponent, stress-strain and load-displacement curves resulted from tension and indentation were plotted respectively and yield stress was derived. Comparing the yield stresses of tension and indentation tests indicates that, instrumented indentation technique can be considered as a reliable substituent for conventional tension method. In order to verify the experimental results obtained from both tests, finite element approach was conducted for process simulation, and curves show acceptable agreement between experimental and predicted results.

Keywords: Bauschinger Effect; Indentation; Finite Element Method; Work Hardening
Effect of Magnesium and Silicon Concentration on Elongation and Electrical Conductivity of 6101 Aluminum Alloy

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Abstract

6101 aluminium alloy, in Al-Mg-Si group, is extensively used as an electrical conductor. Its elongation as well as electrical conductivity is the major properties which should be controlled during production process of aluminium wire conductors. Magnesium and silicon contents of this alloy, both, through affecting on the volume fraction of Mg$_2$Si precipitates and insoluble silicon inclusions in the microstructure can effectively influence on these properties. In this investigation, the influence of Mg:Si concentration ratio on elongation and electrical conductivity of the 6101 rods has been studied by standard electrical resistance and tensile tests. The chemical composition of the samples and their microstructure were respectively evaluated using optical emission spectrometry and scanning electron microscopy (SEM) equipped with energy dispersive spectrometry (EDS) analyzer. The results show that in weight percent ratio of Mg:Si=1 the elongation of 6101 aluminium rods increases to about 18 % while its specific electrical conductivity does not remarkably change. This is considered as a favourite result for produced 6101 aluminium rods which are subsequently used in production process of wire conductors through cold wire drawing.

Keywords: 6101 Aluminium Rod; Elongation; Electrical Conductivity; Mg:Si Concentration Ratio.
Improving the Forming Pressure Curves in Tube Hydroforming Process for AA1050 Alloy at Various Temperatures

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Abstract

Reduction of weight and increase of corrosion resistance are among the advantageous applications of Aluminium alloys in automotive industry. Low formability at room temperature is the major problem in application of these alloys. This problem is due to their microstructure (hexagonal closed pack in magnesium alloys and alloy elements in aluminium alloys) which limits the number of slip planes at the room temperature. Forming at high temperature can solve this problem. In this paper, warm hydroforming of AA1050 aluminium tubes has been studied numerically. A warm tube hydroforming were designed and fabricated. Aluminium tubes were formed at high temperatures. Simulation of process is performed using MSC. Mac commercial software and thickness distribution were studied at various temperatures. Results showed that increasing temperature improved thickness distribution. The pressure curves which were obtained using available equations for forming at room temperature, have been improved to decrease thinning in the final part. Simulations were performed in two states which are called constrained bulge and free bulge. To produce a part without any wrinkling and also to obtain minimum thinning, an axial feeding curve is suggested.

Keywords: Warm Tube Hydroforming; Finite Element Method (FEM); Aluminium Alloy
Effects of ARB Cycles and Holding Temperature on Density of Aluminum Foam

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Abstract

Metal Foams are a group of engineering materials which have many interesting properties that categorize them as advanced materials. Various techniques have been introduced for producing different types, closed cell and open cell metal foams. The aim of this research is to study one of recently introduced process, ARB (Accumulative Roll Bonding), for manufacturing aluminum foam. Numbers of ARB cycles on pre-strips, included TiH₂ particles as blowing agent, were 2, 4, 6 and 8 respectively. It was noticed that increasing ARB cycles is very effective on blowing agent dispersion in aluminum matrix. Samples were heat treated in temperatures, between 620-660 Celsius. Microscopic study using SEM and density measurements were performed on specimens showing that the best result can be obtained at 650 Celsius.

Keywords: Aluminum Foam; Accumulative Roll Bonding; Blowing Agent.
Evolution of Microstructure Texture for Multilayered Al (1100)/Al (5083) Composites by Accumulative Roll Bonding Process

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Abstract

Accumulative roll-bonding (ARB) process is an intense plastic deformation process that has been performed for a multilayered Al/Al composite from pure Aluminum (1100) sheets and Aluminum-Magnesium (5083) sheets to develop ultra-fine grains below 1 µm in diameter and to improve mechanical properties. The ARB process up to six cycles is performed at ambient temperature under unlubricated conditions. The ultra-fine grains surrounded by clear boundaries begin to appear at the third cycle, and the specimen after six cycles shows a microstructure covered with nano-grains with an average diameter of 100 nm. The hardness of the specimens ARBed by one, three and five cycles varies inhomogeneously in the thickness direction; having peak values near the surface and the center. This is due to the redundant shear strain and wire brushing. It has been seen that the textural evolution has no similarity with the simple shear texture; the components can be well represented by the ideal rolling texture components. Texture analysis revealed fiber textures have been discovered with continuous of the ARB process copper. Brass, S and Rotated Cubic textures identify which their differences are in intensity of ARB process.

Keywords: Accumulative Roll-Bonding; Brass Texture; Fiber Texture; Copper Texture; Cubic Textures.
The Effect of Heat Treating on Nano-Structure Sheet Produced by Accumulative Roll Bonding

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Abstract

Grain atomizing is an effective and economical method to improve the mechanical properties of materials. Process of Accumulative Roll Bonding (ARB) is a way of severe plastic deformation which used for metallic grain atomizing in sub-micron scale without dimensional changes of sheets. In this study, ARB process was done on AL 5083 sheet in 6 cycles (strain of 4.8), then heat treated in different temperatures. Micro structure changes during ARB and after heat treatment was studied by TEM. In order to analyze the mechanical properties of ARB Aluminum sheets before and after heat treatments, mono-axes tensile test and hardness test was applied. Also, the analysis of fracture surfaces samples after tensile tests was done by SEM. The results show that changes in micro-structure and dislocation collection starts from 100ºC and the maximum differences and changes of micro structure appears on 200ºC. Furthermore, The tensile and hardness test had the same result as well as micro structure analysis. In addition to, fracture surfaces in different temperatures declared an increase in ductile dimples in accordance with heat treating temperature increase. In this case, in order to obtain the ideal strength and elongation the optimum temperature was 120ºC & grain size was measured about 200 NM.

Keywords: Sever Plastic Deformation; ARB; Aluminum 5083; Dimple; Temperature.
Investigation of Microstructure and Mechanical Properties of Hybrid Composite of Aluminum/Alumina/Titanium Carbide Produced by Rolling Processes

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Abstract

Accumulative roll bonding (ARB) is one of the severe plastic deformation processes that is used nowadays to produce metal matrix composites (MMCs) extensively. In this paper Al/Al$_2$O$_3$/TiC hybrid composite was produced using ARB and anodizing processes. The aim of the present work is to produce high strength Al/Al$_2$O$_3$/TiC hybrid composite with a different volume fraction of alumina and titanium carbide uniformly dispersed in aluminum matrix using the above processes. Alumina layer with different thickness was achieved with anodizing of aluminum at different times. Microstructure observations showed that by increasing the number of rolling cycles, distribution of reinforcement particles (Al$_2$O$_3$, TiC) in aluminum matrix became more uniform. Mechanical properties of hybrid composite were evaluated at different passes of ARB process. As strain was increased (with increasing the number of passes), mechanical properties of produced composite such as tensile strength were increased consequently. But ductility at first was decreased and then increased. It can also be seen that by increasing quantity of alumina and titanium carbide, tensile strength is improved.

Keywords: Metal Matrix Composites; Hybrid Composites; Accumulative Roll Bonding; Microstructure; Mechanical Properties
Formation of Ultrafine Grained in Solution Treated Al-6061 by Two-Dimensional Machining

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Abstract

Imposition of large plastic strain in bulk materials is a well-known method for promoting formation of ultra-fine grained and nanocrystalline microstructures. Generation of large plastic strain by machining is a method of severe plastic deformation. In this study, Characteristics of chips produced by large strain deformation of solution treated Al-6061 has been analysed. By varying the geometry of the tool, different levels of strain were imposed in the chip in a single pass of machining. The microstructure generated in produced chips was characterized by transmission electron microscopy as equiaxed and nano-sized grains. In addition micro hardness tests showed significant increase of chip hardness in comparison to the bulk of solution treated Al-6061.

Keywords: Ultrafine Grains; Two-Dimensional Machining; Solution Treated Al-6061
Evolution of Microstructure and Properties in 6063 Aluminium by Twist Extrusion

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Abstract

Twist Extrusion (TE) is known as a developed and promising SPD (Severe Plastic Deformation) method which is performed by extruding a prism specimen through a die with an inner twist path. In this study, a twist extrusion die with twist line slope of 30 degrees was used and the structure and mechanical properties of Al6063 alloy were evaluated. Since the main dimensions of workpiece remained unchanged after the process, it's possible to repeat the process for several passes. The results indicated that by imposing a great strain on the sample, TE has refined microstructure and improved mechanical properties of the twisted alloy. Thus, the average grain size changed from 11μm for annealed sample to 130 nm for 16 times passed sample. Also with increasing the number of TE passes, yield strength, ultimate tensile strength and hardness increased, while after relative reduction of uniform elongation and elongation to failure by intermediate passes they remained almost unchanged.

Keywords: Twist Extrusion (TE); Al-6063; Microstructure; Mechanical Properties
Production of Nanostructured Composites from Multi-Layered Al Pure (1100) and Al-Mg (5083) Al Alloys by ARB Process: Microstructure Evaluation and Mechanical Properties

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Abstract

Accumulative roll bonding (ARB) is a severe plastic deformation process for achieving ultra-fine grains in metallic sheets without changing the sample dimensions. A high-purity Al(1100) alloy and a Al-Mg(5083) alloy were ARB process up to 6 cycles at ambient temperature to generate sheet composite material consisting of alternating layers of Al and Al-Mg. Sample properties were studied by employing hardness measurements, tensile test, SEM and TEM characterizations. The deformation structure within these layers consisted of lamellar bands aligned parallel to the rolling direction. With increasing the strain, mean spacing of lamellar boundaries decreased. Finally, continuous recrystallization resulted in a microstructure covered with small recrystallized grains with an average diameter below 100 nm at the end of four cycle. The tensile strength and hardness of the 6 cycle ARB processed composite sheet increased about 2 times of the initial 5083 Al alloy values and about five times of the initial 1100 Al alloy values, respectively. Fracture surfaces observations showed that failure mode in ARB processed composite is shear ductile rupture with elongated small dimples.

Keywords: Accumulative Roll Bonding; Severe Plastic Deformation; Aluminum 5083; Aluminum 1100; Nano-Grain.
HEAT TREATMENT
Effect of Deformation on the Microstructure and Hardness of A356 Aluminum Alloy during SIMA Process

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Abstract

The SIMA (Strain Induced Melt Activated) process is a simple process to produce globular microstructure in aluminum alloys. This paper presents the influence of deformation on the globularization of α-Al in A356 aluminum alloy by SIMA process. The alloy was modified with Al-10%Sr and cast in permanent mold. Samples were cut and rolled with the amount of 5%, 10%, 15%, and 20% reduction at 300°C. The samples were heat treated at 590°C for various holding time to spherodize the microstructure. The results showed that, the grains became smaller, spherical shape and having a homogenous distribution by increasing the deformation ratio. The globular grains grew with increasing holding time. In this investigation; the optimum condition was obtained in the samples were 20% warm rolled and heat treated for 15 minutes at the semi-solid temperature. The results indicated that the hardness and resistance to the deformation decreased through semi-solid heat treatment in SIMA process. Therefore, the necessary force for the deformation of the alloy has significantly been decreased.

Keywords: A356 Alloy; SIMA; Deformation; Semi-Solid Process
Intermetallic Formation by Heat Treatment of Explosively Welded Al-Ti Layers

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Abstract

Metallic-intermetallic laminate (MIL) composites are promising materials for the aerospace industry and other applications. One of the interesting laminate composites is Ti-TiAl$_3$. In this work commercially pure aluminum and titanium with almost equal thickness (almost 0.5 mm) joined explosively together and then rolled. The resulted composite annealed in 630 °C in different times to form intermetallic. The resulted structure studied by optical and scanning electron microscopy and Energy Dispersive Spectroscopy (EDS). TiAl$_3$ was the only phase that observed in all annealing periods. Kinetics of the formation of TiAl$_3$ calculated and compared to the researches that had been done on Ti-Al layers (without explosive welding). The effect of explosive welding and rolling on the kinetics of intermetallic formation was investigated.

Keywords: Intermetallics; Laminate Composites; TiAl$_3$; Intermetallic Formation Kinetics
Effects of Cu and Solution Heat Treatment on Microstructure and Hardness of In-Situ Aluminium Metal Matrix Composite Containing Al₄Sr Phase

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Abstract

This study was undertaken to investigate the effects of Cu and solution heat treatment on the microstructure and hardness of cast Al-Al₄Sr metal matrix composite. Different amounts of Cu (0.3, 0.5, 1, 3 and 5 wt.%) were added to the composite. Specimens were heat treated at 500 °C for 4 hours followed by water quenching. Microstructural studies were assessed by the use of optical microscope, scanning electron microscope (SEM) and x-ray diffractometry (XRD). The results showed that addition of 5 wt.% Cu reduces the length of large needle Al₄Sr phase and refines the microstructure. In addition, the presence of Cu-intermetallics increases hardness of the composite. Cu mainly forms θ phase which segregates in grain boundaries. Heat treatment partially dissolves Cu-intermetallics and homogenizes the distribution of θ phase in the matrix.

Keywords: Metal Matrix Composite (MMC); Microstructure; Intermetallics; Hardness; Heat Treatment.
Effect of Age Hardening Parameters on Mechanical Properties of Aluminum Alloys Series A2024 and A6061

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Abstract

In the present work, the influence of different artificial aging conditions on mechanical properties of two types of aluminum alloys A2024 & A6061 was studied. The mechanical properties of these alloys are adjusted by performing age hardening heat treatments. For this purpose after solutionizing treatment for A2024 & A6061 at 495°C and 529°C and water quench. The specimens were aged at 190°C and 170°C respectively for different periods of time (1-10h). For the precipitation stages during ageing were monitored by hardness measurements. After different solution treatment and aging condition for each specimen, Charpy impact, hardness and tensile tests were carried out. Result reveal that during ageing the impact toughness of the alloys first increased, and then, following a maxima decreased due to the precipitation of intermediate phases, finally it reached its minimum at the peak hardness. Finally the relationship between hardness, impact toughness and strength were investigated.

Keywords: Heat Treatable Alloys; Aluminum Series A2024&A6061; Impact Toughness; Mechanical Properties.
Influence of Heat Treatment Parameters on Machinability of Al-Si-Cu Casting Alloys

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Abstract

In this work, Al-Si-Cu cast alloys were selected for a machinability study, due to the high demand of these alloys in the automobile industry. Any metallurgical adjustment that can be made to the aluminum alloys which allows them to enhance the effectiveness of the coolant or reduce the amount of heat generated can be considered an improvement in the overall machinability of the product. Although all aluminum materials tend toward difficult chip formation and material sticking to the tool, the demand on the cutting tool of soft deformable alloys for the electrical industry is very different to the demands of high strength alloys and Al-Si cast alloys for the aerospace and automotive industries. A range of drilling and tapping tools for aluminum machining, which contend with these difficulties are available to cover all applications. General purpose tools, high performance tools as well as special tools are available for both drilling and tapping operations. Machinability, by definition, is a system property that indicates how easily material can be machined at low cost and without tools breakage. Many factors can influence the outcome of the machinability. However, chemical composition, inclusions and heat treatment parameters are main factors that effect to machinability of the industrial parts like automotive cylinder head. In this paper, these factors especially heat treatment parameters are investigated.

Keywords: Machinability; Al-Si-Cu; Heat Treatment; Cutting Tools; Cylinder Head
The Microstructure and Tensile Properties of T6-Heat Treated Al-Mg$_2$Si Composite with Zn addition

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Abstract

The microstructure and tensile properties of an in-situ Al-15%Mg$_2$Si composite have been investigated after adding different Zn contents (0.1, 0.3, 0.5, 1.0, 3.0, 5.0, 10.0 wt.%) and applying solution and ageing heat treatment. The microstructural study of the composite showed both primary and secondary Mg$_2$Si phases in all specimens and Zn addition changes the size and morphology of both primary and pseudo-eutectic Mg$_2$Si particles. The results of tensile test demonstrated that the addition of Zn increases the ultimate tensile strength (UTS) value, but a reduction in elongation occurs with the addition of Zn ($\geq$ 3 wt.%), the results also showed that applying T6 heat treatment improves the toughness of the composite.

Keywords: In-Situ Composite; Mg$_2$Si Particles; Zn Addition; T6-Heat Treatment; Tensile Properties
Study on Microstructure and Mechanical Properties of Rolled Alloy 5083 H112 after Heat Treating at Different Temperatures

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Abstract

Generally control of micro structure for improvement of material properties is very important. Hence, several researches have been done to improve structure and mechanical behavior of materials in sub-micron grain size at recent years. Grain atomizing is an effective and economical method to improve the mechanical properties of materials. In this study a thickness reduction of about 85% was applied on Aluminum 5083 H112 sheet by cold rolling. Then samples were heat treated at different temperatures. The micro structure changes were tested by optical microscopes. In order to analyze the mechanical properties; the samples were applied to mono-axis tensile, hardness and wear tests. Also the investigation of fracture surface of samples after tensile tests and microstructure was done by SEM. The results showed that the critical temperature in micro-structure changes is 250 °C. Also at this temperature a static recrystallization takes place which starts at 200°C. The result of wear test showed that friction coefficient near to static recrystallization process increase slightly which in accordance with temperature increase it starts to decrease. Samples hardness by effect of heat treatment at 250°C, increase then it starts to decrease. Also the fracture surface results show that a mixture of tear ductile dimples at recrystalizlation temperature leads to rupture.

Keywords: Recrystallization; Aluminum 5083 H112; Hardness; Structure”
Investigation of Precipitation Hardening of LM22 by Nondestructive Methods

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Abstract

Apart from traditional application of nondestructive eddy current technique for determination of discontinuities, the method has been recently used to study aging process of 319aluminum alloys manufactured by casting. In this paper, the application of eddy current and conductivity methods for characterization of aging process has been investigated. A relation between mechanical properties and various parameters such as impedance, phase angle and voltage has been established. This study shows that the best results ($R^2 = 0.784$) can be achieved using $110kHz$ frequency which leads to reversely relationship between Vickers hardness and normalized impedance, in other words maximum value in hardness-time curve coincide to minimum value in impedance-time curve. Results of hardness, conductivity and transmission electron microscope images are in agreement with this result.

Keywords: Precipitation Hardening; Eddy Current Method; Normalized Impedance; Conductivity; Aluminium 319.
Study of Rapid Heating effects on Mechanical Properties and Microstructure of Aluminum Alloys

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Abstract

Heat treatment of metals and alloys can be improved by advanced methods of rapid heating using induction, laser, salt bath and infrared radiation. Application of rapid heating enhances the diffusion-controlled processes such as nucleation and growth of the second phases formed during precipitation hardening of aluminum alloys. In this study in order to observe the effect of rapid heating on mechanical properties of AA7075 and AA2024, precipitation hardening was performed in two furnaces, conventional and infrared. Mechanical properties and microstructure of alloys were studied and compared. Results showed hardness and strength of both alloys increased by using rapid heating. It was also observed that aging time was decreased from 24h for heating in conventional furnace to 2h when using infrared furnace for 7075 Al alloy. For 2024 Al alloy reduction in aging time was observed from 12h in conventional furnace to 1h in infrared one (more than 90% reduction in aging time). It was found that production costs were highly reduced when using infrared furnaces.

Keywords: Rapid Heating; Infrared Radiation; Diffusion; Heat Treatment.
ADVANCED MATERIALS
Investigating the formation of intermetallic compounds and the variation of bond strength between Al-Cu layers after annealing in presence of nickel coating on copper

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Abstract

In the present study, the effect of post-rolling annealing heat treatment on the formation of intermetallic compounds between Al-Cu strips, in the presence of nickel coating on the copper strips, was investigated. In addition, the effect of post-rolling annealing and intermetallic compounds on the bond strength of Al-Cu strips was evaluated. In order to prepare samples, copper strips were coated with nickel by electroplating process. After surface preparing, copper strips were placed between two aluminum strips and roll bonded. This method is used for producing Al-Ni-Cu composites. Then the samples were annealed at 773K for 2 h. The formation of intermetallic compounds was studied using energy dispersive spectroscopy (EDS) and X-ray diffraction (XRD), and also the bond strength of Al-Cu strips was investigated using peeling test. The results revealed that by post-rolling annealing of layers, the bond strength between Al-Cu strips decreases dramatically.

Keywords: Intermetallic Compounds; XRD; Bond Strength; CRB Process
Aluminum Nano Particles as High Energetic Materials; Improvement on Combustion Performance through Nickel Deposition on Particles

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Abstract

Aluminium powders are mainly used as energetic additives for propellants. However, particle agglomeration, formation of protective oxide layers on the aluminium particles and high ignition delay time and low ignition velocity of particles, in particular when nano particles are used, lead to incomplete burning of Al particles and subsequently decreasing the propellant efficiency. In this study in order to improve combustion behaviour of aluminium particles, nanometric nickel shell coated on the surface of aluminium nanoparticles. Fabrication of such A/Ni core-shell nano structures by electroless nickel deposition (EN) investigated and high efficiency EN process modelled using Artificial Neural Network (ANN) media. Based on presented model it is possible to design an EN bath with the maximum plating rate, while minimum materials are used and maximum efficiency of process are appeared. These samples charactrizated by scanning electron microscopy (SEM), transmission electron microscopy (TEM), energy dispersive spectroscopy (EDS) and X-ray diffraction (XRD). The results shows, Ni particles were deposited on the surface of aluminium nano particles and form a thin and uniform nickel shell within about 10nm thickness around aluminium cores.

Keywords: Aluminium Nano Particles; Electroless Nickel (EN) Deposition; Artificial Neural Networks (ANN).
Effect of Reinforcement Particle Size and Weight Percent on the Compressive Strength of Al-4.5 wt.% Cu + TiC Nanocomposites

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Abstract

The aim of this study is to investigate the effect of TiC particle size and its amount on the relative density, hardness, yield and compressive strength in Al-4.5wt.%Cu-TiC composites. To this end, the amount of 0–10 wt.% TiC with average particle sizes 48 μm and 40 nm were used along with pre alloyed matrix powder of average particle size of 500 nm. Powder metallurgy is a method used in the fabrication of this composite in which the powders were mixed using a planetary ball mill. Consolidation was conducted by uniaxial pressing at 650 MPa. Sintering procedure was done at 400 °C for 90 min. The results indicated that as the TiC particle size is reduced to nanometre scale and the amount is increased, hardness and compressive strength increase and relative density, elongation, microstructure grain size and distribution homogeneity in matrix decrease. Using micron size reinforcing particulates from 5 to 10 wt.%, results in significant hardness reduction of the composite from 168 to 98 HVN. Compressive test results revealed great enhancement of UTS but poor elongation of the TiC reinforced nanocomposites.

Keywords: Aluminium Metal Matrix Composites (AMMC); Nanocomposite; Mechanical Alloying; Compressive Strength, Electron Microscopy; Hardness;
The Influence of Fe-Rich Intermetallics on the Tensile Properties and Fracture Behaviour of Al-Mg$_2$Si Metal Matrix Composite

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Abstract

In present research, an attempt was made to investigate the influence of different concentrations of Fe (0.5, 1, 1.5, 2 and 3 wt.%) on the tensile properties and fracture behaviour of in situ Al-15wt.%Mg$_2$Si metal matrix composite. The composite ingots were made by casting process. In this work, the matrix composite were characterized by optical microscopy, scanning electron microscopy (SEM) and tensile tests experiment. The obtained results depicted optimum Fe (1 wt.%) levels for improving tensile properties. In the point of fracture behaviour, Fe-containing specimens showed a brittle mode of failure and acceptable cohesion between Mg$_2$Si and matrix.

Keywords: Al-Mg$_2$Si Composite; Casting; Tensile Properties; Brittle Fracture

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Abstract

In this study, synthesis of Al-TiO₂-multi wall carbon nanotubes composite and effect of multi-wall carbon nanotube (MWCNT) on AL-TiO₂ composite has been investigated. Mechanical alloying has been used to mix powders of aluminium, TiO₂ powders and multi-wall carbon nanotubes. TiO₂ in the amount of 1%, 2% and 3% and carbon nanotubes with 0.5, 1, 1.5 and 2 wt% was used. Some properties of different samples of this composite was tested and the results showed that the addition of MWCNTs improved properties such as tensile strength and micro hardness and investigation of microstructure by transmission electron microscopy (TEM) showed that CNTs dispersed homogeneously in the Al-TiO₂ matrix.

Keyword: MWCNT; Al- TiO₂ Composite; Mechanical Alloying
Mechanical Properties of In Situ Al-Li/Mg₂Si Composite Materials with Different Additives

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Abstract

Because of special interfaces between matrix and reinforcement, in-situ composites have special microstructure and properties. This behaviour makes them attractive for different materials engineering research fields. On the other hand, presence of Lithium in Aluminium alloys introduces different behaviours in these alloys. In this paper, Mechanical properties of Al-Li alloys reinforced by in situ Mg₂Si particles and different amount of zinc were investigated. Different amounts of Zn were added to the composite, then samples were cast, homogenized and extruded at 480°C at extrusion ratio of 18:1. Microstructure and mechanical properties of fabricated samples were studied by standard methods in order to find the effect of In situ reinforcement, Zn modifying agent as well as fabrication method on the Al-Li alloy morphology and behaviour. The results showed that zinc addition and homogenizing treatment were highly effective in modifying morphology of Mg₂Si reinforcements. The results also exhibited that the addition of optimum amount of Zn will increase ultimate tensile strength (UTS) of In-situ composites drastically.

Keywords: Composite; Hot Extrusion; Modification; Ultimate Tensile Strength
Evaluation of Time Effect on Mechanical Properties of Al-ZrO₂ Nano-Composites Produced by Microwave Sintering

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Abstract

In this research study aluminum powder was mixed with zirconia nano-powder in planetary mill for uniform mixing. Then, the mixed powders were compacted. Subsequently the compacted discs were sintered both in the conventional furnace, and in the microwave oven. Mechanical behavior was assessed in terms of micro-hardness and compressive properties. Microstructures were observed by SEM. X-ray diffraction was employed to identify various phases if present in the Al-ZrO₂ nano-composites. The optimum time of microwave sintering has been determined.

Keywords: Microwave Sintering; Mechanical Properties; Nano-Composites; Al₃Zr.
Processing and Properties of Multiwall Carbon Nanotubes Reinforced Aluminum Matrix Composites

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Abstract

Novel Al matrix composites reinforced by carbon nanotubes have been processed by powder metallurgy. Different properties of the composite such as hardness, Density and dispersion of the nanotubes in the matrix have been characterized. The results show that PM technique is effective in dispersing the nanotubes within the Al matrix which simultaneously protects the nanotubes from damage under the impact of the milling balls. Finally, increasing in hardness was observed by increasing in wt% CNT up to 1 wt% CNT. Field emission scanning electron microscopy was used to investigate Microstructure.

Keywords: Al-CNT Composites; Mechanical Properties; Reinforcement; Powder Metallurgy Technique
Effect of Annealing Heat Treatment on Microstructure and Mechanical Properties of Melt-Spun Ribbons of Al–20Si–5Fe

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Abstract

Rapid solidification processing provides a typical case of non-equilibrium solidification, hence refine significantly the microstructural features (grain size and size of second phase/intermetallic particles), reduce segregation effects, increase the solid solubility extension and induce constitutional changes in alloys (formation of supersaturated solid solutions, metastable crystalline intermediate, and amorphous phases). The present study is concerned with the effect of annealing heat treatment on microstructure and mechanical properties of rapidly solidified ternary Al–20Si–5Fe alloy at cooling rates between 106 and 17 K/s using the melt spinning technique. The melt spun ribbons characterized using X-ray diffractometry and scanning electron microscopy. The obtained results show that the size of primary silicon, the intermetallic phases, and the eutectic silicon in the melt-spun ribbon were extremely modified as compared to those found in conventionally processed materials. Furthermore, the solid solubility levels of alloying elements (Si and Fe) in Al substantially increased which resulted in solid solution strengthening.

Keywords: Al-20Si-5Fe Alloy; Rapid Solidification; Melt-Spinning; Microstructure; Mechanical Properties; Annealing Heat Treatment.
The Effect of Ce-TZP/Al₂O₃ Nanocomposite Particle Amount on Properties of Al- Ce-TZP/Al₂O₃ Nanocomposite

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Abstract

A zirconia/alumina nanocomposite stabilized with cerium oxide (Ce-TZP/Al₂O₃ nanocomposite) can be a good substitute as reinforcement in metal matrix composites. In present study, the effect amount of Ce-TZP/Al₂O₃ particles on the properties of Al-Ce-TZP/Al₂O₃ nanocomposite was investigated. For this purpose, Ce-TZP/Al₂O₃ nanocomposite synthesized by aqueous combustion with an average grain size of 25nm, in 1,3,5,7, and 10 wt%, and aluminium powder with average size of 30 µm were used. Single action press with 600 MPa for 60 min at 450 °C applied to prepare cylindrical samples. It was found that, a Ce-TZP/Al₂O₃ nanocomposite (0-7 wt.%) increasing, led to the hardness and density increasing also compression strength were increased and then they were decreased; as the amount of Ce-TZP/Al₂O₃ nanocomposite increases to 7 wt. %.

Keywords: Nanocomposite; Combustion Synthesis; Powder Metallurgy; Mechanical Properties
Synthesis and Characterization of Amorphous 
$\text{Al}_{80}\text{Fe}_{10}\text{Ti}_{5}\text{Nb}_{3}\text{B}_{2}$ by Mechanical Alloying

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Abstract

In this study the formation mechanism of the amorphous phase and crystalline phases in the aluminum based amorphous alloy, $\text{Al}_{80}\text{Fe}_{10}\text{Ti}_{5}\text{Nb}_{3}\text{B}_{2}$ has been studied. Using the mechanical alloying technique on this alloy system, powder mixtures containing Al, Fe, Ti, Nb, and B were mixed to the desired weight ratio. To evaluate the amorphization, X-ray diffraction (XRD) was carried out and thermal analysis was performed for the phase formation mechanism study. The results reveal that after mechanical alloying of the considered alloy system for 30 hours, it was determined that the amorphous alloy developed in addition to the crystalline phase of $\text{Al}_3\text{Nb}$. During the milling of the powder crystalline phase of $\text{Al}_3\text{Ti}$ was formed and then dissolved after some more milling of the powder mixture. A DTA test carried out to study the thermal stability of the obtained amorphous phase. After heat treatment of the mechanically alloyed sample for 30 hours, the crystallized phases were $\text{Fe}_3\text{B}$, $\text{Al}_3\text{Ti}$, $\text{Al}_{13}\text{Fe}_4$ and $\text{Al}_3\text{Nb}$ which existed before the heating.

Keywords: Aluminum Based Amorphous Alloy; Mechanical Alloying; Crystalline Phase; Non- Isothermal Crystallization;
WELDING AND JOINING
Feasibility of Joining Al-20%Mg₂Si In-Situ Composite by TIG Welding

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Abstract

The feasibility of joining an in situ Al-20%Mg₂Si composite by TIG is investigated. Welding current was varied at five different values between 80 and 100 amp. Different areas were identified in the weldment region due to effect of welding specification. Mechanical properties of joints were evaluated by Tensile and microhardness tests. Joints welded with a welding current in the range of 80-85 amp displayed the highest degree of hardness. The fracture produced in the welded specimens was in the base metal MMC, indicating a strong interface between the base MMC and the weld. Therefore, the study finds that in situ Al-Mg₂Si MMC can in fact be welded using TIG and Al-Si filler metal.

Keywords: Aluminium, In-situ composite, Joining; TIG
Investigating the Formation of Intermetallic Compounds during Friction Stir Welding of magnesium alloy to aluminium alloy in Air and under Liquid Nitrogen

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Abstract

This research demonstrates the use of submerged friction stir welding (SFSW) under liquid nitrogen as an alternative and improved method for creating fine grained welds, and hence, to alleviate formation of intermetallic phases. Magnesium alloy and aluminium alloy were joined by friction stir welding in two environments, namely air and liquid nitrogen, with 400 rpm rotation and 50 mm/ minute travel speed. The temperature profile, microstructure, SEM-EDS analysis and hardness were evaluated. In the stir zone of air welded specimen, formation of brittle intermetallic compounds cause the weld to crack. These phases were formed because of constitutional liquation. The stir zone of under liquid nitrogen welded specimen showed that, formation of intermetallic compounds is suppressed significantly because of lower heat input.

Keywords: Friction Stir Welding; Aluminum Alloy; Magnesium Alloy; Intermetallic Compound.
Friction Stir Welding Al-TiC Composite Produced by Accumulative Roll Bonding

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Abstract

The aim of this work is to demonstrate the feasibility of friction stir welding (FSW) for joining of Al-TiC composite. In this regard, the composite was manufactured by accumulative roll bonding (ARB) process after 10 cycles and subsequently were joined by FSW at the tool rotation speed of 560 rpm and welding speeds of 100 and 160 mm/min. The microstructural evolutions in the stir zone of the welded samples were investigated by scanning electron microscopy (SEM). It was revealed that in the stir zone of the sample by welding speed 100mm/min, TiC particles were uniformly imbedded in the aluminium matrix and had smaller average size after FSW, but tensile strength decreased due to grain growth caused by frictional heat of tool rotation.

Keywords: Friction Stir Welding; Accumulative Roll Bonding; Tic ; Aluminium Matrix Composite
Effect of Shielding Gas Composition on Structural and Mechanical Properties of Al5083H321 Gas Metal Arc Welding

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Abstract

The unique properties of aluminum have turned this metal to one of the most commonly used industrial metals in the world. Unlike steel welding, aluminum welding is much more complicated due to some thermo-physical properties of aluminum. Shielding gas is one of the most important parameters of GMA-welding that affects the melting rate, arc stability, the shape and depth of penetration. Experiments were carried out using different amounts of N₂ and O₂ added to Argon as the shield gas and then investigating the physical and mechanical properties of weld zone. It was concluded that adding minor amounts of oxygen and nitrogen (up to %0.5) to Argon was resulting to increase the arc stability, increase the depth of penetration and its mechanical properties. However, adding higher amounts of nitrogen and oxygen (more than 0.5%) to Argon, beside the formation of excessive brown and black oxide film on bead surface, bigger holes and inter-metal compounds observed. The results of tensile test of these samples showed that small amounts of N₂ and O₂ (up to % 0.1) increases the tensile strength of the penetration by 5.5 times more in compare with pure Argon. On the other hand, increasing much bigger amounts of N₂ and O₂ not only is not improving the quality of penetration, but also lead to decreasing the outfit quality.

Keywords: Double Pulsed Gas Metal Arc Welding; 5083H321 Aluminum Alloy; Shielding Gas Mixture; Micro Structural And Mechanical Properties
Friction Stir Welding of AA7075 by Adding SiC Nano Particles at the Interface

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Abstract

Friction Stir Welding (FSW) is a novel process capable of welding materials such as Aluminum, copper and so on, that could not be joined effectively by conventional welding techniques. During the aforementioned process, a tool, made from a harder material than the workpiece, is hired to introduce adequate heat by means of friction between itself and the surrounding material. In recent study, the material under study was 6mm AA7075 plate and also a H13 tool was used. Before the process initiation, one side of each sliced strip (150mm × 60mm) was prepared such that a symmetrical notch obtained exactly at the joint interface. The SiC nano powder was inserted in the gap and then was capped by a pin-less tool. Another tool was used to stir the caped area. As a matter of fact the outcome was a metal, in this case AA7075, metal matrix composite contains SiC nano powder. It is found that the best process parameters are 800 rpm and 30mm/min.

Keywords: Friction Stir Welding; Sic Nano-Powder; AA7075; Composite
Effect of Rotational and Traversal Speeds on Microstructure and Mechanical Properties of Friction Stir-Welded 7075-T6 Aluminium Alloy

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Abstract

In this article, effects of rotational and traversal speeds on the microstructure and mechanical properties of friction stir-welded 7075-T6 Al alloys were investigated. Good correlation existed between the rotational and traversal speeds and weld properties. It was found that with increase in the rotational and traversal speed, wider thickness of the heat-affected zone were obtained, and then grain coarsening, dissolution, and accumulation of hardening precipitates in grain boundaries. In addition, the highest toughness during tensile test was obtained at moderate rotational and traversal speeds of 325 r/min and 30 mm/min. However, the highest microhardness was obtained at moderate rotational and traversal speeds of 325 r/min and 60 mm/min. It was imposed high temperature which cause of this different.

Keywords: Friction Stir Welding; 7075-T6 Al Alloy; Rotational Speed; Mechanical Properties; Microstructure.
The Effect of Friction Surfacing Parameters on Surface Quality and Microstructure of Al-13%Si Cladding Layer on Pure Aluminium

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Abstract

In this investigation, the Al-13% Si was clad by friction surfacing on the pure aluminium. The friction surfacing by consumable rods in different conditions such as rotational speed (W), linear velocity (V) and pressure force (F) was carried out. The visual test and macrograph examinations results of different samples showed that by decreasing of welding parameter ratio (V/W) and increasing of pressure force (F), depth of penetration was increased. Moreover in low or high pressure force (F) and welding parameter ratio (V/W), low surface quality of joint between clad layer and substrate metal was gained. The results of metallographic examinations of the accept quality joint samples showed that by increasing of the pressure force and decreasing of the welding parameter ratio (V/W) the size of Si particles in clad layer were decreased and the hardness value of clad layer were increased.

**Keywords:** Aluminium, Friction surfacing, Cladding, Surface quality, Microstructure
Microstructure and Charpy Impact Energy of Aluminum Based Composites Reinforced with 20% SiO₂ Particles in Friction Stir Welding

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Abstract

Friction stir welding (FSW) is a fairly recent technique that utilizes a non-consumable rotating welding tool to generate frictional heat and plastic deformation at the welding location, thereby affecting the formation of a joint while the material is in the solid state. The aim of the present research is to investigate the effect of friction stir welding processes on the microstructure and impact toughness of the aluminium composited reinforced with 20% SiO₂. Because of the severe deformation during this process the size of both reinforced particles and aluminium grain are affected. The result of impact test shows that the total energy is increased in the friction stir welding composites comparing with the base material.

Keywords: Aluminium; Composite; Friction Stir Welding; Impact Energy.
Thermite Welding of Aluminum Conductor by Addition of Copper

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Abstract

Aluminum conductors welding is an important issue in electricity transportation industry. Thermite welding is a good method to weld such parts. In some conditions, electrical arc welding or friction stir welding could not be used to weld these conductors due to environmental conditions, lack of welding tools, etc. In these cases, thermite welding could be used as an appropriate method. In this work, two aluminum conductors (with 9.3 mm diameter and 12.5 cm length) were welded by the use of thermite welding. These conductors were made of commercially pure aluminum (Al>99%) to enhance the weld strength, different contents of copper (0.73- 2.4 wt%) were added to the thermite powder and mechanical properties, electrical resistance and microstructural changes were studied by the use of hardness testing, resistance measurements and optical metallography, respectively. The results show that increasing the percentage of copper causes the reduction of electrical conductivity and increases the strength and hardness of the welded joint. Furthermore, grain size decreases due to Cu presence in the weld.

Keywords: Thermite Welding; Aluminum; Copper; Mechanical Strength; Electrical Conductivity
Effect of Friction Stir Welding Parameters on the Microstructure and Hardness of Compocast Al–7Si–2Mg/10% SiCp metal matrix composites

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Abstract

This paper aimed at studying the Friction Stir Welding (FSW) of Al–7Si–2Mg/10% SiCp metal matrix composites. The effects of tool rotational speed and the number of passes on the resultant microstructure and the final hardness of friction stir welded Al–7Si–2Mg/10% SiCp were studied. The microstructural studies were done using an Optical Microscopy (OM). Also, hardness test was performed in different regions of welded specimens. The results indicated an improvement in hardness of nugget zone in comparison to base metal due to the fragmentation of SiC particles, improved SiC distribution, and refined matrix. By increasing the tool rotational speed and number of passes, a finer matrix was achieved. Also the distribution of SiC particles was improved.

Keywords: Friction Stir Welding; Metal Matrix Composite; Mechanical Properties.
Effect of Al$_2$O$_3$ Particles on the Hardness, Tensile Strength and Microstructure of Dissimilar A2024 Aluminum Alloy to Pure Copper FSW Joint

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Abstract

In this paper the effect of Al$_2$O$_3$ particles on the microstructure and the mechanical properties of A2024-Cu dissimilar joint by the FSW method have discussed. Al$_2$O$_3$ particles with the mean size of 15µm were injected through the weld zone of the dissimilar A2024-Cu joint before welding with the purpose to improve mechanical properties and after the welding procedure the microstructure and micro hardness and tensile tests were held to study the behavior of this weld. The results of the microstructure analysis by the XRD and EDS showed that during this weld two saturated solid solution of Al in copper (intermetallic compounds) CuAl$_2$ and CuAl produced. Results of the tensile test showed that the joint failed under the tensile strength of 181.7 Mpa and elongation of 2.8% and micro hardness test and hardness profile showed a range of 70 up to 548 HV from the A2024 side to the weld zone and 548 up to 85.1 HV from the weld zone to the Copper side.

Keywords: Friction Stir Welding (FSW); Intermetallic Compounds; Mechanical Properties; Microstructure; Dissimilar Joint
CORROSION

AND

SURFACE TREATMENT
The Effect of Cryolite $\text{Na}_3\text{AlF}_6$ and Sodium Fluoride Naf on the Corrosion and Wetting by Molten Aluminum Alloys of Andalusite Based Refractories

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Abstract

Aluminosilicate based refractories are widely used in furnace installations for melting aluminum because they are inexpensive, readily available and generally exhibit the properties desired from a refractory material. In order to improve the corrosion resistance of aluminosilicate refractories by molten aluminum, alkaline fluoride NaF and cryolite $\text{Na}_3\text{AlF}_6$ powders were used. Andalusite based castable with and without addition of different percent (0-10 wt%) of NaF and $\text{Na}_3\text{AlF}_6$ were selected and Static cup tests were performed for corrosion and wetting experiments with molten Al/alloy. Understanding effect of non-wetting chemical additives and interfacial phenomena with Al-alloys is essential for improving corrosion performance of refractories in melting/holding furnaces. Both physical and chemical properties are known to influence wetting and corrosion behavior. This paper devoted to determine the influence of alkaline fluoride and cryolite added to andalusite based castable on the reaction with aluminum alloys. These additives led to the in-situ formation of celsian phases within the refractory matrix that led to improved corrosion resistance at 1300°C. Phase analysis revealed that celsian formation suppressed the formation of mullite within refractories, thereby reducing Penetration.

Keywords: Aluminosilicate Based Refractories; Molten Aluminum Corrosion; Non-Wetting Chemical Additives.
Improvement of Coating Adhesion To Aluminum Alloys by the Application of Anodic Film Interlayer

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Abstract

Adhesion of coatings to aluminum components is a critical factor due to the presence of a surface oxide film that prevents intimate contact between coating and the metal. In this research, two different types of interlayers were produced on aluminum alloy specimens prior to electroless nickel coating in an attempt to improve the low adhesion of such coatings to aluminum substrates. The amorphous Ni-P layer of medium phosphorous content was deposited on 3004 aluminum alloy sheet after an interlayer of either a zinc coating (zincate process) or an oxide coating (anodizing process) was applied to the substrate. Formation of electroless coating was evaluated by X-ray Diffraction and microanalysis (EDS). The surface morphology and topography of the coatings were characterized by scanning electron microscope (SEM) and atomic force microscope (AFM), respectively. Adhesion of the coating to aluminum substrate was evaluated by the bending test according to ASTM B571. It was observed that application of a nano-porous aluminum anodic oxide as interlayer effectively increased the adhesion of electroless Ni-P coating to aluminum surface; the adhesion strength was considerably more than that obtained by the presence of zincate interlayer.

Keywords: Adhesion; Interlayer; Anodizing; Zincate Process; Electroless Ni-P.
Specular Reflectivity of Aluminum 6063

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Abstract

In anodizing done for decorative purposes the object of etching is to transform the metallic luster of the aluminum surface into a uniform matt finish which diffuses reflected light uniformly in all directions. This is always perfectly done by warm solutions of sodium hydroxide base solutions. Different factors can affect final matt finish in etching process. These include alloying elements, extrusion conditions; extrusion dies surface conditions, aging conditions, time of etching in etching bath as well as etching bath chemical composition and temperature. By controlling and studying the effect of each parameter, we will be able to achieve desired gloss after etching is done. This investigation can be helpful in anodizing industry. In this article, we will discussed the mechanism of etching and the effects of alloying elements, especially iron and magnesium, in 6063 alloy, aging parameters and etching bath conditions on the speculars reflectivity after etching process

Key Words: Etching; Affect; Alloy Element; Aging; Specular Reflectivity
Influence of Die Temperature on Adhesion of the Paints on Die Casted Aluminium Parts: A Case History

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Abstract

The Companies that paint casted parts, are often in trouble with paint adhesion problems. These problems arise often randomly, making it very difficult to keep them under control. Recently, with new mild “eco-treatments” of cleaning and pickling, the problems became even more difficult to solve. In this work we have shown that other parameters, affecting paint adhesion, have to be taken into account. The die surface temperature and other variables play a capital role in the adhesion of paints and coats. The authors disclose a case history and assume some hypothesis of possible mechanisms to explain the influence of die surface temperature on paint adhesion. Besides that, will be given suitable industrial solutions also exploiting a new technology based on infrared devices applied on-process and suggestions around new further investigations to be carried out on the other parameters.

Keywords: Die Temperature; Paint Adhesion; Die Lubricant.
Mechanism of Hot Corrosion of Ni-6Al-10Cu-11Fe-15Cr Nickel Base Supperalloy in Molten Cryolite

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Abstract

As a candidate for inert anodes for aluminium electrolysis, in this paper the mechanism of hot corrosion of Ni-6Al-10Cu-11Fe-15Cr nickel base supperalloy investigated. The samples prepared by casting, and then oxidized at 1000 °C for 30, 70 and 100 hours respectively. Then the surface oxide layer studied by scanning electron microscope (SEM). By attention to the result, it can be seen that by increase the oxidation treatment time, thickness of oxide layers increased. The surface oxide layer studied by XRD and it is found out that the major oxide compounds that appeared on the surface were Al$_2$O$_3$ and Cr$_2$O$_3$. Also by increase of Oxidation time, the amount of mentioned compounds increased. To determine the samples hot corrosion resistant, they exposed to molten cryolite at 930 °C for 70 hours. After hot corrosion test, the samples picked up to study by SEM, and dimensional variety of the samples measured. The results showed that the sample that oxidized for 100 hours, because of higher amount of diffusion barrier compounds, is very stable than the others, and another one that oxidized for 30 hours, corroded severely.

Keywords: Hot Corrosion; Oxidation; Inert Anode; Electrolysis; Aluminium
RAW MATERIALS AND REDUCTION TECHNOLOGY
Alumina for Aluminium Smelting

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Abstract

Around 95% of the commercial production of alumina is destined for the smelting industry. The specification of this material has steadily converged as the design and operation of reduction cells has converged, however significant variation in the performance of alumina in the reduction cell is still observed. Alumina is the largest raw material input into the reduction cell and has the most profound effect on cell thermal stability and process control. In addition alumina plays key roles in the generation and capture of HF from cell emissions and in the general environmental performance of the smelter. The properties which dictate dissolution and contribute to cell excursions, particularly anode effect frequency, are strongly related to particle and crystallographic structure, properties which are challenging to analyse and often not well represented on the specification sheet. This arises from the complex structural relationship of the transition aluminas and for example, the push to progressively increase specific surface area, targeted at aiding dissolution and dry-scrubber performance.

Keywords: Metallurgical Alumina; Microstructure; Cell Emissions; Dissolution
Optimizing Energy Efficiency in Smelting Cells

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Abstract

The scenario for aluminium production has changed dramatically with the global concern on greenhouse gas emissions and the world becoming exhausted in potential sources for generating large blocks of environmentally friendly and low-cost electrical energy. The earlier energy production as was traditionally available from hydro electric sources and the low-cost of this helped the economics of aluminium production. Furthermore, the advances in living standards have meant that people become more important than processes when it comes to the demand for electricity. This raises the price while distributing their networks mean all parties can share. While the Mid-East is in fortunate position with abundant sources of natural gas for generation of electricity it is still important to conserve valuable resources for future generations. But when this is can bind with the increase in price, clearly it becomes more important to minimise energy consumption per unit production.
Evaluating of sintered Al-Zn-Mg-Cu from mixed powder by measuring resonant frequency

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Abstract

In sintering of Al-Zn-Mg-Cu (EA431) compacts, liquid phase formation as a function of sintering temperature plays an important role in densification and resulting properties. The effect of sintering temperature and the necessity of applying its optimum value can be revealed by measuring resonant frequency, which is a quick and nondestructive testing. However, time consuming study of metallographic sections and fracture surfaces as well as measuring physical and mechanical properties give a good reference to the mechanism taking place during sintering. In this research the measured frequency formulated as Dynamic Young’s modulus and then correlated with sintered density, dimensional change, hardness and transverse rupture strength of sintered specimens. The established correlations demonstrate the effectiveness of measuring resonant frequency for easy evaluating sintering circumstance of this grade of materials.

Keywords: Al-Zn-Mg-Cu Mixed Powder; Sintering Temperature; Resonant Frequency; Nondestructive Testing.
Combustion Synthesize of TiC Composite in Nickel Aluminide Matrix

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Abstract

In this study investigated production TiC-NiAl and TiC-Ni3Al composites with a combustion synthesis technique. Ti₂Ni, Al, Ni and carbon powders were used as the starting materials. X-Ray diffraction (XRD) method was used to characterize the reaction products and scanning electron microscopy (SEM) analysis was used to study the microstructure of the composites. The results show that production of the TiC-NiAl & TiC-Ni3Al composites, is feasible by the combustion synthesis. XRD analysis shows that NiAl and Ni3Al can be formed at different ratio of Ni, Al. Also the results of the micro hardness testing for the mentioned composites indicates that with increase in the combustion temperature and the C/Ti ratio in the TiCx compound, the hardness will increase.

Keywords: Combustion Synthesis; Composite; Nickel Aluminide; Titanium Carbide.
Optimization of Cleaning Evaporator Tubes in Bayer Process

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Abstract

During Bayer process of Jajarm Alumina Complex, sodium aluminosilicate scales in different equipment, especially in thermal heat exchangers of condensation units of sodium aluminates. This leads to reducing total heat transfer coefficient and increasing energy consumption. We use sulfuric acid as a solvent, acetic acid as an organic additive and refalgan as a corrosion inhibitor. Using 3 %w of acid with 0.1 %w of refalgan in 25 °C and 75 minutes removed the whole scales from inner surface of heat exchanger tubes. Using optimum amounts in industrial scale, causes to %80 increase of heat transfer coefficient and tubes corrosion are measured 0.00037 mm. The effect of organic additive “acetic acid” on descaling was assessed separately, which led to %15 increases in the descaling efficiency.

Keywords: Bayer Process; Sulfuric Acid; Descaling; Heat Exchanger; Aluminosilicate
Optimization of the Gallium Solvent Extraction from Jajarm Bayer Liquor Process

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Abstract

Optimization of the gallium solvent extraction process from Jajarm Bayer process liquor containing 164.90 g/L of Na₂O, 86.70 g/L of Al₂O₃ and 197 mg/L of gallium was carried out using Kelex-100, a 7-alkyl substituted-8 hydroxyquinoline as an extractant. According to our previous results, the main problems of the process were high coextraction of aluminium with gallium, formation of crude and impossible reusing of the stripped organic phase. Different scenarios were studied to make the reusing of the organic phase possible. The results showed that using 10 vol% iso-decanol as a modifier instead of etanol causes less coextraction of aluminum with gallium, which decreases from 30% to 11%. Also, in scrabbing process, almost 100% of Al is removed from the organic phase. Isodcanol also prevents formation of crude and recovery of organic phase is possible.

Keywords: Gallium; Solvent Extraction; Kelex-100
Determination of crystallite size and influence of coke calcinations level on CO$_2$ reactivity and specific electrical resistance of coke

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Abstract

The average crystallite size ($L_C$) is an important property of carbon materials for aluminum electrolysis. $L_C$ is a useful factor to characterize the petroleum coke (PC) calcination level and in some cases to estimate the baking level of anodes. CO$_2$ reactivity of coke and specific electrical resistance (SER) are two important parameters in manufacturing of anode in aluminum industries. In addition the amount of sulfur and calcination temperature of coke is very effective. We demonstrate the effect of coke calcination with different sulfur level on CO$_2$ reactivity and specific electrical resistance. Many types of coke samples which were calcinated in different temperatures have been examined in this study. The $L_C$ of coke samples has been estimated by the XRD then CO$_2$ reactivity and specific electrical resistance of coke were determined. Our data shows that when calcination of coke increases, CO$_2$ reactivity and specific electrical resistance of coke will decrease.

Keywords: Crystallite Size ($L_C$); CO$_2$ Reactivity of Coke; Specific Electrical Resistance; Calcination Level
Practical Experiment in Confronting / Dealing with a Sick Cell in an Aluminum Production Smelter

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Abstract

This paper describes a useful experience, which was conducted during start-up and potroom operation regarding a sick cell treatment in an aluminum smelter in Iran, which we will call smelter X in this paper. Different parameters in the potroom have influence on cell stability, which need to be considered all together. Metal pad stability is the main concern for a smooth operation in an aluminum smelter to reach a low noise level and a high current efficiency. One of smelter X’s aluminum reduction cells, which was started with good and smooth operating parameters, turned into a sick cell with a very high noise level two months after its start up. A special team started to monitor, test, analyze and try different strategies to bring the cell back to normal condition. This paper is a summary of the aforementioned challenge, team endeavor, possible solutions and final results to overcome this problematic issue.

Keywords: Cathode Collector Bar; Cathode Current Distribution; Anode Current Distribution; ACD (Anode Cathode Distance); Finger
Study on Anode Baking Parameters in Open-Top and Closed-Type Ring Furnaces

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Abstract

Anode quality has strong impacts on the net carbon consumption in electrolysis cell and subsequently on aluminum production costs. Moreover, inasmuch as baking process is the most expensive step in the anode production and in the other side, anode properties influenced by baking process, therefore furnace selection (open-top or closed-type) and baking process control are always prime priorities that have to be deliberately taken into accounts by smelters. Furthermore, the most important baking parameters are the anode heat-up rate and the baking level, in that the present study deals with the main factors such as influence of firing section on temperature gradient as well as the effect of heat-up duration and anode size on baking level.

Keywords: Anode; Baking; Heat-Up Rate; Baking Level
Potline Start Up without Anode Effect Frequency

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Almahdi-Hormozal aluminium smelter, P.O. Box: 79171-76385, Bandar Abbas, Iran

Abstract

In this Research the details of preheat stages, bath up and metal pouring, the pots number 186 (new method without anode effect) and 38 (old method with anode effect) through 175KA-D18 technology, and pots number 88 (new method without anode effect) and 103 (old method with anode effect) by technology 230kA-D20 have been Compared and studied. Our calculations have shown that in these technologies for starting up the one pot, we have respectively 11.89 and 21.41 Mwh reduction energy consumption for one pot. It seems with this new method we would have such reduction 3532.96Mwh for the other of the pots up to the end of year.

Keywords: Potline Start Up; Without Anode Effect
Retrofit Upgrade of Center Break Cell Technology to Point Feeding Cell Technology Implementing Required Mechanical and Automation Changes

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Abstract

Aluminium reduction cells have benefited from point feeding technology for a long time, but there are still smelters which are using the old technology of center break and center feed system. Due to several factors this system is no longer approved and there have been a few attempts worldwide to upgrade these cells so as to implement the newer technology by applying mechanical and automation changes. In this paper 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.

Keywords: Center Break; Reduction Cell; Point Feeder System; Superstructure Retrofit
Preparation of Pharmaceutical Dried Aluminium Hydroxide Gel from Iranian Nepheline Syenite

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Abstract

In the first step of this research we produced Aluminium hydroxide from nepheline syenite ore using of a pyrometallurgical and hydrometallurgical method. We dissolved aluminium hydroxide in the sulphuric acid and added the obtained aluminium sulphate to potassium hydrogen carbonate solution. Product was washed with water and ethanol carefully and its solvents were emitted by centrifuge method. Resulting gel was dried between 40 °C -50 °C.

Keywords: Dried Aluminium Hydroxide Gel; Nepheline Syenite; Hypertension.
Impact of Energy on the Production of Aluminum and the Geographical Distribution of Primary Aluminum Plants

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Abstract

The Hall–Héroult process is currently the major industrial process for the production of aluminum which utilizes electrometallurgical reduction. %80 of production cost largely depends on the price of alumina, electricity and carbon materials, with the rest divided between labor, additives, maintenance and repairment. Electric power represents about 20% to 40% of the cost of producing aluminum, depending on the location of the smelter. Energy issues have a profound impact on the location and production of aluminum as well as environmental issues related to production. During the past decade scientists and producers have sought to save energy, reduce greenhouse gas emissions, reduce aluminum production costs, and increase productivity. The industry is a large consumer of both natural gas and electricity, with natural gas consumed in the anode baking plant and electricity in the potroom for electrolyzing of aluminum. This paper seeks to give a brief account of the current status and challenges of energy sources across the world in general and Iran in particular. The authors will also dwell on the effects of available energy sources such as hydro-electric, gas and steam on the geographic location of aluminum smelters. In conclusion this paper offers suggestions on how to overcome the existing challenges and assist the expansion on the industry on a national level.
SIMULATION
AND
AUTOMATION
AlPSim®: Simulation Software for Modeling of Aluminum Electrolysis Cell

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Abstract

Due to a limiting number of operational parameters that can be measured in an operating cell, the process is not fully understood and cell operation based largely on experience. In this work, the principles of the Hall-Héroult process are presented and a mathematical model developed to predict the behavior of an aluminum reduction cell. 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 Liquidus Temperature) in order to optimize operational parameter in aluminium production systems. AlPSim is a mathematical-experimental model with a static simulation base with ability to evaluate the effect of additive same as Alumina, Carbonate Sodium and Aluminium Fluoride on the electrolysis properties and cell voltage. Cell Voltage in this model separated to decomposition voltage, over voltage and ohmic voltage drops which is part of the ohmic voltage measured manually with operators and will be used as an input parameters.

Keywords: AlPSim; Mathematical Model; Aluminium Electrolysis; Mass & Energy Balance; Electrolyte Properties
An EWMA –Based Method for Monitoring Polytomous Logistic Profiles (Case Study: Alloy Fasteners' Manufacturing Process)

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Abstract

In certain statistical process control applications, quality of a process or product can be characterized by a function commonly referred to as profile. Some of the potential applications of profile monitoring are cases where quality characteristic of interest is modelled using dichotomous or polytomous variables. Polytomous variables, especially multinomial variables, have various applications. In this paper, we proposed three methods for monitoring a profile when the process output is a multinomial response variable. Multinomial logistic regression (MLR) provides the basis for our profile model. Two methods including Multivariate exponentially weighted moving average (MEWMA) statistics, and Likelihood ratio test (LRT) statistics are proposed to monitor MLR profiles in phase II. Performances of these three methods are evaluated by average run length criterion (ARL). A real case study from alloy fasteners manufacturing process is used to illustrate the implementation of the proposed approach. Results indicate satisfactory performance for the proposed method.

Keywords: Average Run Length (ARL); Multivariate Exponentially Weighted Moving Average (MEWMA) Control Chart; Multinomial Regression; Profile Monitoring; Alloy Fasteners
Numerical Investigation of the Effects of Constraint Design on 5XXX Al Alloy GTA Welding

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Abstract

One of the most conventional approaches of quality control in metal weldments is the evaluation of residual stresses and distortion. Constraining the structure during welding, is the significant key parameter for optimizing the residual stress. In this research, an attempt was made to obtain the best welding constraint of 5XXX Al alloy lap joints during double pass GTAW. A 3-Dimensional finite element simulation was utilized for determining the effect of three different types of local U-shape Fixture (LUF) on residual stresses distributions and distortion. Considering sequentially coupled thermal-mechanical strategy, double ellipsoidal modelling of heat source and element death and birth technique were used in simulation. Thermocouple and LVDT’s set up were applied to validate thermal and mechanical results, respectively. Results provided by simulation show acceptable agreement with experimental values. According to results obtained from simulation, suitable LUFs selected based on optimum residual stresses and distortion in welding the aluminium structure.

Keywords: GTA Welding; Residual Stress; Numerical Analysis; Distortion
Simulation of Heat Transfer and Phase Change in Laser Welding of Aluminum Alloy 6061T6


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Abstract

According to vast applications of aluminium alloy in automobile, aerospace, and other industries, laser welding is an important technique in welding alloys. The purpose of this study is to develop a numerical model to predict temperature distribution during melting and solidification in laser welding process. The governing equation including heat transfer and phase change equations are solved by using a numerical code based on finite volume technique written with FORTRAN programming language. The results obtained from the developed model have been compared to results from experimental studies. The comparison of these data shows a desirable conformity. Finally, parametrical studies have been performed with the verified model in order to investigate the effect of operating parameters on laser welding procedure of AA6061.

Keywords: Numerical Simulation; Laser welding; AA6061T6; finite Volume Method; heat transfer
Theoretical Investigation of Roll Bonding Process of Clad Sheets by Finite Element Method

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Abstract

Roll bonding is a solid-state welding process to join similar and dissimilar metals and a well-established and widely used manufacturing process. In this study the rolling process of St12/Al1050 clad strips were simulated by finite element methods (FEM). Effects of various parameters such as the total thickness reduction of strip and friction coefficient in roll-sheet interface upon the bonding behaviour and deformation of each sheet were also studied. The validity of FEM results were verified according to experimental investigations that showed satisfactory consistency with finite element results.

Keywords: Roll Bonding; Relative Bonding Length; FEM
Evaluation of Heat Transfer Coefficient and Solidified Structure of Al-9Si3Cu Alloy Using Thermal Analysis and Inverse Modeling Method

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Abstract

In this investigation heat transfer coefficient at the interface of Al-Si melt and green sand mold was evaluated using thermal analysis and inverse modeling method. Also, the solidifying structure of sample was simulated by Cellular Automaton-Finite Element (CAFE) method. For this purpose, a cylindrical part of Al-413 alloy was cast in a green sand mold and the temperature changes versus time was measured by K-type thermocouple and the data was recorded using data logger apparatus at the interface of the cast/mold. Inverse modeling was carried out using traditional finite element ProCAST software equipped with CAFE module. Macrostructure of the solidified sample was evaluated and compared with the result of the CAFE to validate the simulation results. Good agreements between modeling and the experimental results were observed.

Keywords: Heat Transfer Coefficient; Green Sand Mold; Inverse Modeling; Thermal Analysis; Cellular Automaton-Finite Element (CAFE).
Applying Nano Technology to Remove Toxic H2S Gas Compounds from Exhaust Gases in Primary Aluminium Industry (Monte Carlo Simulation)

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Abstract

Dealing with the exhaust gases from aluminium smelters is still an interesting subject for investigation. The amount of H2S in aluminium reduction cells is enough to produce H2S gase. Immediate removal of the highly toxic H2S gases makes FTP (Fume Treatment Plant) to just deal with fluoric gases such as HF. Due to the capability of nanotubes in adsorbing gases, this study has been conducted to figure out the adsorption of H2S on (8,8) armchair carbon nanotubes (CNTs). Lenmaed-Jones potential was used for gas-gas and gas-carbon nanotube interactions and the potential parameters for the carbon-gas and carbon-carbon interactions were obtained from the Lorenz-Berthelot combining rules. The study has been done by using the equation state of Virial and finding the second coefficient in Virial equation. Final steps were the inside density, outside density and total density of nanotubes calculation.

Keywords: Carbon Nanotube; Adsorption Gas; Monte Carlo Simulation
Grain Growth Analysis during Annealing of ECAPed 2024 Al Alloy by Monte-Carlo Technique in the Time Scale of Days

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Abstract

Equal channel angular pressing (ECAP) is the most promising among the developed severe plastic deformation (SPD) techniques to induce strain and Energy in bulk metals. A two-dimensional Monte-Carlo method of simulating the microstructure evolution was developed and applied to studying Grain growth in 2024 aluminum alloy processed by preliminary Ecap. The grains map and grain-growth exponent (n) was computed at temperatures in the range of 200–450 °C and the time Scale of Days.

Keywords: ECAP; Monte Carlo Method; Grain Growth; Aluminium Alloy
Thermo-Electrical Modeling of an Aluminum Reduction Cell

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Abstract

In this research a 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. The aim, in this paper, has been to evaluate influence of increasing the amperage on side wall ledge (frozen electrolyte) by using thermo-electric model of reduction cells of Almahdi Aluminium Company located in Bandar Abbas. By comparing of the Results obtained from the solution of model with those obtained from real operation of reduction cells the possibility to increase to production by applying higher amperage was evaluated. Results from numerical solution including operational temperature, frozen ledge thickness are to a large extent according to expectations and measurements. It was found that increasing the amperage in Almahdi Pots from plant nominal value of 175 K Amp to 185 K Amp would melt down the protective side freeze resulting in pot failure.

Keywords: Modeling-Reduction Cell (Pot)-Heat Balance-Ledge(Frozen Electrolyte)-Finite Element
A Numerical Study on the Effect of Air Gap on the Solidification of A356 Alloy

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Abstract

Among the numerous methods available to evaluate the heat transfer coefficient within the mold/casting interface, the air gap measurement and reverse-simulation methods are more common because of their simplicity and accuracy. In this research, the heat transfer coefficient at the interface between a low-carbon steel mold and A356 aluminum casting was evaluated using the reverse-simulation method. The temperature was measured in two different points of the mold in order to assess the heat transfer coefficient at the interface. The cooling curves of A356 aluminum alloy at two different superheat temperatures within the steel mold were obtained by means of a thermal analysis system. Mathematical simulation was performed using a FORTRAN code assuming complete transfer of heat from the mold wall and geometrical symmetry of the air gap, and the cooling curve information was obtained from the program. Considering the differences between the temperatures obtained from the two methods, the heat transfer coefficient at the mold wall was modified at each time interval to make the data from simulation approach the experimental data.

Keywords: Heat Transfer Coefficient; A356 Aluminum; Simulation; Low Carbon Steel Mold.
POWDER METALLURGY
An Investigation of Aluminum Foam Produced by Sintering Evaporation Process

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Abstract

Aluminum foam has been manufactured successfully by sintering evaporation process. This process consisted of mixing Al and NaNO₃ powders, pressing and final sintering to evaporate the filler material of NaNO₃ powders. NaNO₃ was eliminated completely during sintering, and strong metallurgical bonding in the cell walls was achieved. The morphology (pore size, shape, and direction) and the compressing deformation behavior of metal foams have been investigated. It was found that the maximum stress and the energy absorption of the cellular aluminum increased with the using of NaNO₃.

Keywords: Aluminum Foam; Sintering Evaporation Process; Filler Materials; Nano₃ Powders
**Structural and Mechanical Properties of Powder Metallurgical AA5056/15 Vol% MoSi$_2$ Composites: Effect of the Processing Route**

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**Abstract**

In this research, the effect of different blending procedures on structural and mechanical properties of PM AA5056 aluminum matrix composites reinforced with 15 vol% MoSi$_2$ intermetallic compound particles is reported. Low energy cube blending and high energy ball milling were used for mixing the matrix and intermetallic compound powders. The resulted composite powders then were encapsulated and hot extruded to composite bars. The results confirmed the effect of ball milling on production of a finer distribution of the reinforcement in the matrix, and a higher strength and hardness of the composite in comparison to cube mixed powder. The interface between the matrix and the reinforcements was clean in both composites as confirmed by scanning electron microscopy. Fracture surface analysis revealed particle/matrix debonding and particle fracture as main failure modes of the low energy and high energy blended composites, respectively.

**Keywords:** Aluminum Matrix Composites; Intermetallic Compound MoSi$_2$ Reinforcement; Mechanical Properties.
Structure Development of Al-Zn-Cu/Al₃Mg₂ Composite Fabricated by Mechanical Alloying

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Abstract

In the current study, the effect of milling time on the grain size of Al-Zn-Cu/Al₃Mg₂ composite was investigated. In order to produce the composite, Al₃Mg₂ milled powders as a reinforcement particles were added to Al-Zn-Cu milled powder as a matrix phase and then they were milled together. Different milling times (10, 15 and 20 hours) were used in this study. XRD analysis and Scanning Electron Microscopy (SEM) were used to investigate the grain size of the milled composite powder. The result indicates that the optimum milling time to achieve the lowest grain size is 20 hours. Longer milling times (more than 20 hours) were found to be unsuitable due to the declined Al₃Mg₂ grain size resulted from the expansion of Al₃Mg₂ particle special surfaces. Therefore, this phenomenon causes more reaction between the particles and environment which results in burning loss of the particles.

Keywords: Complex Metallic Alloy; B-Al₃Mg₂; Metal Matrix Composite; Mechanical Alloying.
The Production of Al/Al$_2$O$_3$ Composite Strips Using a New Method

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Abstract

In this work, particle reinforced aluminum composite strips with 2 and 4 wt% of Al$_2$O$_3$ were obtained from powder mixture using powder metallurgy (P/M), mechanical alloying (MA), and vacuum hot pressing (VHP) were followed by hot rolling process. The microstructural evolution and mechanical properties of Al/Al$_2$O$_3$ composite strips were evaluated. Optical microscopic investigations of hot rolled aluminum matrix composite (AMC) were done to study the redistribution of alumina particles in the matrix and also the morphology of Al$_2$O$_3$ particles after 90% thickness reduction. The effect of alumina content in the matrix on hardness, tensile strength, and elongation was examined. Scanning electron microscope (SEM) was used for evaluation of fracture surfaces after tensile test and also aluminum-alumina interface.

Keywords: Powder Metallurgy; Mechanical Alloying; Vacuum Hot Pressing; Hot Rolling; Mechanical Properties
Effect of Annealing Temperature on Synthesis of Aluminum Carbide with Mechanical Alloying Process

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Abstract

Guidelines Aluminium and its alloys due to the ease of formability and lightweight have a wide application in variety of industries including aerospace, automotive, electronics and so on. But because do not have enough strength in some engineering applications, many research has been on the production of aluminium composites by mechanical alloying process in recent years. In this study the effect of annealing temperature on the synthesis of aluminium carbide product with mechanical alloying process has been studied. Phase formation and particle size identified by scanning electron microscopy and X-ray diffraction analysis and determine the optimal grinding. The experimental results show that no chemical interaction occurred between Al powders and carbon black during mechanical alloying processing and mechanical alloying causing high deformation of powders, which results in the formation of amorphous structure. after the mechanical alloying for 30 hours, and the annealing temperature in 550 ºC resulted in higher deformation of Al particles and caused a high internal energy, This energy facilitated the formation of the Al4C3 phase during sintering.

Keywords: Mechanical Alloying; Powder Metallurgy; Aluminium Carbide; Synthesis
Production and Effect of Heat Treatment on the Microstructure and Mechanical Properties of AA2124/Vol%25MoSi₂ Composites

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Abstract

In the present work, AA2124/25vol%MoSi₂ composites were produced by two different powder metallurgy routs: high energy ball milling of the reinforcement and alloy powder and then consolidation by extrusion (B composite), and wet blending of the powders with cyclohexane and extrusion (W composite). The composite bars then were cut to small pieces ready for structural and mechanical characterization. Some of the samples were heat treated to T6 temper (solution treated and artificially aged to peak hardness). Hardness, micro hardness and compression tests performed on both as-extruded and heat-treated samples. The compression tests were performed under quasistatic loading (strain rate of $8 \times 10^{-4}$) at room temperature. Microstructure and fracture profile were observed by scanning electron microscopy (SEM). The forming reaction products at matrix were identified by energy-dispersive X-ray (EDX) and X-ray diffraction analysis. The results showed that in both cases, the copper rich interphase has been formed. Hardness increased substantially by addition of intermetallic compounds to 2124 matrix. Heat treatment improved the mechanical properties of both composites. The composite produced by high energy method had higher yield strength and lower elongation to failure comparing to wet blended composite. Study the fracture surface features by SEM verified that the lower elongation of B composite is due to work hardening of the matrix during the milling and/or dynamic recrystallization of the matrix during extrusion. Particle debonding was also more sensible in W composite.

Keywords: 2124 Aluminium Composites; Molybdenum Disilicide; Heat Treatment; Microstructure; Mechanical Properties.
Investigation of Microstructure and Wear Properties of Al–4.5 wt% TiC Nanocomposites Produced by Mechanical Milling

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Abstract

The present work deals with studies on the manufacturing and investigation of mechanical and wear behavior of aluminum alloy matrix composites (AAMCs), produced using powder metallurgy technique of ball milled mixing in a high energy attritor and using a blend–press–sinter methodology. Matrix of pre-mechanical alloyed Al–4.5 wt.% Cu was used to which different fractions of nano and micron size TiC reinforcing particles (ranging from 0 to 10 wt.%) were added. The powders were mixed using a planetary ball mill. Consolidation was conducted by uniaxial pressing at 650 MPa. Sintering procedure was done at 400 °C for 90 min. The results indicated that as TiC particle size is reduced to nanometre scale and the TiC content is increased up to optimum levels. The wear resistance of the composite increase significantly, whereas relative density, grain size and distribution homogeneity decrease. Microstructural characterization of the as-pressed samples revealed reasonably uniform distribution of TiC reinforcing particulates and presence of minimal porosity. The wear test disclosed that the wear resistance of all specimens increases with the addition of nano and micronsize TiC particles (up to 5 wt.%). Scanning electron microscopic observation of the worn surfaces was conducted and the dominant wear mechanism was recognized as abrasive wear accompanied by some delamination wear mechanism.

Keywords: Metal Matrix Composite; Mechanical Alloying; Wear
RECYCLING
Process Development for the Removal of Cr(VI) from Effluents Using Red Mud, an Aluminium Industry Waste:
Batch Studies

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Abstract

Red mud is the waste material of alumina production industries. Hematite (Fe₂O₃) constituent of this material is an active component for adsorption of anion pollutants. In this study, removal of hexavalent chromium ions from aqueous solution using raw red mud (RRM) and chemically activated red mud (CARM) by nitric acid was investigated as an alternative to the conventional methods of Cr (VI) ions removal from industrial effluents. Raw and activated red muds were characterized by X-ray diffraction (XRD) and scanning electron microscopy (SEM). The results showed that activation of red mud by nitric acid resulted in an increase on the removal percentage of Cr (VI) ions from 55% to 97% for the following condition: initial pH of solution 2.5, activated red mud dosage of 10 g/L, contact time of one minute and initial Cr (VI) concentration of 10 mg/L at the temperature of 30 °C and mixing velocity of 500 rpm. The percentage of Cr (VI) ions removal increased with higher amounts of adsorbent and decreased with higher concentration of Cr (VI) ions. The results suggested that activated red mud could be used as effective and economical adsorbent for Cr (VI) ions removal from aqueous solutions.

Keywords: Red Mud; Chemical Activation; Hexavalent Chromium; Industrial Effluents.
A New Approach for Recycling of Aluminum Machining Chips into the Form of an Al/Al₂O₃ Composite

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Abstract

Recovery of aluminum from machining chips using conventional remelting processes is very low due to the high surface oxidation of chips and also difficulties in remelting practices. The aim of this work was to investigate possibility of recovery of aluminum machining chips into the form of aluminum based composite material with Al₂O₃ particles as reinforcement. The applied experimental procedures involves cold pressing of chips inside an especially designed steel mould followed by subsequent repeated thermo-mechanical stages in none protected ambient, including heating up to 1050°C and impact loadings. The resulted microstructure contains nearly homogeneously distributed Al₂O₃ particles originated from the oxide layer on the surface of the chips. Due to growth of surface oxide layer of chips during thermo-mechanical treatments, sufficient amount of dispersed oxide particles were available to produce suitable composite microstructure. Vickers hardness measurements indicated that optimized structure had hardness values of greater than 550 VHN which is comparable with Al/Al₂O₃ composite materials produced by conventional methods.

Keywords: Aluminum Chips; Al/Al₂O₃ Composite; Hardness
MISCELLANEOUS
Aluminium Extrusion Industrial Application—Vast Potential Ahead—

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Abstract

Global usage of aluminium extrusions in 2011 is estimated at 14.6 million tonnes and of this, the industrial applications account for about 5.4 million tonnes. The need for light weighting of vehicles, numerous industrial systems & components combined with new opportunities in the electrical energy sector, has opened up new avenues for the usage of aluminium extrusions. This coupled with stringent environmental requirements will drive the demand for aluminium extrusions through this decade. This paper attempts to provide an overview of the growth potential for aluminium extrusions in industrial applications from a market perspective.

Keywords: Aluminium; Extrusions; Transportation; Industrial; Electrical
The Best Possible Energy Management in Primary Aluminum Industry by Constructing Waste Heat Recovery Plant – A Detailed Investigation

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2Department of Chemical Engineering, Razi University, Kermanshah, Iran

Abstract

Half of the input energy to aluminum reduction cell will be lost as waste heat which could be studied for possible recovery. One of the possible choices for recovering is from aluminum exhaust gases that needs minimum modifications for reduction cell and has no influence on cell heat balance, which is vital for the operation. By using heat exchangers with in-line and staggered tube arrangements, which placed before fume treatment plant (FTP) we will be able to recover enough amount of heat. The main challenging problem, which is necessary to overcome, will be the heat exchanger material and its design because of corrosive and dusty exhaust gases from potroom. In this paper, a desalination system with six effects of evaporator is proposed for producing distilled water by using recovered heat from hot exhaust gases. The theoretical calculated amount of produced distilled water is around 27,000 kg/hr in this specific suggested desalination plant. Besides theoretical investigation, we are trying to make a quick and simple understanding of the real situation for the waste heat recovery plant regarding heat exchangers fouling, how often we need to shut down the plant for maintenance or cleaning, and plant thermal efficiency with considering fouling.

Keywords: Desalination; Heat Exchanger; Fouling; Corrosion; Thermal Efficiency; FTP (Fume Treatment Plant)
Roadmap of Iranian Aluminum Industries Development, Considering New Energy Cost Situation

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Abstract

This article is surveying the condition of Aluminum industry, technology and economy for the new condition in Iran. It analyzes the situation with respect to the production in the region and the world. It also investigates the effects of subsidization elimination on strategies of Aluminum development, and shows a proper road map to Aluminum producer industries in the new circumstance. Electricity consumption of production one kilogram Aluminum is about 14 KWh. So Aluminum production is one effective method to saving and condensing energy. This is a reason for Iran and other Persian Gulf countries, whose oil and gas is excessive for export, to think about converting their raw oil to Aluminum primary products. For this reason the strategy of Iranian Aluminum industry had developed to producing about 1.5 million tons primary Aluminum. Iran had a subsidized economy for about 30 years. The subsidization was considered for some common consumable products, especially for energy, electricity and even some capital investment. The subsidize capacity for energy was almost more than 50 billion US dollars in 2010. The whole economy, industry and even the culture were affected by this policy in Iran. Since 2011, after 30 years governing subsidy regulation, the policy changes competitive condition by elimination of subsidized policy. This changes the economical and technological condition of Iranian industries. The most effect will be for Aluminum production industries, as primary Aluminum production needs a lot of energy.

Keywords: National Development; Aluminum; Aluminum Road Map; Iranian Aluminum; Aluminum Industry; Industry Development Strategy;
Aluminium Market Drivers; Will They Steer a Winning or Losing Future for the Metal?

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Abstract

Since aluminium is a commodity and is being traded globally, its destiny is very much dependable on the economic conditions of the world, especially in today's situation where there's a continuing threat of a "Deep Recession". Therefore, indices like dollar/euro fluctuations, bank interest rates, powerful economies' GDPs and their macroeconomic factors influence this metal's fate and prices, as well as other basic metals. Besides general business atmosphere of the world, other drivers leading aluminium's market through a more direct approach include balance between production and demand (raw material and ingot) and its price structure, applications and substitution potentials, its energy-intensity and recyclability. In this paper we are going to discuss which of the above drivers or characteristics could most probably draw a booming or gloomy future for aluminium. A special focus would be given on aluminium's abilities or faults to become a dominant metal to be chosen by tomorrow's industrialists over other competitors like Steel and Carbon fiber reinforced plastics for uses in its big customers; automotive and aerospace.

Keywords: Aluminium; Economy; Market Drivers; Price; Future; Automotive; Aerospace
Managing the Effects of Iranian National Subsidy Reform in Primary Aluminum Industry

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Abstract

Continuous reforming of economy is one of the most important tasks for each national or international policymaker. This includes both developed countries and developing nations, especially when the world economy is not in a great situation. Investment funds to develop economy need new financial resources, which should be provided also from other sources than the regular national budget. The money which goes for national subsidy without any designated target or plan will be a great source of investment funds to prosper economy. In order to decrease the negative impacts of subsidy reforming on different parts of society and industry, it will be necessary to prepare a thorough study on these subjects before taking any action. This paper is an educated study with a detailed investigation regarding the aluminum industry situation after establishing subsidy reforming plan in Iran. It is also discussing short-term and long-term solutions to overcome the possible problems.

Keywords: Subsidy Reform; Economy Infrastructure; Primary Aluminum Industry; Potroom; Current Efficiency
Establishing Fundamentals for Calculating Aluminum Factory's Product Final Price by Implementing Level3 Automation

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Abstract

This paper presents a sample Standard Level3 Automation implementation for improvement an Aluminum factory. Different approaches of an aluminum factory, the conditions of transferring information, the effect of these information on work cycle, the solution for decreasing the cost value, the importance of producing standard reports from manually and automatically collected data in a factory and finally the explanation of a realized sample implemented are the main approaches of this article. This kind of Total Information system will help the managers for the best usage of all potential, making new opportunity, improving situation, establishing operator controls, more exact prediction of future acts. Also the managing process will be improved by strict evaluating produces information. And by all these, analysis can act as a consultant for the managers.

Keywords: Level3 Automation; Information System; Product Lifecycle Management