Book of abstracts; 19th International foundrymen conference, Humans - Valuable Resource for Foundry Industry Development

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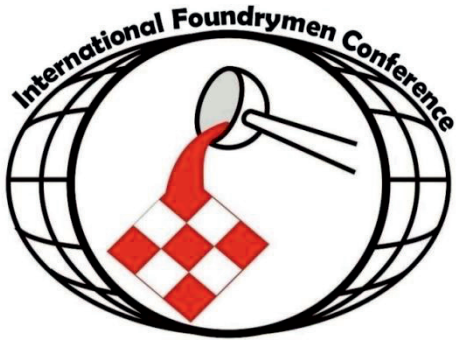
BOOK OF ABSTRACTS

19th INTERNATIONAL FOUNDRYMEN CONFERENCE

Humans - Valuable Resource for Foundry Industry Development



PROCEEDINGS BOOK

with papers *in extenso* included on USB

Split, May 16th – 18th, 2021

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PROCEEDINGS BOOK
19th INTERNATIONAL FOUNDRYMEN CONFERENCE
Humans - Valuable Resource for Foundry Industry Development

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Natalija Dolić, Zdenka Zovko Brodarac, Sandra Brajčinović

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PREFACE

Knowledge is becoming an increasingly important resource for economic development. The Republic of Croatia is facing the challenges of the world economy, with the aim to meet certain requirements in shaping the education system. Ensuring the quality assurance of the education system is just one of the requirements set up as a continuous mission of University of Zagreb Faculty of Metallurgy and other co-organizers from the high-education. As the level of education of the population affects the progress of the economy, it is extremely important for the Republic of Croatia to increase the ratio of highly educated persons. In recent years, the ratio of the highly educated population of the Republic of Croatia has been growing, but in comparison with Europe, Croatia is still lagging behind. In order to increase the share of highly educated persons, it is necessary to invest in the quality of education, both in higher education and in secondary and primary education. This would increase awareness of the importance of education, which would ultimately result in an increase in the ratio of highly educated and competent professionals.

Metal industry as a base branch represents an important factor contributing to the economic potential of each country. Current market development as well as technical and economic objective, the production of high-quality, low-cost and environmentally friendly casting, requires application of recent and advanced materials, as well as production technologies, followed and supported by understanding of production process. The metal industry has been recognized as a "driving subdivision" of economy development.

Until the recession and deepening of the economic crisis in Croatia, companies operated stably, focused on streamlining production, investing in technology and employee's education, increasing product quality and productivity, developing innovation and fighting for the market. The recession and economic crisis have slowed the strengthening of this economic activity. In order to overcome and mitigate the negative results caused by falling orders and reduced production, companies have developed new production programs and sought new customers and markets in order to maintain good positions within their market niches. Taking into account the growing need of large (global) producers for small series products, it is assumed that it will build a network of suppliers in which Croatian producers can be included. Small quantities are sufficient to employ their production capacities, and with a skilled workforce and new market opportunities, the growth of existing companies is expected, as well as the establishment of new ones. By investing in modern equipment and production certification, metal producers indicate a desire for growth. The main features of Croatian industry are stable product quality and reliability in accordance with EU standards, while on the other hand it is important to invest in available professional workforce, targeted support of scientific institutions, good production infrastructure with emphasis on modern technologies and transport links to the world.

Despite the recognizability and importance of the profession, the profession is underestimated by the amount of the average net monthly salary per employee in legal entities. The gross value added of the product is also indicative. Since the Croatian market is too small for significant production growth, companies in the observed activity primarily direct their production capacities to EU countries, which also means increasing the level of productivity of assets and labor. Competitiveness can be based exclusively on modern technology, efficient production processes but also on a highly skilled workforce. All this requires investment in infrastructure and educational study programs that should strive to acquire primarily practical knowledge and skills with an emphasis on the development and application of modern materials and technologies, in order to change this status of the Republic of Croatia.

Therefore, the motto of the ***19th International Foundrymen Conference*** is focused to the **HUMANS** as a **valuable resource for foundry industry development**. Human resources have an unavoidable role in scientific, technological and practical aspects concerning research, development and application of casting technology with the common perspective – increase of competitiveness.

Special attention will be focused towards the competitiveness ability of foundries, improvement of materials features and casting technologies, environmental protection as well as subjects connected to the application of castings.

During this Conference 49 papers will be presented in hybrid mode (online and in situ) due to pandemia of COVID-19 virus. In this Conference scientists from 14 countries (Australia, Austria, Bosnia and Herzegovina, Croatia, Czech Republic, India, Kosovo, Poland, Romania, Spain, Serbia, Slovenia, Slovakia, United States of America) recognized the importance to be a part of this scientific event. Book of Abstracts of the 19th International Foundrymen Conference includes summaries of the papers. The Proceedings book consists of papers *in extenso* published in electronic format (USB). Full length papers have undergone the international review procedure, done by eminent experts from corresponding fields, but have not undergone linguistic proof reading. Sequence of papers in Proceedings book has been done by category of papers in following order: plenary lectures, invited lectures, oral and poster presentation, and inside the category alphabetically by the first author's surname.

Within the Conference Student section is organized. This is an opportunity for industry to meet and recruit human resources as a main potential for business development. Coexistence of material science and sustainable technology in economic growth represent a knowledge transfer between small and medium enterprises' (SMEs´), industry and higher education institutions. Higher education at the Faculty of Metallurgy (HEI), conceived through the program and the learning outcomes, is based, inter alia, on promoting students' scientific and research work on applied topics, enabling ambitious and creative young people to become independent problem solvers, developing and supporting their curiosity, analytics and communication: **Graduates like the labour market needs!**

This occasion represents an opportunity to discuss and increase the mutual collaboration between HEIs' and industry with the aim of information exchange related to advanced experience in foundry processes and technologies, gaining the new experience in presentation and / or teaching methods and techniques within lifelong learning process.

The organizers of the Conference would like to thank all participants, reviewers, sponsors, auspices, media coverage and all those who have contributed to this Conference in any way.

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SOLIDIFICATION PATTERN OF HIGH-Si DUCTILE IRON CASTINGS IN THE PRESENCE OF MOULD COATINGS WITH S OR O CONTENT AND WITH OR WITHOUT PROTECTIVE AGENTS FOR THEIR DIFFUSION INTO THE IRON MELT

Denisa Anca, Mihai Chisamera, Stelian Stan, Iulian Riposan*

Politehnica University of Bucharest, Bucharest, Romania

Plenary lecture
Subject review

Abstract
The main objective of the present paper is to evaluate by thermal (cooling curve) analysis the solidification pattern and the occurrence of the layer of degenerate graphite at the surface of ductile iron castings (3.15 % Si, typically as 450-18 grade, ISO 1563/2011), with and without mould coating, including S or O, and different agents (carbonic material, iron powder) to blocking their diffusion into the iron melt. The obtained cast samples [standard ceramic cup] are used for structure evaluation [metal matrix and graphite parameters], in the superficial layer and the casting body.
It is found that the mould coating materials influence not only the parameters of the solidification cooling curves, during eutectic reaction and up to the end of solidification, but also the occurrence and the thickness of the un-desired skin layer, in the same or in an opposite way. Despite that the used ceramic mould is not able to supply active agents for nodularising elements consumption into the iron melt, a surface layer at different graphite morphologies comparing to the casting body is present, but at a large range of thickness, from 50 up to 200 μm. Higher level of skin thickness as metal matrix evaluation comparing to the graphite phase evaluation is present in all of the experimented variants.
Sulphur presence in the mould coating will promote higher skin thickness comparing to oxygen [up to 50 % by oxygen and 2.5-3.3 times for sulphur action], despite than in the casting body the graphite nodularity limited decreased (from 85 % up to 82-83 % level). Carbonic material or iron powder supplementary addition decreases these un-desired effects, but the solidification undercooling comparing to the equilibrium system is prominently increased. It is found that carbonic material is more efficient to limit oxygen and iron powder to limit sulphur negative effects on the casting skin thickness.

Keywords: *thermal analysis, solidification cooling curves, eutectic undercooling, ductile cast iron, mould coating, sulphur, oxygen, degenerated graphite surface layer, structure*

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MORE THEN A MANUFACTURER - BRODOSPLIT

Luka Čadež*

BRODOSPLIT d.d., Croatia

Plenary lecture
Subject review

Abstract

Progress of process of informatization and digitalization in Brodosplit in last five years is based on employment of young people who are ready to accept challenges and who can quickly accept any kind of software. Their contribution enabled implementation of new 3D software and consequently new way in making of drawings for production, beginning of integration process between new 3D software and legacy IT system that encompasses all the business processes, as well as automatization of certain tasks. Thanks to such an approach, production efficiency has been increased, particularly in technological process of pre-outfitting that has direct impact on significant savings in shipbuilding production.

Keywords: *informatization, digitalization, employment, implementation, integration, automatization, production, pre-outfitting*

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NUCLEATION AND CRYSTALLIZATION OF SPHEROIDAL GRAPHITE IN CAST IRON

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Plenary lecture
Subject review

Abstract

The last decade has witnessed significant research efforts directed to the understanding of nucleation and crystallization of graphite and associated solidification phenomena, driven in part by the ever-growing interest in the use of spheroidal graphite cast iron in the manufacture of large castings such as wind turbine parts. These applications raised new challenges to the production of sound castings, mostly because of the exceedingly long solidification times imposed by the size of the castings. These solidification conditions resulted in many instances in graphite degeneration with subsequent decrease of mechanical properties. Obviously, the subject of graphite nucleation and crystallization in cast iron is still in need of additional answers. Over the years, many reviews of the subject have been published. The goal of this paper is to provide an update on the advances achieved in comprehending the mechanisms that govern the nucleation and crystallization of spheroidal graphite and related imperfect morphologies from iron-carbon-silicon melts. In this analysis, we examine not only the crystallization of graphite in cast iron, but also that of metamorphic graphite (natural graphite formed through transformation by heat, pressure, or other natural actions), and of other materials with similar lattice structure and crystallization morphologies.

Keywords: *spheroidal graphite, graphite nucleation, graphite crystallization, graphene, metamorphic graphite*

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INFLUENCE OF ELEVATED WORKING TEMPERATURES ON MECHANICAL PROPERTIES OF AUSTEMPERED DUCTILE IRON

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Invited lecture
Original scientific paper

Abstract

Austempered Ductile Iron (ADI) is a class of ductile iron subjected to a specific heat treatment process (austenitization and austempering). The heat treatment gives to that type of Ductile Iron excellent mechanical properties. The high mechanical properties (tensile strength, hardness and impact energy) of ADI are the result of its unique ausferrite microstructure. In this paper an example of influence of elevated operating temperatures on the mechanical properties of the ADI samples is presented. Mechanical properties of the additionally treated ADI samples were changed due to decomposition of the ausferrite microstructure especially in the temperature region higher than 450 °C.The ADI samples were additionally heat treated at 250 °C, 350 °C, 450 °C, 500 °C, 600 °C, and 700 °C for two hours respectively and correlation between applied temperature and mechanical properties due to decomposition of the ausferrite microstructure were investigated.

***Keywords**: austempering, ausferrite microstructure decomposition, isothermal treatment, tensile strength, mathematical modeling*

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LOAD CAPACITY AND CORROSION BEHAVIOR OF QUENCHED AND TEMPERED STEEL 42CrMo4 AND CAST STEEL GS-42CrMo4

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Invited lecture
Original scientific paper

Abstract

In this research the load capacity and corrosion behavior of quenched and tempered steel 42CrMo4 and cast steel GS-42CrMo4 was investigated. Load capacity and corrosion behavior of steel and cast steel depend on processing history. The influence of processing parameters on load capacity, i.e. strength and toughness was investigated by using the 2^{5-2} factor experiment. It was found out that yield strength is insensitive on differences between applied manufacturing processes, but by application of hot working (plastic deformation above recrystallization temperature) and with proper pouring temperature the Charpy-V notch toughness is increased. Also, Charpy-V notch toughness is increased by interactive effect of the proper cooling rate during the casting and hot working. Corrosion behavior was evaluated by electrochemical measurements in 3.5 % aqueous solution of sodium chloride, NaCl. It was found out that by application of hot working the corrosion resistance is increased. Microstructure analysis shows that hot working leads to refining of microstructure and thus increasing load capacity and corrosion resistance of steel. It was found out that ASTM grain size number of prior austenite was equal to N.6-N.7 for steel processed by hot working, and N.4-N.5 for cast steel processed without hot working.

***Keywords:** load capacity, corrosion, cast steel, steel, quenching, tempering*

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SEMI-SOLID METAL PROCESSING; CHALLENGES AND INOVATIONS

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Invited lecture
Subject review

Abstract

Semi-solid metal (SSM) processing is novel melt treatment and alloy manipulation dealing with semi-solid slurries. SSM could be considered as an effective alternative to classical casting and forging manufacturing processes. In the absence of shear forces, the semi-solid slug is similar to a solid, while applying of shear forces the viscosity is greatly reduced, and the material flows like a liquid. Currently, this process strives to be industrially successful, generating different products with high quality parts in various industrial sectors. Since its establishment until today, numerous technologies around the world have been developed and implemented in order to produce the correct globular microstructure. The main objective of this paper is to classify currently available innovative technologies and to provide a comprehensive overview of possible mechanisms that result in better product quality and lower costs, taking into account the many challenges related with this new technology.

Keywords: *semi-solid processing, thixoforming, globular microstructure*

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MICROSTRUCTURE AND FORMABILITY DEVELOPMENT IN Al STRIP CASTING FOR QUALITY-DEMANDING FOIL PRODUCTION

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Invited lecture
Original scientific paper

Abstract

In comparison with hot-rolled strip, continuous cast strip is a cost-effective raw material for foil production, but different in terms of microstructure, phase composition, formability, and other technological characteristics. Due to the very rapid solidification of molten metal in a continuous thin strip, the microstructure consists of a strongly supersaturated aluminum solid solution and an increased fraction of fine particles of intermetallic phases, precipitated in Al crystal grains. This reduces cast-strip formability. Also, the cast strip's surface is oxidized and contaminated with graphite, which is an additional difficulty.
To produce strip from technical aluminum (group AA 1XXX) and alloys of the Al-Fe type (group AA 8xxx) it was necessary to change the casting parameters as well, as the parameters for further strip processing, which differ from conventional roll-casting procedures. Continuous cast strip is primarily intended for insulation, converter, and household foils of different widths. The principal foil characteristics, prescribed by EN standards, are the mechanical characteristics, surface quality, porosity, and thermostability.
The research work was focused on achieving the listed characteristics by changing the alloy composition and the conditions of transformation of continuous cast strip into the foil. A suitable thermomechanical treatment changes the distribution of alloy elements in the existing microstructural phases and thereby also their effect on static recrystallization, thereby affecting the surface quality and the mechanical characteristics of the foil.
In this study, the optimum composition and the process parameters of continuous casting that make it possible to use the strip as raw material for producing sheets and insulation, converter, and household foils of standard quality are presented.

Keywords: *continuous casting of Al strips, production of foil stock and foils, tailoring of microstructure, composition and formability of strips*

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EXPERIMENTAL AND NUMERICAL ANALYSIS OF PRINTED LATTICE STRUCTURE

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Invited lecture
Original scientific paper

Abstract

Additive manufacturing techniques enable produced components with extremely complex, not only external shapes, but also with the internal structures in their cores. One of these structures are lattice structures. Mechanical characteristics of such a 3D printed lattice structure depend firstly on the material from which it is made. Further, it also strongly depends on the topology of the structure itself. By varying of topology of a lattice structure, the physical response of such a structure can be significantly different and accordingly it can be easily adopted for a specific case.
This research deals with the originally designed 3D printed lattice structure, which is analysed both experimentally and numerically by uniaxial compression test. The samples were made from ABSplus - P430 Ivory plastic by FDM technique without the use of supporting material. The produced lattice specimens were subjected to a full range (up to failure) compression tests on the Zwick 1456 testing machine equipped with TestExpert software to process the measured data. The force-displacement diagram has been recorded during the testing. It was simulated also by finite element method to determine the stresses, displacements and reaction force obtained on upper plate, as well. The mesh sensitivity study was performed to check the mesh convergence.

Keywords: *3D printing, ABS plastic, lattice structure, finite element analysis, force-displacement, compression test*

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EFFICIENT METHOD OF MANUFACTURING DEMANDING PROTOTYPE CASTINGS USING INVESTMENT CASTING TECHNOLOGY

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Invited lecture
Original scientific paper

Abstract

Recently, the shapes of the castings have been designed to meet at least the basic requirements of the construction technology. It is the adaptation of the part construction to the production method to ensure efficient and quality production. The construction technology was focused on the model partition with respect to the pre-selected production technology focused on the elimination of hot spots by an ideal connection and wall transition to the elimination of foundry defects. For these reasons, the shapes of the castings were rather conservative, to meet the requirements for functionality and production technology. The development of new optimization methods in the 3D design such as topological optimization or generative design and the development of 3D printing methods have shifted the design of part shapes to an area that previously only belonged to artistic castings. Investment casting technology is trying to meet these new challenges. The speed of model preparation using 3D printing has advanced this technology considerably, especially when it comes to prototyping production. Connection with virtual manufacturing using numerical simulations then creates a field to produce castings on the first attempt. Rapid prototyping also includes Cyclone technology, which shortens the preparation of a ceramic shell from a few days to a few hours. This article deals with the interconnection of several different approaches and methods for casting production, where the main requirement is the time of delivery of the first prototype.

Keywords: *ceramic mold, additive manufacturing, numerical simulation*

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STRUCTURAL AND THERMAL PROPERTIES OF THE Sn–Zn ALLOYS

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Invited lecture
Original scientific paper

Abstract

Four hypereutectic Sn-Zn alloys with 69.5, 48.3, 28.1 and 14.1 at.% of Zn were produced by mixing and melting of pure metals Sn and Zn followed by cooling in air to room temperature. Microstructure and chemical compositions of prepared samples were analyzed by using scanning electron microscopy (SEM) with energy dispersive X-ray spectrometry (EDS). It was found that morphology of primary (Zn) phase changes from rounded and equiaxed dendritic structure to plate-like grains and finally to needle-like shape of grains with decreasing Zn content. Formation of characteristic broken-lamellar type of eutectic microstructure was observed in all investigated alloys. Melting behavior of the alloys was studied using differential scanning calorimetry (DSC). Phase transition temperatures and corresponding heat effects were experimentally determined and compared with the results of thermodynamic and phase equilibria calculations using the CALPHAD (CALculation of PHAse Diagrams) method and optimized thermodynamic parameters from literature. Thermal diffusivity of the studied alloys was measured using xenon flash method in the temperature range from 25 to 150 °C. Based on the measured values of thermal diffusivity and calculated specific heat capacity data, thermal conductivities of the solid alloys were obtained. It was found that thermal conductivity decreases monotonously with increasing temperature and Sn content. The results of thermal conductivity measurements were compared with literature data and with the data obtained from the Wiedemann-Franz law and measured electrical conductivities.

Keywords: *Sn–Zn alloys, solder, microstructure, thermal conductivity*

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PRINCIPLE OF TITANIUM DIOXIDE REDUCTION IN LIQUID ALUMINIUM

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Invited lecture
Original scientific paper

Abstract

Titanium dioxide is the most widely used white pigment and is present as a base in majority of paints used in the painting of aluminium tubes and cans. When remelting secondary aluminium painted with paint based on titanium dioxide, it is necessary to know the effects of different melting parameters. In the case of reduction of titanium dioxide in liquid aluminium, the acceptable limit of titanium in the melt could be exceeded. The aim of this investigation was to determine the influence of parameters and conditions of melt treatment, and how they effect on possible reduction of titanium dioxide in liquid aluminium. A series of samples were prepared to which the melt treatment conditions, the temperature and holding time of the meltwere changed, and the certain amount of titanium dioxide powder was added. Based on simple thermal analysis, cooling curves and characteristic temperatures were plotted, chemical composition was analysed, differential scanning calorimetry, XRD analysis of slag, optical microscopy was performed, and inclusions were analysed by scanning electron microscope and EDS analysis. Since there was no change in the chemical composition of any sample during the preparation of the first series of samples, and no reduction in titanium dioxide, an XRD analysis of the slag was performed, whereas its presence was investigated. The same happened with a series of samples made with the recycling process, where the presence of titanium dioxide in slag by XRD analysis was provedand no reductionwas confirmed. It turned out that under none of the implemented conditions there was no reduction of titanium dioxide in liquid aluminium and consequently introduction of titanium into the melt.

Keywords: *titanium dioxide, aluminothermic reduction, titanium, recycling of aluminium*

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DAMAGE ANALYSIS OF COMPACTED GRAPHITE CAST IRON

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Invited lecture
Original scientific paper

Abstract

Thermal fatigue testing of SiMoCr CGI (compacted graphite cast iron) cast alloy was performed with nitrided and non-nitrided samples, where cracks were evaluated at 400 / 600 °C and with following number of thermal cycles repetition: 1000, 2000 and 4000. Samples were cyclic inductive heated to set temperature and rapidly cooled with water stream through the bore in the sample. After the test, all the samples were sectioned where cross section was evaluated in detail. All cracks and their lengths were measured and statistically evaluated at 10 mm size measuring area.
Quantitative evaluation of cracks showed correlation between increased crack length and increased temperature and number of thermal cycles. Nitrided samples showed higher surface cohesion, further resulting with less smaller cracks in the surface area. Despite mentioned observation, total length of the cracks was higher on the nitrided samples.

Keywords: *thermal fatigue testing, damage analysis, CGI*

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BENTONITE – ECOLOGICAL BINDING MATERIAL OF FIRST GENERATION AND ITS USING IN FOUNDRY

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Invited lecture
Preliminary work

Abstract

Bentonite is an off-white montmorillonite clay formed from altered volcanic ash. It has a sheet-silicate structure and is especially notable for the way in which it absorbs and loses water and for its base-exchange properties. Sodic bentonite can absorb up to 10 times its own weight in water and can swell to 18 times its dry volume. Thus, it can be applied where its colloidal properties can be exploited. Bentonite has a wide variety of uses including foundry, animal feed, drilling mud, absorbent, industrial, and specialty uses. About 70 % of the world's known supply of Western or sodium-type bentonite occurs in the state of Wyoming (notably in the Mowry Formation), with additional significant deposits elsewhere in the Western United States. Volcanoes of the Yellowstone area of Wyoming were active for long periods in the early Cretaceous (c. 100 million years) and deposited ash layers of a few centimeters up to 15 m thick into nearby shallow seas. The ash weathered with time, forming the bentonite. Early uses of bentonite in the 1800 s, included lubricant for wagon wheels, sealant for log cabin roofs, and soap. Modern uses are highly variable. In foundry or metal casting, bentonite is mixed with sand to make the molds. The bentonite forms a pliable bond with the sand grains, so the mixture holds its shape well. Bentonite also absorbs excees moisture and oils. Some recent research has shown that the base-exchange properties of bentonite allow it to help remove certain toxins and ammonia. It also reduces feed flow through the intestines so that nutrient uptake is improved, indirectly aiding such factors as milk production, wool growth, and the quality and production of eggs. The aim of this paper is to explore the complex physical – chemical characteristics of bentonite of slovak provenance and to compare with non-slovak, which is considered as European highest quality standard in foundry and to compare from the point of foundry application. These characteristics of raw material have direct relationship with technological properties of bentonite sand mixtures and mainly with the quality of castings poured into these mixtures. To compare technological properties of bentonite forming mixtures with use of various clay types point of view application in foundry industry.

Keywords: *moulding mixture, opening material, inorganic binding system, clay binder*

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DEMAND, SUPPLY, ENERGY CONSUMPTION AND SUSTAINABILITY OF PRIMARY AND SECONDARY COPPER PRODUCTION

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Invited lecture
Subject review

Abstract

The paper presents a brief overview of the history of copper as the first known metal in human history. Principal properties and chemical compositions of the modern-day copper alloys are described. The methods of primary (i.e. from the ore) and secondary (i.e. from waste) production of copper are discussed. Some countries mine a lot of copper, while the others mostly process the copper ore into copper materials. The growth in value as well as in weight of primary and secondary copper in the last 20 years is presented and analyzed. Several predictive models for future copper production and associated energy consumption have been presented and discussed: for the period up to year 2050 and up to 2100. Current data on end-of-life for copper in different parts of the word and a global average were given, based on which a sustainability level of copper production form the ore in 200, 500, and 1000 years was presented. For the same time periods, the needed global copper resources were estimated based on higher end-of life recycling rates. Sustainable Development Goals applicable to the production of copper and the use of copper in modern technology is discussed. The Goal that is currently in focus of the world leaders' is Decent Work and Economic Growth, which is also highly applicable to the extractive industry of copper.

Keywords: *copper, production, recycling, sustainability*

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EFFECT OF HIGH SILICON CONTENT ON THE PROPERTIES OF DUCTILE IRON CASTINGS

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Oral presentation
Original scientific paper

Abstract

This paper investigates the influence of silicon content of 3.5 wt.% on the microstructure and mechanical properties of ductile cast iron at different cooling rates. The cast geometry consists of samples with different thickness; cone block with diameter 300 mm and height 350 mm and standard Y2 and Y3 keel-blocks. Microstructure analysis and tensile test were performed on the as-cast materials. Based on the metallographic observations of the present work, it could be concluded that silicon content of 3.5 wt.% has negative effect on spheroidal graphite morphology for this melt and solidification conditions. Tensile test showed that silicon strengthens the ferrite, resulting in an increase in yield and tensile strength, while the elongation decreases. Also, based on the metallographic observations in this investigation, the risk of chunky graphite formation increases with increase in wall thickness, i.e., lowering of the cooling rate. Chunky graphite formation negatively effects on mechanical properties, especially elongation, in cast irons with silicon content higher than 3.5 wt.%.

Keywords: *ductile cast iron, high silicon, cooling rate, microstructure, mechanical properties*

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MODERN ALPHASET (APNB)-REFINED FORMULATIONS WITH BETTER UNDERSTANDING OF CHEMISTRY

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Oral presentation
Original scientific paper

Abstract

At present APNB binder, best defined chemistry wise as alkali catalyzed phenol formaldehyde resin in strong aqueous alkaline media, is one of the two most popular self -sets in use in foundries across the World, including India, other one being Furan (FNB). Among many, few basic reasons for rapid growth of this system as sand binder in foundries are friendliness towards workplace environment, compatibility to metals of all chemistry and elimination or drastic reduction in defects in castings related to silica sand expansion at 573 °C. Main variables in formulations of APNB are Phenol: Formaldehyde mole ratio, nature and quantity of alkali used, ratio of two alkalis (NaOH:KOH) if applicable and nonvolatile content. Apart from variation in recipe, there is scope for process variation, for example extent of reaction, sequence of addition of raw materials, reaction temperature, reaction time, parameters to control progress and termination of reaction and likes. Scope of this manuscript is to study eight resin formulations processed with single Phenol: Formaldehyde mole ratio with varying extent of reaction, ratio of two (NaOH and KOH) alkali and sequence of alkali addition for physical properties including initial viscosity and viscosity rise on storage. Also compression strength values of samples made using mixed sand at different stages simulating mold movement for fresh as well as aged resin were studied. Apart from dry compression, which simulate strength of molds during movement till closing, this paper has attempted to test compression strength of samples in hot conditions simulating resistance offered by molds from puncture or deformation during or post pouring (hot strength) till solidification of castings and there after ease of disintegration (retained strength) of molds relating ease of de coring. This method is simple and has been developed by author.

***Keywords*:** *binder, alkali, strength, reclamation, case studies*

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INFLUENCE OF ANNEALING OF AUSTENITIC STAINLESS STEELS ON PITTING CORROSION RESISTANCE

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Oral presentation
Expert work

ABSTRACT

Austenitic stainless steels are mostly used at high temperature and it is very important to know a behavior of these materials at temperature region of application. It is known that during heating of the austenitic stainless steel i.e. with increasing temperature and time of annealing a microstructure is changed. On the first place, there is precipitation of carbides followed by precipitation of secondary phases. Change of microstructure influence on steel properties especially on mechanical properties and corrosion resistance. In this work influence of annealing at 750 °C on the pitting corrosion resistance is presented. Change in microstructure as precipitation of carbides and formation of sigma phase decrease the pitting corrosion resistance.

Keywords: *austenitic stainless steel, pitting corrosion resistance, delta ferrite, carbides, sigma phase*

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APPLICATION OF COMPUTER SIMULATION FOR VERTICAL CENTRIFUGAL CASTING

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Oral presentation
Preliminary work

ABSTRACT

Vertical centrifugal casting is used for casting of tubes where the diameter is larger than the length or it is used for cone shaped castings. Both non-cylindrical and asymmetrical parts can be casted using this process. Short tubes, slide bearings and smaller ring-shaped products are commonly casted.
Simulation helps to understand filling and solidification process and casting parameters. A significant problem of vertical centrifugal casting is related to the solidification process. Using simulation software, which is based on the finite element method, it is possible to find optimal parameters and thus reduce the occurrence of defects. Also, using the software leads to significant savings on the production line, the production is more economical with better quality, extended product life and better mechanical and tribological properties of the castings. The main parameters that need to be defined are pouring rate, pouring temperature, mould temperature and rotational speed of the mould.
Simulation of filling and solidification was carried out using ProCAST software to determine influence of parameters on final quality of stainless-steel casted tube. According to the results of simulation, rotational mould speed of 1400 rpm and the pouring temperature of 1510 °C are recommended.

Keywords: *centrifugal casting, casting parameters, numerical simulation, stainless steel, ProCAST software*

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INFLUENCE OF SEMI-SOLID METAL PROCESSING AND ARTIFICIAL AGING ON MICROSTRUCTURE AND HARDNESS OF THE AlSi9Cu3(Fe)

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Oral presentation
Original scientific paper

Abstract

In order to achieve a uniform, non-dendritic microstructure with less porosity, semi-solid metal processing has been widely used in aluminum production as an alternative to conventional casting methods. In order to successfully perform semi-solid metal processing suitable globular microstructure must be obtained at required semi-solid temperature. In this paper, as cast dendritic structure was severely deformed with equal channel angular pressing and after reheating on suitable semi-solid temperature fine globular microstructure was formed. Influence of holding times at selected semi-solid temperature on globule formation was investigated. Hardness of the obtained microstructure after artificial aging was determined.

Keywords: *semi-solid metal processing, heat treatment, ECAP, microstructure, hardness*

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CO-DESIGN IN CASTING - A WAY TO ACHIEVE OPTIMAL DESIGN AND PRODUCTION OF CASTINGS

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Oral presentation
Preliminary work

Abstract

The article deals with optimal "work-flow" from the initial design of an aluminum casting through its optimization using virtual tools up to its own production using so-called hybrid technology. The case study demonstrates the use of new approaches in the design of a machine component using generative design (GD), which is the entry point for the so-called Co-Design - a quick evaluation of the technological design of the structure. Final numerical simulations verify both the suitability of the machine component for the required load, and the technological simulation confirms the ability of manufacturing the designed casting for the chosen foundry technology. In this case, the design was directed to the production of prototypes using a 3D printed model and subsequent production of ceramic shell by rapid prototyping methods.

***Keywords**: Co-Design, numerical simulation, rapid prototyping, generative design, virtual manufacturing, investment casting*

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POSSIBILITY OF ENERGY EFFICIENCY IMPROVING OF THE MELTING FURNACE IN SECONDARY ALUMINIUM PRODUCTION

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Oral presentation
Original scientific paper

Abstract

The type of a rotary furnace is often used in secondary aluminium processes. The furnace is charged with the scrap feed, which rotates to be melted under a salt layer. The furnace drum rotation enables more effective heat transfer from the hot refractory to the charge. The rotary furnace under consideration is fired by natural gas with the built-in oxy-fuel burner. Achieved higher temperatures of combustion gases allow heat transfer intensification and shortening the melting period. This paper identifies cost-effective energy savings that can be achieved through performance improvement of combustion processes in the industrial furnaces. The operating conditions having the greatest impact on the energy efficiency in an open-flame furnace are specified and the effect of oxygen-enriched air combustion on the combustion efficiency was particularly analysed. Particular attention is paid to the effect of temperature of exhaust gasses and excess oxygen on the combustion efficiency as well as the specific fuel consumption.

***Keywords:** secondary aluminium process, rotary furnace, oxy-fuel burner, energy efficiency, combustion efficiency*

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PRODUCTION AND CASTING OF AlSi7MgLi ALLOY

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Oral presentation
Original scientific paper

Abstract

Presented paper describes the effect of lithium addition to AlSi7Mg cast alloys on solidification, microstructure development and mechanical properties. Mentioned alloy was produced in induction furnace with inert gas atmosphere and cast in various mould materials to study the suitability of mould material for casting Al-Li alloys. Thermal analysis was performed and compared to thermodynamic calculations of phase diagrams. Microstructure was analysed by optic and Scanning Electron Microscopy (SEM) equipped with Energy Dispersive Spectroscopy (EDS). X-ray Diffraction Analysis (XRD) was used to confirm microstructural constituents. Solidification path is changed at addition of lithium and first phase to precipitate is AlLiSi, followed by α_{Al}, iron rich phases, β_{Si} and Mg_2Si. Micro hardness of alloy containing Li is about 20 % higher and the most suitable moulding materials are steel and graphite.

Keywords: *Al-Li alloys, casting, mechanical properties, solidification*

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NUCLEATION AND GRAPHITE GROWTH IN NODULAR CAST IRON - AN OVEREVIEW

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Oral presentation
Subject review

Abstract

The term nodular iron cast refers to a group of iron alloys with a maximum carbon content of 4 wt.% and silicon from 1.7 wt.% to 2.8 wt.%. This type of cast iron is characterized by the presence of carbon in the spherical or nodular form of graphite in a ferrite, pearlite or ferrite-pearlite matrix. Due to its better mechanical properties in relation to the other iron cast groups, it is widely used in production of gearboxes, crankshafts, turbine rotors, tanks, transportation industries, etc. Generally, size, distribution and shape of graphite nodules ensure a good toughness, high value of elongation and yield strength, castability and machinability.
The course of solidification and each parameter of the production and solidification process has a certain impact on the mechanical properties and microstructure of the final product. However, solidification and graphite growth mechanisms in nodular cast iron have not been fully explained in despite to a large amount of research on the subject. Different experiments have led to the creation of different theories about the solidification process which aim to enable the creation of models for predicting the solidification process and the growth of graphite nodules. Predicting the development of microstructure and defining optimal parameters of the production process could prevent casting and microstructural defects thus ensuring desired properties of the casting.
This paper provides an overview of several studies regarding the nucleation and graphite growth mechanism theories and experiments.

Keywords: *casting, nodular iron, solidification, nucleation, graphite growth, overview*

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THE COPPER ADSORPTION ON ZEOLITE NaX - THE IMPELLER LOCATION IMPACT

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Poster presentation
Original scientific paper

Abstract

Copper is a metal that naturally exists as a mineral in rocks, soil, plants, animals, and water but, it is also an essential trace element required to maintain a good health. Considering that copper is easily shaped, molded, or it may be combined with other metals, it is commonly used to make electrical wiring, pipes, valves, fittings, coins, cooking utensils, building materials, and household plumbing materials. The copper level in surface and groundwater is generally very low. However, higher levels may get into the environment through farming, mining, manufacturing processes, and municipal or industrial wastewater releases into rivers and lakes. Additionally, copper pipes can corrode and release copper into drinking water to a level that can affect its quality and safety. Since copper can be removed from water by applying various adsorbents, it is important to know the copper adsorption process as much as possible. The impact of hydrodynamic conditions in a batch reactor on the copper adsorption from solutions containing Cu^{2+} ions on zeolite NaX particles with a size of 0.063 to 0.090 mm was investigated. The aim of this research was to examine the influence of impeller location inside the batch reactor on Cu^{2+} adsorption on just suspended NaX zeolite, in baffled and unbaffled reactor. First, test suspended impeller speed were determined for further kinetic examination. During examination, beside solution concentration the power consumption at a constant suspension temperature was measured as well. The Blanchard model, Mixed surface reaction and diffusion controlled adsorption kinetic model and Weber-Morris model were used for the kinetic analysis of the experimental data. According to AARD values the reaction is kinetic controlled and follows the kinetics of the second order. It was also evident that the increase in the turbine location height results in the power consumption increase.

Keywords: *copper, zeolite NaX, kinetic models, impeller location*

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INHIBITORY EFFECT OF COMMERCIAL INHIBITOR VCI 379/611 ON CORROSION BEHAVIOR OF X153CrMoV12 TOOL STEEL FOR COLD WORK

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Poster presentation
Original scientific paper

Abstract

In this paper, the influence of water and the influence of the commercial inhibitor VCI 379/611 on the corrosion processes of X153CrMoV12 tool steel for cold work were investigated. The research was carried out by electrochemical methods: by measuring the potential of an open circuit, by determining the corrosion parameters using the method of electrochemical impedance spectroscopy (EIS) and method of Tafel extrapolation. After each measurement, the sample surface was analyzed using an optical microscope. The obtained corrosion parameters showed a high efficiency of the applied inhibitor in the protection of tool steels for cold work from corrosion. For the sample that was exposed to distilled water medium with the addition of inhibitor, a significantly lower corrosion rate was registered and no damage to the sample surface was visible. Metallographic images of the electrode surface after polarization measurements in tap water indicate the occurrence of pitting corrosion.

Keywords: *tool steel for cold work, electrochemical techniques, corrosion parameters, inhibitor, microstructure*

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CORROSION RESISTANCE OF CEMENTING STEEL X19NiCrMo4 IN MEDIUM OF 5 % NaOH AND 5 % H_2SO_4

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Poster presentation
Original scientific paper

Abstract

This paper presents the results of testing the corrosion behavior of X19NiCrMo4 cementing steel in 5 % NaOH and 5 % H_2SO_4 solution. Electrochemical measurements were performed by measuring the open circuit potential, determining the corrosion parameters using electrochemical impedance spectroscopy (EIS) and Tafel extrapolation. The corrosion rate, which was determined by Tafel extrapolation method, was lower in 5 % NaOH solution than that in 5 % H_2SO_4 solution. The obtained results were confirmed by the method of electrochemical impedance spectroscopy, which showed a higher value of charge transfer resistance of the tested steel in an alkaline medium, which proves higher corrosion resistance.
Metallographic analysis were performed on a sample previously etched in nital and on a sample after polarization measurements. Images of the electrode surface after polarization measurements in 5 % H_2SO_4 medium showed a completely corroded steel surface indicating dissolution of the oxide layer due to acid exposure. No changes were observed on the sample surface in the alkaline medium.

Keywords: *cementing steel, corrosion rate, impedance, charge transfer resistance, microstructure*

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ACTIVITY ASSESSMENT OF PHOTOSENSITIVE DYES ANTHOCYANIN, RHODAMINE B, RUTHENIUM N3 AND RHODAMINE B+ANTHOCYANIN MIXTURE FOR APPLICATION IN SOLAR CELLS

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Poster presentation
Original scientific paper

Abstract

The activity of photosensitive dyes such as anthocyanin, ruthenium N3, rhodamine B and anthocyanin + rhodamine B mixture was analyzed for potential use in solar cells based on nanostructured porous TiO_2 and ZnO films. Anthocyanin was extracted from a dry hibiscus (*Hibiscus sabdariffa*) flower in ethanol. The commercial light-sensitive dye N3 is an organometallic ruthenium complex, while rhodamine B is an indicator used in chemical laboratories. The UV-Vis spectrum of extracted anthocyanin, selected dyes and their combinations (anthocyanin + rhodamine B) were determined. The photoanodes were prepared by depositing an oxide layer based on TiO_2 and ZnO nanoparticles and were heated in furnace for a total of 40 minutes at different temperatures. The graphite film was applied to the conductive side of the solar cells by spray method, and the cathodes were dried at 80 °C for 1 hour to remove the organic solvent and then heated in furnace at 250 °C for 30 minutes. The graphite films and oxide layers were analyzed by digital microscope. From the microscopic images, it can be seen that the TiO_2 film is not compact andhas visible cracks, while the ZnO film is also incompact, thinner and with smaller visible cracks. The solar cell efficiency of the open-circuit voltage (V_{oc}) and short-circuit current density (J_{sc}) were measured under simulated light (60 W) to obtain values of fill factor (*FF*) and conversion efficiency (η). Considering all the calculated parameters, the N3 dye is the most suitable for use in solar cells. In general, the TiO_2 layer gave better results than the ZnO layer.

Keywords: *solar cells, photosensitive dyes, TiO_2 and ZnO nanoparticles, conversion efficiency, fill factor*

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PREPARATION AND CHARACTERIZATION OF POROUS ALUMINA CERAMICS USING WASTE COFFEE GROUNDS (WCG)

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Poster presentation
Original scientific paper

Abstract

Different methods have been used to produce porous ceramics for various applications. The generation of pores in ceramic samples offers a new range of different properties. Moreover, that porosity can be achieved using all kinds of various waste such as industrial, agricultural, domestic etc. One example being the process of coffee brewing which produces a large amount of waste, that was therefore used as a pore-forming agent in the production of porous ceramics.
Suspensions of 60 wt.% alumina with different amount of waste coffee grounds were prepared. Viscosity of all suspensions was determined by means of rotational viscometer. Green bodies were prepared by slip casting in plaster mold. DTA/TGA analysis of waste coffee grounds revealed multistep endothermic and exothermic events related with release and burning of the precursor materials accompanied with mass loss. The sintering regime was determined according to the DTA/TGA analysis of thermal decomposition of waste coffee grounds. Density of the obtained sintered samples was investigated and calculated.

Keywords: *alumina, porous ceramics, coffee, density, slip casting*

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RAPID MICROWAVE-ASSISTED SYNTHESIS OF $Fe_3O_4/SiO_2/TiO_2$ CORE-SHELL NANOCOMPOSITE

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Poster presentation
Original scientific paper

Abstract

Magnetic nanomaterials have been getting a lot of attention lately due to their specific physical properties and various applications in medicine and biomedicine as well as support for photocatalyst in advanced oxidation processes for degradation of organic micropollutants. Magnetic behaviour of nanomaterials greatly depends on their particle size. Such behaviour enables a facile extraction of the magnetic nanoparticles from matrix or solution using an external magnetic field.
In this paper, magnetic nanoparticles were successfully prepared via rapid microwave-assisted synthesis. They were subsequently coated with a layer of silica (SiO_2) as a protective layer for magnetite and after that with titania (TiO_2) to photocatalytically degrade micropollutants from wastewater. The prepared nanocomposites were characterized by Fourier-transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD), on behalf of which the core-shell configuration and chemical distribution of iron oxide, silica and titania chemical species was discussed.

Keywords: *microwave synthesis, magnetite, silica, titania, core shell nanocomposite*

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IMPACT OF FeSi FERROALLOY CASTING CONDITIONS ON THEIR STRUCTURE AND GRAIN SIZE AFTER CRUSHING PROCESS

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Poster presentation
Original scientific paper

Abstract

In the article, the effects of FeSi75 ferroalloy casting conditions on the finished product size distribution after the crushing process have been presented. Liquid metal is cast into horizontal ingot molds or iron boxes that constitute a separate space in the casting hall. The casting method used in the process affects the alloy cooling, which determines segregation of elements in the cross-section of the layer and grain growth in the crystallizing material. These phenomena strongly affect heterogeneity of the chemical composition and phase transformations occurring in the solid state. The grain size and structure of the alloy determine its mechanical properties, which transfer into the crushing process and the resulting size distribution. For commercial purposes, it is desirable to obtain the largest amount of 10 ÷ 50 mm size pieces; therefore, it is important to determine the optimal casting conditions for FeSi.

Keywords: *ferroalloys, crushing process, casting FeSi alloys, FeSi structure*

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IMPROVING THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF EN AC 43200 CAST ALUMINUM ALLOY MODIFIED WITH ZIRCONIUM

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Poster presentation
Original scientific paper

Abstract

Understanding the effect of alloying elements on the melt quality is of vital importance for foundryman. Therefore, the impact of primary and especially minor alloying elements need to be well known. The impact of the small addition of Zr into commercial EN AC 43200 cast alloy on its structural and mechanical properties in as-cast and heat-treated conditions was investigated to be better understood. It has been found that addition of Zr up to 0.24 wt.% reduce the grains size (from 3.5 mm to 1.2 mm) significantly, SDAS (from 57.3 μm to 50.4 μm) and porosity (from 19 % to 5 %), leading to the production of sound cast parts. The addition of Zr increases the hardness of investigated alloy in as-cast (from 71 to 77 HB) and heat-treated conditions (reaching 85 HB). An increase in the hardness after various solid solutions times correlate very well to the formation of small needle-like coherent Al_3Zr particles.

Keywords: *EN AC 43200 alloy, zirconium, cast microstructure, hardness*

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INFLUENCE OF COLD REDUCTION ON THE STRUCTURE AND HARDNESS OF COLD DRAWN COPPER WIRE

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Poster presentation
Original scientific paper

Abstract

The production of copper wires involves the application of various processing operations that lead to the certain structural changes. The electrical properties of wire depend on certain structural changes. Research was carried out on copper wire produced by the UPCAST process. Copper wire was subsequently subjected to the cold drawing through the dies in multiple passes. The structural changes in the process of cold drawing of Cu-wire were observed. During the cold drawing of Cu-wire through dies, a significant change in deformed structure occurred in relation to the initial cast structure. The microstructure analysis and hardness values of the deformed sample indicated that during the initial reduction the majority of the deformation was performed at the surface area of the Cu-wire that was in contact with the die. The initial equiaxed grains at the surface of the Cu-wire elongated in the drawing direction as a consequence of the deformation degree increase.

Keywords: *cold drawing, copper wire, microstructure, hardness*

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PREPARATION AND CHARACTERIZATION OF ARTIFICIAL PATINA ON BRONZE

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Poster presentation
Original scientific paper

Abstract

Numerous bronze objects and works of art are exposed to outdoor atmosphere that causes the formation of patina. Patina creates a protective layer that slows down further corrosion processes. The composition of patina will determine its protective properties as well as its color. The formation of natural patina can take years, but also it can be formed artificially, by chemical and thermal treatment of the surface. Therefore, the application of artificial patina has become a very common form of protection of bronze artefacts.
The aim of this work was to examine morphological and electrochemical properties as well as chemical composition of artificial patina formed on CuSn6 alloy. Chemical patina was formed by using sulfide solution to induce corrosion processes, while electrochemical patina was synthesized by polarization of bronze electrodes in an artificial rain solution. The samples were exposed either to urban outdoor atmosphere or artificial rain solution, after which the composition and structural properties were investigated by attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR), optical microscopy (OM) and scanning electron microscopy (SEM). Electrochemical properties were examined by electrochemical impedance spectroscopy (EIS). The results showed an increase in the impedance modulus with the exposure time, i.e., higher corrosion resistance, which confirms the protective effect of the patina. Morphological results show that the surface of the chemical patina obtained by spraying method is the most homogeneous.

Keywords: *artificial patina, bronze, atmospheric corrosion, electrochemical methods*

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MAKING PROTOTYPE CASTING USING 3D PRINTING AND INVESTMENT CASTING

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Poster presentation
Expert work

Abstract

In this paper a production of a prototype casting made by using 3D printing technology, numerical calculation and investment casting technology is described. The 3D printing parts for investment casting were made using Fused Deposition Modelling (FDM) 3D technique using a Polylactic Acid (PLA) material. PLA is used due to low expansion during the burning the printed model out of a ceramic shell. Printed models were prepared in such a way that the printed layers did not have an affect on the surface roughness regarding the layer tolerance.
To design and check the proper gating system for investment casting technology the numerical calculationwas used. After selecting the proper gating system and casting parameters the gating system was printed and final casting with gating system was assembled.
On the assembled casting finally, the ceramic shell was made. Before pouring the aluminum alloy the PLA model is burntout using electrical furnace. Before purring the cheremic shell is sintered and heated up.
To produce the final prototype only six days was needed.

Keywords: *3D printing, numerical calculation, investment casting, prototype casting*

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ANALYSIS OF THE CRACK FORMATION IN ASIS M2 HIGH-SPEED TOOL STEEL DURING UTILIZATION

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Poster presentation
Expert work

Abstract

Tool steels are carbon, alloyed or high-speed steels, produced and processed under the tool steel manufacturing practices to meet special requirements. The advancements in tool steel engineering properties enabled work efficiency improvements in industrial applications. The high-speed tool steels(HSS) are complex iron-based alloys containing carbon, chromium, vanadium, molybdenum, tungstenor substitutional amount of cobalt. The chemical composition of HSS is designed to achieve the highest attainable hardening response, high wear resistance, high resistance to softening effect at elevated temperatures, and good toughness necessary for effective use in industrial cutting operations. The ASIS M2 is a molybdenum-based medium alloyed HSS with good machinability. Favorably designed chemical composition and adequately performed heat treatment assure good combination of toughness, wear resistance and hardness enabling its utilization as twist drills, taps, milling cutters, saws, and knives. It is also commonly used as cold work punches. The research was performed on two samples of ASIS M2 punchers to estimate the cause of the shorter service life. In sample 1 the crack nucleation occurred after 50.000 punched marks, while in sample 2 cracking initiated after 20.000 punched marks. To indicate the cause of sample 2 shorter service life, the results of chemical composition analysis, metallographic analysis, and microhardness measurements were compared. The higher amount of carbide forming elements in sample 2 led to the solidification of higher number of eutectic carbides and precipitation of secondary carbides in intercellular regions. The microstructure analysis indicated significantly higher number of carbide particles in sample 2. The presence of carbide particles led to the texture development and impacted crack propagation direction. Higher amount of carbide particles in sample 2 caused higher crack dissipation and material layering with a decrease in crack propagation depth and shorter service life.

Keywords: *ASIS M2, high-speed tool steels, cracking, service life, microstructure, carbides*

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MICROSTRUCTURE AND MICROHARDNESS OF Cu-Al-Mn-Zr ALLOYS BEFORE AND AFTER HEAT TREATMENT

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Poster presentation
Original scientific paper

Abstract

In this work preliminary results of the heat treatment effect on microstructure and microhardness of Cu-8.5Al-10Mn-(0.25-1.00)Zr alloys were presented. Ingots (8 mm in diameter and 15 mm in length) were produced by melting and casting process. Production of investigated alloys was performed in laboratory electric arc furnace. Melting was carried out using the heat produced by electric arc and by a water-cooled, specially constructed copper anode that also served as a casting mould. The samples were analysed in as-cast state and after heat treatment at 900 °C/15 min/water. Microstructural analysis was performed by optical microscopy (OM), scanning electron microscopy (SEM) equipped by device for energy dispersive spectroscopy (EDS). Preliminary optical microscopy analysis of investigated alloys confirmed that microstructure was consisted of martensite only in Cu-8.5Al-10Mn-0.25Zr alloy in as-cast and heat treated state. SEM analysis show the start of martensite formation in some places at all investigated alloys in both, as-cast and heat treated state. A microhardness measurement was performed by Vickers method. Microhardness values of Cu-8.5Al-10Mn-(0.25-1.00)Zr alloys were up to 215.8 HV1 after casting and up to 224.5 HV1 after heat treatment.

Keywords: *Cu-Al-Mn-Zr alloy, microstructure, heat treatment, microhardness*

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CHARACTERIZATION OF WELDED DUPLEX STAINLESS STEEL AFTER ANNEALING

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Poster presentation
Original scientific paper

Abstract

In this work microstructure analysis and microhardness testing was carried out on duplex stainless steel X2CrNiMoN22-5-3 after welding and annealing. Investigated stainless steel was welded using two welding procedures. The root of weld join was performed with TIG process and for filling SMAW process was used. Analysis of microstructure and microhardness was carried out before and after annealing. Annealing of welded joint was performed at temperature of 850 °C in duration for 60 minutes followed by cooling in air. After annealing, the samples were metallographic prepared. Optical microscopy and scanning electron microscopy with energy dispersive spectrometer were used for characterization of microstructure. Results shows that before annealing microstructure was consisted of ferrite and austenite, and after annealing presence of sigma phase was determined in weld metal. Microhardness values of samples before and after annealing was determined by Vickers method. A significant increase in microhardness values was observed in weld metal after annealing (from 294.9 HV1 to 357.0 HV1).

Keywords: *duplex stainless steel, microstructure, microhardness, welding, annealing*

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RHEOLOGICAL PROPERTIES OF WATER-BASED ALUMINA SUSPENSIONS IN RECYCLING WASTE ALUMINA POWDER

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Poster presentation
Original scientific paper

Abstract

Waste, i.e. secondary alumina (Al_2O_3) ceramic powder is produced when green bodies are machined prior to the sintering of ceramic products. This industrial waste, although non-hazardous, has to be disposed of using the legally adequate methods. Typically, landfills are used for this purpose, which presents additional manufacturing costs. This paper focuses on how to recycle waste alumina by slip casting of alumina water-based suspensions. Slip casting process requires limited suspension viscosity. When virgin alumina powder is substituted with waste alumina powder, the suspension viscosity increases.
This paper presents the results of studying the influence of adding commercially available dispersant on apparent viscosity of suspensions with 60 wt.% of solid loading. There were three different solid samples studied: 30, 45 and 60 wt.% of waste alumina, as expressed by total dry weight.
The water-based Al_2O_3 suspension were homogenized by a planetary ball mill, after which the suspension stability was tested to rheological properties. The tests have showed that in aqueous ceramic suspensions with up to 60 dry wt.% solid component it is possible to achieve favorable viscosity for slip casting when 0.06 dwb.% of the dispersant Tiron is added. The increase in waste alumina content caused a gradual increase in the apparent viscosity. Suspensions with more than 60 : 40 ratio of waste to virgin alumina powder become unusable for slip casting due to too high viscosity.

Keywords: *recycling, waste, alumina, rheology, viscosity*

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SIMULATION MODEL OF CONVENTIONAL SOLID STATE SINTERING OF Al_2O_3 CERAMICS

Darko Landek*, Lidija Ćurković, Ivana Gabelica

University of Zagreb Faculty of Mechanical Engineering and Naval Architecture, Zagreb, Croatia

Poster presentation
Original scientific paper

Abstract

The paper presents a finite element method (FEM) of solid state sintering of aluminum oxide ceramics in an electric furnace. Alumina green bodies were prepared by slip casting of stable 70 wt.% Al_2O_3 aqueous suspension in a plaster (gypsum) mold. Dispersant Dolapix CE-64 was used for stabilization of highly concentrated alumina suspension. Sintering of green bodies was performed at temperatures of 1600 °C, 1625 °C and 1650 °C for 2 h, 4 h and 6 h. The FEM model was solved as a nonlinear thermo-mechanical problem with the heating, sintering and cooling phases in the FEM program Comsol Mulitiphysics. The density of the sintered samples was determined by the Archimedes method and compared with the density predicted by FEM simulations. The concordance of numerically predicted and measured density amounts, for the same sintering parameters is 86 %.

Keywords: *aluminum oxide ceramics, sintering, Archimedesdensity, FEM model*

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IMPACT OF MOULD POWDER ON PHYSICOCHEMICAL PROPERTIES OF SLAG IN THE CONTINUOUS CASTING PROCESS

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Poster presentation
Original scientific paper

Abstract

Mould powder is essential for the reliable operation of the continuous casting system and the quality of the cast steel. The very responsible roles of mould powder are fulfilled by selecting combinations of components that affect physicochemical properties of the resulting liquid slag, which lubricate the walls among the crystallizer and slab. The contribution of mould powder refers to the range of melting temperature and speed and the viscosity of glassy or crystalline slag and formation temperature. These connections are the research subject in this paper, emphasizing the functional dependence of viscosity and liquidus temperature of mould powder with its material composition.
This research investigates the impact of basicity, alkali oxides (Na_2O and K_2O), and carbon-free content on viscosity and liquidus temperature of mould powder in the continuous casting process. The liquidus temperature of mould powder was obtained empirically after a year of experimental examination, and viscosity was determined using several models. Based on experimental investigation, we show empirical parameters for equitation of liquidus temperature of mould powder. Also, using established equations, we presented isolines for viscosity and liquidus temperature with experimental parameters.

Keywords: *casting powder, continuous casting, viscosity, liquidus temperature*

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POSSIBILITIES OF ONLINE LABORATORY PRACTICALS IN TEACHING OF CASTING COURSES

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Poster presentation
Expert work

Abstract

Due to the pandemic, reconfiguration of teaching and operating approaches during 2020 became a reality for universities (as well as all other sectors). There was a need to adjust the delivery for students, whom were now not able to attend laboratory practicals, in order to provide them with a learning experience as close as possible to real laboratory conditions and allow them to achieve planned learning outcomes. This paper describes some adjustments to a casting laboratory practical for a Manufacturing Course (introductory and more advanced level).

Keywords: *casting laboratory practicals, online delivery, education*

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DETERMINATION OF RESIDUAL STRESSES IN STRESS LATTICEWITH SIMULATION SOFTWARE

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Poster presentation
Preliminary work

Abstract

Residual stresses take place mainly due to unequal changes of volume and non-simultaneous phase and structural changes in different parts of the casting. If stresses exceed tensile strength of the component in production or service, deformation or cracking of the casting will happen. To avoid casting defects, it is necessary to know how big the residual stresses are and if they surpass the allowed values. In this paper determination of residual stresses in stress lattice with simulation software device are presented. These simulations confirm previous researches on the influence of mold thickness on the occurrence of residual stresses in the stress lattice. From the representation of the dependence of residual stresses on the thickness of the mold, it can be concluded that with increasing thickness of the mold, the residual stresses decrease. The greater the thickness of the mold causes a slower cooling which results in less residual stresses in the stress lattice.

Keywords: *residual stresses, stress lattice, software simulation*

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CHEMICAL LEACHING OF SUBBITUMINOUS COAL FROM THE BOGOVINA - EAST FIELD (BOGOVINA BASIN, SERBIA) USING HYDROCHLORIC ACID

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Poster presentation
Original scientific paper

Abstract

All over the world, huge amounts of coal are available and it is utilized in large quantities for different purposes. The coal combustion causes environmental problems, such as the release of toxic metals and other pollutants into wastewaters, emission of noxious gases, produce of ash dumps, etc. One of the solutions for the reduction of environment pollution, caused by coal combustion, is demineralization and desulphurization of coal. In that sense, treatment of coal by different chemical reagents becomes important. A subbituminous coal, used in this study was taken from the Bogovina - East field (Lower Miocene ≈ 20-16 Ma) of the Bogovina Basin, which is located in Eastern Serbia. The sample was selected based on the previous studies of Bogovina - East field which indicated a high amount of sulphur, relatively high percent of mineral matter and considerably amount of liptinites for humic coal, which represent the most reactive maceral group. The aim of the study was an attempt to reduce the amount of ash and sulphur in coal, keeping the organic matter unaltered as possible, using simple and cheap method e.g. treatment with hydrochloric acid (HCl). Ash and total sulphur content was determined before and after HCl leaching. In addition characteristics of initial and treated coal were tracked by X-ray diffraction (XRD) analysis and Fourier-transform infrared (FTIR) spectroscopy. The obtained results showed that the high percentage of deashing (≈ 80 %) was achieved with cheap hydrochloric acid. XRD analysis of ash before and after sample treatment provides more information about mineral phases in coal and effects of chemical leaching. FTIR analysis indicates almost no changes in structure of coal organic matter after treatment by HCl, which is important for further coal usage (e.g. combustion). On the other hand, the applied chemical leaching with HCl had low impact on the sulphur content in Bogovina coal (desulphurization percentage ≈ 8 %). Therefore, in future research other reagents for efficient desulphurization should be investigated.

Keywords: *coal, acid, demineralization*

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PRELIMINARY STUDY ON TEMPERATURE DISTRIBUTION PATTERNS IN PEM FUEL CELLS

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Poster presentation
Original scientific paper

Abstract

This work presents a preliminary study on the degradation effects of low-temperature polymer electrolyte membrane (PEM) fuel cells caused by locally elevated temperature inside the membrane electrode assembly (MEA), where electrochemical reaction takes place. Overheated spots arise as a result of insufficient heat removal generated within a fuel cell. This study aims to investigate the performance resistivity of PEM fuel cells, due to effects of unsteady local temperature distribution on heat flow patterns, in order to optimize operating conditions and improve internal heat management. Local current and local temperature distribution in a PEM fuel cell has been mapped experimentally by using a specially designed segmented S ++® measurement sensor composite plate. An array of 121 individual conductive segments collected the current distribution measurements, while the temperature distribution measurements were obtained across 36 segments array. Furthermore, time-dependent current and temperature parameter changes were observed during the experimental study, together with their variations on the cathode side under different humidity conditions at three operating points, which includes the lowest and highest current density possible to achieve. The obtained preliminary results give the first insight into the thermal distribution phenomena within the observed fuel cell. Overall, a given approach could contribute to the deeper understanding of the local current and temperature distributions effects, in order to identify the local maximum temperature within the catalyst layer, as a possible local cell degradation spot, and it could be a helpful indicator to improve a design process of the fuel cell components.

Keywords: *current distribution, heat flow patterns, temperature distribution, PEM fuel cell*

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EVALUATION OF INFRARED DRIED SOLVENT-BORNE COATINGS

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Poster presentation
Original scientific paper

Abstract

Accelerated infrared (IR) drying of coatings is increasingly used in the industry. Drying is performed via IR emitters, powered by gas or electricity. The main advantage of using IR drying is drying time reduction and higher production rate. Another advantage is burning the harmful VOCs (Volatile organic compound) from the coatings, therefore the environmental impact of this drying method is very low. In this study, solvent-borne coating systems were applied and dried by infrared as well as in atmospheric conditions. Catalytic IR emitters were used for accelerated drying of the coatings. The purpose of the investigation was to show how much time can be saved by using IR technology and to compare the protective properties of differently dried coatings. After the coatings were cured, chambers for accelerated corrosion testing were used. The succeeding steps were the adhesion and the hardness measurements, which were evaluated using Pull-off and Pencil test. The results have shown the same or even better properties of IR-dried coatings, along with the significant drying time reduction. This study is part of the project “Smart plant for drying liquid coatings” (reference code: KK.01.2.1.02.0030) which is co-financed by the European Union from the European Regional Development Fund.

Keywords: *IR drying, corrosion, solvent-borne coatings, drying properties, testing*

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TESTING OF ANTICORROSIVE PROPERTIES OF ELECTROSTATIC POWDER COATING ON DIFFERENT TYPES OF ELECTRIC RESISTANCE WELDS

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Poster presentation
Original scientific paper

Abstract

Corrosion of metal surfaces is inevitable, so it is needed to be prevented by a proper corrosion protection method. Powder coatings are effective way to prevent corrosion in metal parts. Critical areas on the structures are welded joints which can have negative effect on the coating durability due to different weld geometry and deformations. The aim of this work was to investigate the corrosion resistance of several electro-resistant weld types. Coating was performed at an electrostatic powder coating plant. All samples were treated under the same coating parameters, the difference is the chemical pre-treatment (phosphate and zirconium) and shape (appearance) of the welds. Namely, three weld types participated in the testing: 1. welds with minimal or no deformation, 2. welds with a slight degree of deformation, while the 3. weld type had significant and very significant deformations (needles, protrusion, foamy deformations). Research included salt spray test, microscopic analysis, and electrochemical impedance spectroscopy. Results of this work showed that phosphate conversion coating under epoxy-polyester coating is better for anticorrosion durability of spot-welded wire products that have significant weld deformations.

Keywords: *powder coating, corrosion, organic coatings, chemical pre-treatment, salt spray chamber, electric resistance spot weld*

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EFFECT OF BINDER ADDITION ON THE RHEOLOGICAL BEHAVIOUR OF ALUMINA SUSPENSIONS

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Poster presentation
Original scientific paper

Abstract

The aim of this research was to prepare a stable and highly (65 wt.%) loaded aqueous alumina suspension and to investigate the influence of binder addition on the rheological properties of the prepared suspensions. For that purpose, alumina suspensions with dispersant concentration from 0.3 to 0.7 wt.% were prepared and their viscosities were analysed. Also, suspensions with optimal dispersant concentration and polyvinyl alcohol (PVA) based binder with different amount, from 1 to 4 wt.%, were prepared and their rheological behaviour was analysed. It was found that concentration of 0.4 wt.% dispersant is optimal for preparation of 65 wt.% alumina suspension. Also, addition of PVA binder into stable alumina suspension affect rheological properties, i.e. increases viscosity and shear stress.

Keywords: *alumina suspension, dispersant, binder, polyvinyl alcohol, rheological behaviour*

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CORROSION STUDY OF CuAlNi ALLOY IN STIRRED H_2SO_4 SOLUTION

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Poster presentation
Original scientific paper

Abstract

CuAlNi alloy has been evaluated for its corrosion behaviour in the 0.5 mol dm^{-3} H_2SO_4 stirred solution at the rotation rate of magnetic stirrer of 150 and 450 rpm, at 20 and 40 °C. Investigations were performed using open circuit potential measurements, linear and polarization measurements. After polarization measurements corroded surfaces were evaluated using light microscopy analysis. It was found that increasing in electrolyte temperature leads to higher corrosion damages of alloy while increase in rotation rate of stirrer has smaller impact on corrosion. The presence of intergranular corrosion on the electrode surfaces was clearly seen with optical microscope.

Keywords: *CuAlNi alloy, corrosion, polarization, optical microscopy*

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ELECTROCOAGULATION AUGMENTED WITH NATURAL ZEOLITE – THE NEW HYBRID PROCESS FOR TREATMENT OF LEACHATE FROM COMPOSTING OF BIOWASTE

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Poster presentation
Original scientific paper

Abstract

The efficiency of electrocoagulation augmented with natural zeolite is tested on two leachate samples obtained from composting of biowaste. Electrocoagulation is conducted with aluminum electrode in duration of 60 min, at current intensity and applied voltage of I = 0.1 A, U = 29.9 V, respectively. Results show that addition of zeolite (at solid/liquid ratio of 20 g/L) influencing on neutralizing the final pH values in leachate solutions, while decreasing the el. conductivity (> 34 %), turbidity (> 99 %), COD (> 84 %) and total Kjeldahl nitrogen (> 81 %). Moreover, zeolite particles acted abrasively on the electrode and contributed to cleaning the electrode surface from oxides, corrosion products and organic mucous layer formed on anode by complexing aluminum with organic compounds in leachate. Beside aluminum dissolution from the anode, aluminum dissolution from the cathode is also recorded, confirming that both electrodes are influencing on forming floc of $Al(OH)_3$ during electrocoagulation. In addition, the overall operational costs of were evaluated and discussed. Results indicate that electrocoagulation augmented with zeolite can be considered as a cost-effective process for treatment of leachate from composting of biowaste.

Keywords: *electrocoagulation, natural zeolite, hybrid process, treatment, leachate from composting of biowaste*

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Organizer of the International Foundrymen Conference

Historical development of the University of Zagreb Faculty of Metallurgy and evolution of studies in the field of metallurgy should be considered in actual socio-economic situation and the status of the profession. Courses form the metallurgy begin within the High Technical College in 1919.

The city of Sisak has a long tradition in the field of metallurgy. Therefore, it is no coincidence that the study of metallurgy was first founded in Sisak, as a city of metallurgical industry of the 20th century. In the area of today's Sisak in Roman times, the city of Siscia grew, as one of the ten cities of the Roman Empire in which there was a mint. Sisak gained a new metallurgical role in 1939 by laying the foundations of metallurgical production, i.e. by founding the Caprag smelter, building of blast furnace with a daily capacity of 40 t of pig iron. In the middle of 1947, the Caprag smelter changed its name to the Željezara Sisak.

Rapid economic development in the middle of the 20th century imposed the need for faster training of highly qualified and specialized personnel in Croatia in the technical fields, including metallurgy. At that time, existing higher education institutions in the field of metallurgy in Ljubljana and Belgrade did not offer a sufficient number of metallurgical professionals. High education at the Department of the Faculty of Technology in Sisak began in 1960/61. After number of restructuring processes, in 1991 the Faculty of Metallurgy became an independent scientific and educational institution of the University of Zagreb for the following activities: Scientific and educational activities in the field of technical sciences (metallurgy); Scientific and research activities in the field of metallurgy, chemical engineering and other technical and technological areas relevant to the field of metallurgy; Auxiliary scientific and research activities.

Today, the Faculty of Metallurgy, University of Zagreb (hereinafter MF, Faculty) is the only scientific and educational institution in the Republic of Croatia that, respecting the culture of quality, provides undergraduate, graduate, postgraduate and professional education in metal materials and technology, metallurgical engineering. and industrial ecology, safety, occupational health and the working environment as well as foundry technology. By organizing conferences, seminars, workshops, public forums and lectures, it systematically implements a program of lifelong education and training and provides support to economic entities in the metallurgical, metalworking, shipbuilding and foundry industries. The Faculty of Metallurgy bases its activity on high academic and ethical values, contribution and responsibility towards society, world strengths and weaknesses, but also willing to solve difficulties.

The Faculty is a pivotal place of scientific research and publishing in the field of technical sciences - metallurgy, provides scientific and professional support to economic entities of metallurgical, metalworking, shipbuilding and foundry industries in the Republic of Croatia, which is especially important after the closure of relevant industrial institutes. The Faculty of Metallurgy of the University of Zagreb is the backbone and promoter of the metallurgical profession in the Republic of Croatia.

Scientific research activity at the Faculty of Metallurgy is carried out by proving projects at the National Science Foundation (HRZZ) and financial support for research at the University of Zagreb, bilateral projects or is initiated in direct contact with economic entities. The research is primarily focused on the production and processing of metallic and non-metallic materials, energy, ecology, protection and application of metals for the needs of the

metallurgical, metalworking and oil industries. Part of the scientific and professional potential of the Faculty of Metallurgy, in addition to teaching and scientific research activities, actively participates in solving practical technical and technological problems of existing companies, environment, etc.

Despite the hardships, wartime and destruction, and the post-war devastation of economic entities and the lack of a strategy for economic development of the Republic of Croatia, the Faculty of Metallurgy managed to preserve scientific and teaching potential, modernize studies, acquire modern and innovate part of existing scientific research equipment. In addition to the above, the implementation of an infrastructure project called Center for Foundry Technology - SIMET, highly positioned on the indicative list of the then Ministry of Science, Education and Sports, and funded by the European Regional Development Fund, Operational Program for Cohesion and Competitiveness 2014-2020; Strengthening of research, technological development and innovation; Investment Priority 1a - Improving the infrastructure and capacity for research and innovation (I&I) in order to develop I&I performance and promote competence centers, especially those of European interest, Specific objective 1a1 Increased research, development and innovation (IRI) capacity to conduct research top quality and meeting the needs of the economy. The project Center for Foundry Technology - SIMET (KK.01.1.1.02.0020), worth 40.401.494,36 HRK, is in the implementation phase, and is funded by the European Regional Development Fund, Operational Program for Cohesion and Competitiveness 2014- 2020 under the call "Investing in organizational reform and infrastructure in the research, development and innovation sector". This project includes the reconstruction and adaptation of existing scientific research infrastructure and the procurement of highly sophisticated equipment which will improve scientific excellence, research capabilities of scientific institutions, improve teaching methods using modern technologies and encourage strengthening links between the scientific research sector and the economy. At the same call, the project VIRTULAB - Integrated Laboratory for Primary and Secondary Raw Materials (KK.01.1.1.02.0022) worth 3.038.562,92 HRK was applied for, accepted and implemented. The project holder is the Faculty of Mining, Geology and Petroleum Engineering, and the Faculty of Metallurgy is one of the 6 partners from the University of Zagreb consortium.

Teaching, scientific research, professional and publishing activities, as well as the work of professional and administrative services of the Faculty of Metallurgy are based on the following values: personal approach to students and associates, openness, transparency, responsibility, ethics, communication, collegiality, efficiency, cooperation, interdisciplinary cooperation, improvement work based on the results of analyses and readiness to solve difficulties.

The metal industry in Croatia has a future, but it is necessary to concentrate on the trinity of competitiveness of the metal industry - modern technology, efficient production process and highly qualified workforce. A representative triangle of influential factors (Triple Helix) plays a key role in the development of scientific, teaching and professional activities of the Faculty of Metallurgy, but also in the development of the metal industry in the Republic of Croatia: business sector, scientific research capacities and public policy. In that sense, the Faculty of Metallurgy justifiably enjoys the recognition and evaluation of influential factors such as the University of Zagreb and the Sisak-Moslavina County as representatives of local and public policy. The cooperation resulted in support and partnership of both institutions with the efforts of the Faculty of Metallurgy to achieve excellence by investing in scientific research capacities and, consequently, to innovate the curricula.

The demands of students and employers and the economy market are changing faster than ever before and, although the goals of education remain constant, the ways in which they are achieved must be continuously changed, upgraded and improved through three basic groups of Metallurgical activities: teaching, research and professional work. These three groups of activities are systematically monitored by the quality assurance procedures which results in development of human, material and financial resources.

Socially responsible service to the community, as the goal of the Faculty of Metallurgy, is visible through a series of thoughtful and prepared activities in all five strategic directions, the outcomes of which are purposefulness and justification of existence by answering the common question WHY?. Only by thinking outside the comfort zone of reliable, small and current successes, it is possible to define a dominant and competitive parameter in the form of innovation in the field of teaching, research and professional activities in metallurgy and other related industries with the imperative to maintain quality standards. At the same time, with an inventive methodology and activities we answer the questions HOW? and WHAT?.

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University of Zagreb Faculty of Metallurgy, Sisak, Croatia

University of Split Faculty of Chemistry and Technology, Split, Croatia

Co-organizer and host of the International Foundrymen Conference

The Faculty of Chemistry and Technology in Split (FCT) was founded in 1960 in accordance with the need for the engineers in the field of chemical technology and chemistry, due to the intensive development of the chemical industry in Dalmatia. It is the oldest and the largest technological faculty outside the city of Zagreb. Until 1974, FCT was a part of the University of Zagreb. In 1974, it became a part of the University of Split (UNIST) as one of its founders. FCT is located at the University Campus Split, on address Ruđera Boškovića 35. The Faculty has 5058 m^2 of surface area, consists of 9 lecture halls, one amphitheater with the capacity of 250 seats, IT classroom, 28 student laboratories, 3 semi–industrial laboratories, 28 smaller science–research laboratories, 49 offices for teachers, 10 offices for the Faculty specialist services employees and Dean's Office, 2 IT offices, library, the Hall and 2 chemical warehouses.

The main activity of the FCT is higher education, scientific research and professional work in the scientific areas of: a) the technical sciences in the field of chemical engineering, b) the natural sciences in the field of chemistry and c) the biotechnical sciences in the field of food technology. The activity of FCT is evidenced by numerous competitive projects, in which FCT employees are the principal investigators or team members, collaborations with the domestic and foreign research and academic institutions, published scientific papers in distinguished scientific journals and participation in the organization of scientific congresses. Taking into account its area of interest, FCT develops both professional work and cooperation with the industry, through knowledge and technology transfer to the industry.

With 97 full-time employees and over 700 students, FCT is a recognized scientific and educational institution that educates experts for the modern technologies, necessary for the development of society. Today, the FCT is a recognizable component of the University of Split with a wide range of study programs within the four scientific fields: undergraduate university studies (Chemistry, Chemical Technology and Food Technology) and graduate university studies (Chemistry, Chemical Technology and Food Technology), integrated undergraduate and graduate study of Pharmacy (in cooperation with School of Medicine in Split) and postgraduate university (doctoral) studies (Chemical Engineering in Materials Development and Environmental Protection and Chemistry of the Mediterranean Environment).

More than 2.500 students have graduated at the FCT. Many of them performed the responsible positions in the industry, science, schools, local and state administration bodies, hospitals, laboratories and numerous successful scientific domestic or foreign projects…

In accordance with the strategic program of scientific research, scientists are engaged in research of the following main scientific topics: Research and development of environmentally friendly materials and sustainable processes, Profiling and potential of natural organic compounds and Development of advanced methods of analysis. In the last five years, 217 papers in the WoSCC database and 231 papers in Scopus database have been published. The total number of FCT employees' citation was 9789 (WoSCC) and 14835 (Scopus).

60th anniversary of the Faculty of Chemistry and Technology in Split was celebrated in October 2020. On this occasion, Monography of the Faculty of Chemistry and Technology in Split as well as the special edition of the journal Chemistry in Industry were issued (http://silverstripe.fkit.hr/kui/arhiva-brojeva/issue/178). With its overall activity within the last sixty years, FCT has significantly impacted the development of the City of Split, Dalmatia and Croatia and will continue to the same in the future.

South West side of Faculty building,
University of Split Faculty of Chemistry and Technology, Split, Croatia

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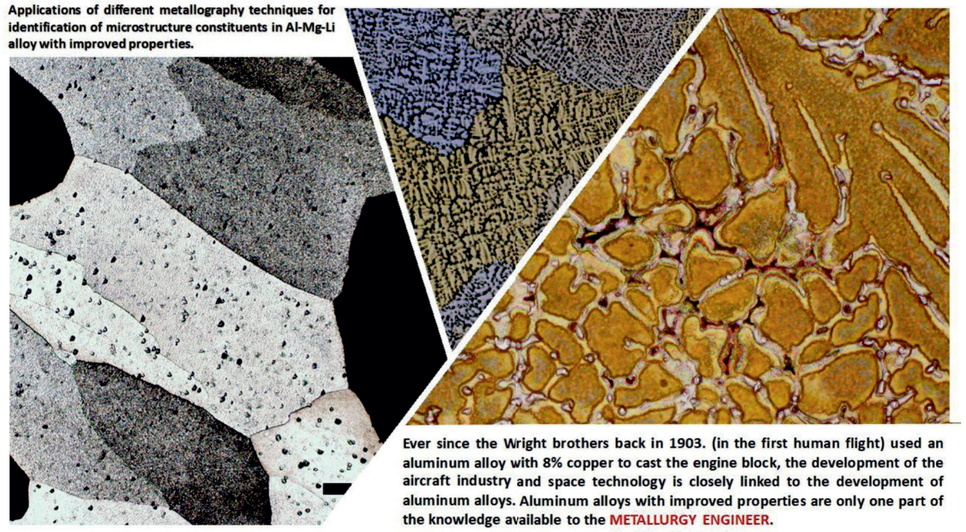

F. Kozina, Z. Zovko Brodarac, M. Petrić, Application of different metallography techniques for identification of microstructure constituents in Al-Mg-Li alloy with improved properties

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	Labeko d.o.o., Zagreb (HR)	Labeko laboratorijska oprema

Five steps to **high quality castings**

1. Base iron preparation
2. Metal treatment of Grey Iron and Ductile Iron
3. Grey Iron and Ductile Iron Inoculation
4. Focus on ductile iron production
5. Optimisation of Cast Iron Production

Stable and well nucleated base iron

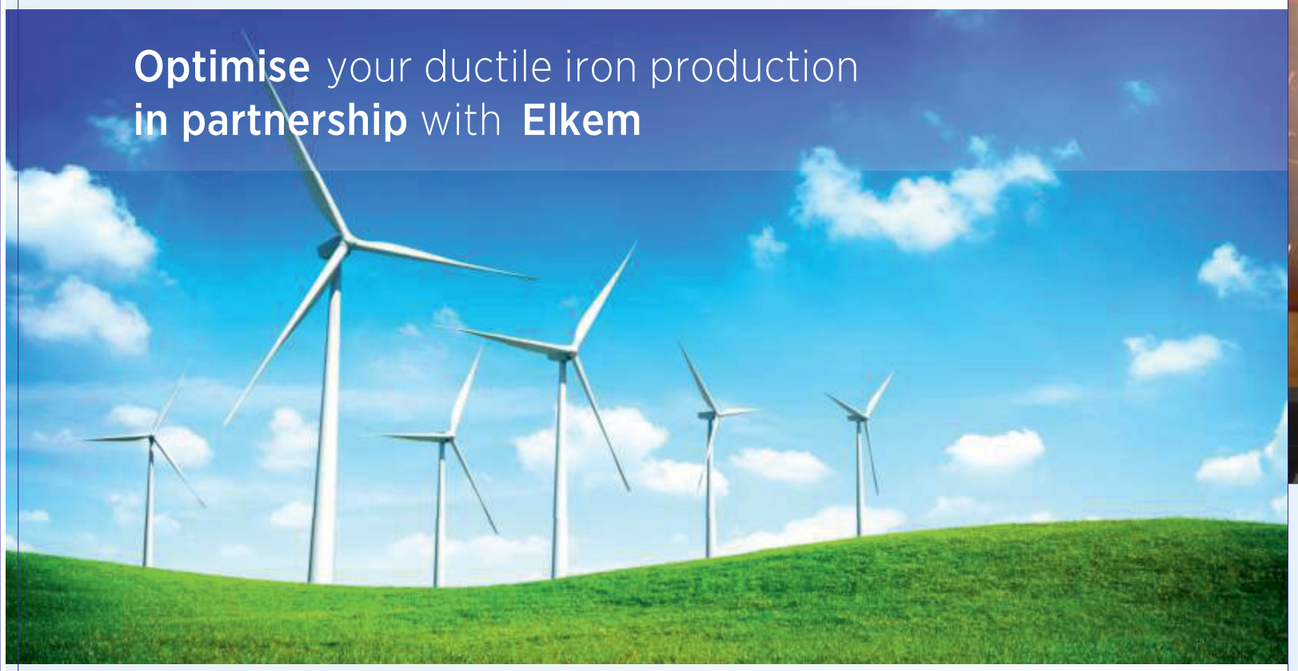
Production of sound and cost effective iron castings begins with the selection of good quality raw materials and additives. Yet the best materials can deliver a poor quality iron unless there is sufficient nucleation carried through the process to give the graphite morphology, chill control and mechanical properties required.

Preconditioning with a long-lasting material, such as Elkem´s unique Preseed ™ preconditioner is the optimal way to ensure that the nuclei, once created in the melt, are stable enough to survive subsequent treatment processes prior to casting.

Essential to the process is a means of measuring the graphite activity with a melt and the thermal analysis system EPIC™ is able to quickly and accurately give and indication of whether the iron is suitable for pouring or requires correction.

www.elkem.com/foundry

Optimise your ductile iron production **in partnership** with **Elkem**



Business areas:

Silicon Materials

Silicones

Foundry Products

Carbon

Representative office:

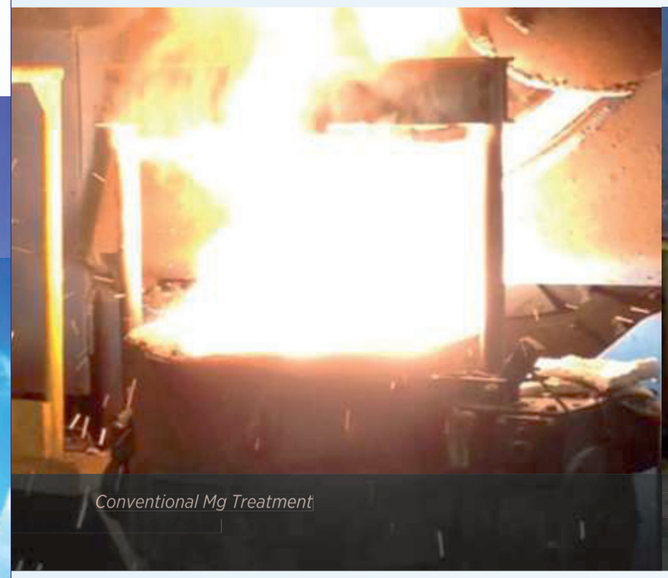
Elkem ASA

J.J. Strossmayer 176, Sisak Croatia · Tel. +385/44/659-065 · Fax +385/44/659-067 · gordana.gojsevic@elkem.com · zoran.kovacic@elkem.com

Innovative Metal Treatment Solutions

More then 100 reasons to have a partnership

Getting the best value from nodularising alloys can be a big saving for foundries. The trend towards low Mg alloys, which have lower reactivity and hence higher recovery, continues. Elkem´s extensive range of over 100 MgFeSi chemistries, coupled with Topseed® cover alloy, means that together we can optimizes your total treatment alloy package. Please contact your local Elkem representative for more details or visit us at www.elkem.com/foundry.



Conventional Mg Treatment

® cover alloy

Our Partner: **Ferrosad Low Carbon Steel Shot**

METALLTECHNIK SCHMIDT GMBH & CO. KG

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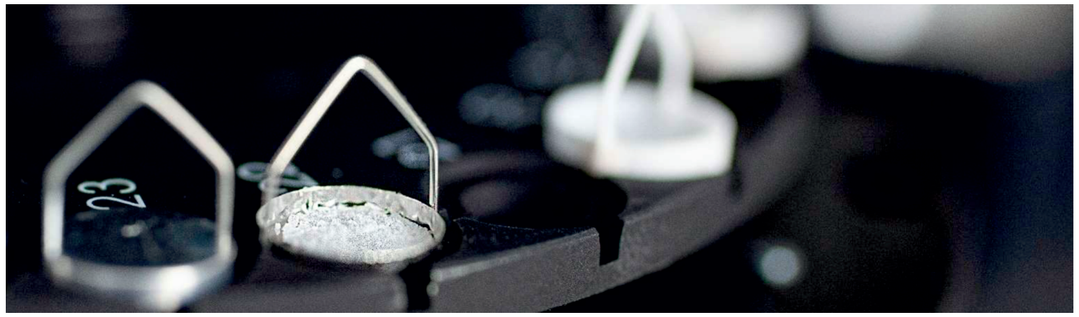
MCT LAB

Material Characterization and Testing Laboratory



Cooperation in the development and research projects of industrial partners in the field of materials science development.

Vision
To become a reliable and innovative analytical laboratory and to strengthen the position of a leading partner for the chemical development of companies.

Mission
Innovative sustainable economic development using state-of-the-art knowledge and approaches.

Values
Reliability, responsibility, professionalism and efficiency, innovation and creativity.

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Split, June 16th-18th, 2021
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SUPPORTING ASSOCIATION AND COMPANIES

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