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PROGRAM

02.04. 2025 - Streda

12:00 – 15:00	**Registrácia účastníkov**
13:00 – 14:00	**Obed**
14:15 – 14:45	**Zahájenie konferencie**
15:00 – 16:00	**Plenárna sekcia**
16:00 – 16:15	**Prestávka - Coffee break**
16:15 – 18:40	**Sekcia I**
17:30 – 17:40	**Prestávka - Coffee break**
19.30 – 24:00	**Spoločenský večer**

03.04. 2025 - Štvrtok

9:00 – 12:00	**Sekcia II**
9:00 – 12:00	**Sekcia III**
10:15 – 10:30	**Prestávka - Coffee break**
12:00 – 13:00	**Obed**
13:00 – 16:30	**Výlet:** Plavba na pltiach
	Wellness
16.30 – 17.00	**Prestávka - Coffee break**
18.30 – 24:00	**Pivný večer**

04.04. 2025 - Piatok

9,00 - 10,15	**Sekcia IV**
10.45 – 11.00	**Slávnostné ukončenie konferencie**

OBSAH ABSTRAKTOV

ANALYSIS OF THE POSSIBILITIES OF USING COATINGS TO IMPROVE THE PERFORMANCE PROPERTIES OF MAGNESIUM ALLOY CASTINGS

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Abstrakt

The paper presents the results of scratch test tests of the connection of two Al_2O_3+40%TiO_2 and WCCoCr coatings with an AZ91 alloy casting. The coatings were applied using the APS (Atmospheric Plasma Spraying) method. The criterion for the correct coating production was the thickness of the Al_2O_3+40%TiO_2 coating ranging from 280 to 300 μm, while for the WCCoCr coating the thickness was from 140 to 160 μm. Microstructure tests and analysis of the chemical composition of the substrate material and Al_2O_3+40%TiO_2 and WCCoCr coatings were performed. The analysis of the coating-substrate connection condition was performed based on microstructure tests before and after the scratch test. The scratches were made in the direction from the substrate to the coating. The scratch depth and width were determined in the scratch test. Based on the conducted tests, a very good quality of the Al_2O_3+40%TiO_2 and WCCoCr coatings connection with the with the AZ91 alloy casting was found. The effect of the indenter interference during scratching is the process of degradation of the AZ91 alloy microstructure and coatings. Cracking plays the main role in this process. In the case of coatings, the effect of the indenter action is a network of microcracks, while in the AZ91 alloy microstructure, cracks appeared in large precipitates of the γ-$Mg_{17}(Al, Zn)_{12}$ phase. The obtained lower values of the geometric scratch parameters (width and depth) of the coatings, compared to the AZ91 alloy substrate, indicate the possibility of using coatings to improve the functional properties and scratch resistance of elements and machine parts made of magnesium alloy.

THE INFLUENCE OF MICROSTRUCTURE MODIFICATION OF ALSI ALLOY USING FSP ON MATERIAL PROPERTIES

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Abstrakt

An aluminum-silicon casting alloy was subjected to friction-based surface layer modification with material mixing using the Friction Stir Processing (FSP) method. The aim of the study was to assess the impact of the modified microstructure on the linear distribution of microhardness values and on material properties. The HV0.1 microhardness of the modified material was analyzed under a 100 g load, maintaining a distance of 0.4 mm between individual points and 1 mm between the lines along which microhardness measurements were performed. The coefficient of friction was determined by performing scratches under varying force values using the scratch test method with a diamond Rockwell indenter at a sliding speed of 0.5 mm/min. Additionally, the scratch test assessed the depths and widths of the grooves. Macro- and microstructural analyses of the subsurface layer area of the AlSi alloy after modification were conducted. The research results indicate a smaller variation in microhardness values in the modified material compared to the as-cast state. Changes in other material parameters are also observed.

ANALÝZA ÚNAVOVÝCH VLASTNOSTÍ AUSTENITICKÝCH LIATIN S GUĽÔČKOVÝM GRAFITOM

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Abstrakt

Austenitické liatiny s guľôčkovým grafitom majú výbornú kombináciu pevnostných a plastických vlastností, ale aj ďalšie výhody, ako napr. vysokú odolnosť proti korózii, vynikajúcu odolnosť proti opotrebeniu a erózii, dobrú húževnatosť a stabilitu pri nízkych teplotách, vynikajúcu tepelnú a oxidačnú odolnosť, dobrú zlievateľnosť, obrábateľnosť podobnú austenitickým nehrdzavejúcim oceliam a niektoré austenitické liatiny sú navyše nemagnetické. Pre praktické použitie týchto liatin sú však dôležité aj únavové vlastnosti a lomové správanie odliatkov pri únavovom namáhaní. Tie súvisia s mikroštruktúrou a mechanickými vlastnosťami. Cieľom tejto štúdie je stanovenie únavových vlastností a analýza únavového lomu dvoch austenitických liatin s guľôčkovým grafitom v spojitosti s ich mikroštruktúrou a mechanickými vlastnosťami.

ANALÝZA TVRDONÁVARU VYHOTOVENÉHO TECHNOLÓGIOU ZVÁRANIA TIG

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Abstrakt

Príspevok sa zaoberá analýzou makroštruktúry, chemického zloženia, tvrdosti a tribologických vlastností tvrdonávaru vyhotoveného technológiou TIG s použitím tvrdokovového prídavného materiálu UTP-A 696. Analyzovaný bol jedno, dvoj a trojvrstvový návar. Analýza je zameraná na vplyv počtu vrstiev návaru na jeho vlastnosti. Výsledné vlastnosti tvrdonávaru ovplyvňuje najmä premiešanie prídavného a základného materiálu a tepelný režim pri zváraní. Tvrdonávar vyhotovený technológiou TIG je možné použiť na renováciou opotrebených funkčných častí strojných súčastí ako sú zlievarenské formy, tvárniace nástroje, mlecie mlyny a pod.

HODNOTENIE KORÓZNEJ ODOLNOSTI NÁVAROV MERANÍM INTERMETALICKÝCH FÁZ

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Abstrakt

Príspevok prezentuje výsledky výskumu zameraného na renováciu foriem pre vysokotlakové odlievanie zliatin hliníka. Na renováciu bola použitá technológia laserového navárania. Boli overené renovačné postupy, ktoré zvýšia technologickú životnosť foriem. Bola realizovaná úprava povrchu textúrovaním pre zabezpečenie potrebného mazacieho účinku pri zábehu formy. V prevádzkových podmienkach je možné uplatniť navrhnutú metodiku hodnotenia kvality separačných prostriedkov meraním kontaktných uhlov a zvýšiť ochranný účinok vhodným textúrovaním povrchu tvorbou zásobných jamiek. Bol navrhnutý postup pre hodnotenie odolnosti materiálu návaru pri kontakte s taveninou zliatiny hliníka stanovením koeficientu koróznej odolnosti, ako pomer hrúbky intermetalickej fázy vzniknutej na povrchu návaru k hrúbke intermetalickej fázy na povrchu materiálu tvarového dielu formy po ponore v tavenine zliatiny hliníka. Jedná sa o efektívny spôsob stanovenia vhodnosti materiálu pre renováciu exponovaných častí foriem v podmienkach vysokoteplotnej korózie.

MATRIX REPLICA METHOD IN DIAGNOSIS – STEREOLOGICAL PARAMETERS AND IMAGE ANALYSIS FOR MATERIAL CONDITION ASSESSMENT

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Abstrakt

Diagnostics in the power industry is a complex issue that determines the safe operation of equipment and systems. The future challenges for the energy sector include, among others, improving the efficiency of power units and, consequently, the development of energy control and diagnostic processes. In this work presents a new approach to assessing the microstructures of 13HMF steel after long-term operation. Using stereological parameters with the simultaneous use of digital image analysis, the author show that the non-destructive method of matrix replicas allows a very accurate representation of the microstructure of the material. Non-destructive testing and machine learning used in diagnostics for the analysis of the obtained results are promising techniques applying modern methods of artificial intelligence. However, they are not utilized in actual engineering practice due to the lack of a sizable database of materials following extended use. The development of such a diagnostic model, which is a challenge now, will enable the further development of material testing not only for the energy sector but also for other key industries. The author present a preliminary evaluation of combining quantitative assessment of the microstructure via semi-automatic image analysis with the participation of an operator. It was demonstrated that numerical parameters for the chosen microstructure of 13HMF steel after long-term operation could be added to the operator's comparison evaluations. The tests were carried out using the matrix replica technique and the measurements were made on metal samples and identical regions of the replicas. The mean chord length and the mean cross-sectional area were measured on metallographic specimens and replicas. Values of 15.78 and 15.39 μm mean chord and 373.4 and 352.4 μm^2 mean cross-sectional area were obtained. No statistically significant differences between measurement results were found.

INFLUENCE OF THERMAL CONDITIONS DURING PLASTER MOLD CASTING ON THE PROPERTIES OF AlSi10Mg ALLOY

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Abstrakt

This study examines the influence of plaster mold cooling conditions on the as-cast structure and properties of AlSi10Mg alloy. The aim was to describe how different combinations of pouring and mold temperatures affect the alloy's behaviour during solidification. While the effect of pouring temperature on casting properties is well known, this study extends the analysis to explore the impact of mold preheating, providing a broader understanding of how cooling rates influence microstructure, fluidity, linear thermal expansion, and mechanical properties such as tensile and compressive strength. These parameters were assessed under different casting conditions. Microstructure analysis combined optical observation and quantitative SDAS measurement. The results confirmed that lower mold temperatures (25 °C) produced finer-grained structures with fewer shrinkage cavities and porosities, resulting in higher mechanical properties. However, these conditions reduced fluidity and increased thermal expansion. In contrast, molds preheated to 580 °C improved fluidity and reduced thermal expansion but led to coarser microstructures and lower mechanical properties. The study identified the optimal casting conditions for balancing fluidity, mechanical properties, and thermal stability. Lower mold temperatures (25 °C) combined with higher pouring temperatures (680 °C or 730 °C) helped offset the reduced fluidity caused by rapid cooling, while still maintaining acceptable mechanical properties and relatively low thermal expansion. The results also showed that using extremely high mold temperatures significantly reduces mechanical performance. For practical applications, preheating molds to more moderate temperatures would provide a better balance across all measured properties. Future research could further refine these temperature ranges to optimize process parameters for geometrically complex and thin-walled castings, as well as other demanding applications.

SPRAWNOŚĆ CIEPLNA SPAWANIA LASEROWEGO STALI ARMOX

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Abstrakt

Rosnące potrzeby przedsiębiorstw przemysłu obronnego przyczyniają się do zmian technologicznych i konstrukcyjnych w produkcji pojazdów specjalnych. Produkcja pojazdów specjalnych to głównie procesy cięcia i spawania stali pancernych oraz trudnościeralnych stosowanych do ich budowy. Spawanie stali pancernej jest szczególnie ważne ze względów na właściwości użytkowe konstrukcji oraz ich późniejszą zdolność ochrony balistycznej. Prowadzenie procesu spawania wymaga dokładnej wiedzy o parametrach jakie należy zastosować. Głównym czynnikiem wpływającym na jakość połączeń spawanych jest ilość ciepła pochłonięta przez łączone elementy, która w istotny sposób wpływa na mikrostrukturę złącza spawanego. Dobór parametrów spawania bez znajomości ich efektywności przyczynia się do niekorzystnych zmian właściwości połączenia spawanego lub jego uszkodzeń. Dlatego istotne znaczenie ma określenie sprawności cieplnej procesu spawania. W niniejszej pracy wykorzystano spawalniczy kalorymetr przepływowy do oceny ilości ciepła przejętego podczas laserowego spawania stali ARMOX. Podczas badań zmieniano moc lasera P od 1000 do 4000 W oraz prędkość przemieszczania źródła ciepła v_s od 200 do 800 mm/min. Na podstawie uzyskanych wyników określono rzeczywistą ilość ciepła $Q_{kal.}$ przejętego przez spawaną blachę ARMOX o grubości 10 mm i wyznaczono sprawność cieplną tego procesu h. Wyniki badań porównano z obliczoną teoretyczną ilością ciepłą $Q_{teor.}$ oraz energią liniową spawania E. Uzyskane wyniki wskazują, że w pewnym obszarze parametrów można uzyskać zbliżoną sprawność cieplną np. stosując dużą moc wiązki lasera i wysoką prędkość przemieszczania lub niską prędkość przemieszczania i małą moc wiązki lasera.

UDRŽITELNOST VE VÝROBĚ JADER A FOREM

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Abstrakt

Na základě obecně známé definice lze jako udržitelnost chápat efektivní využití omezených zdrojů při tvorbě produktů a služeb v souvislosti s dlouhodobým dosažením zisku a bezpečnosti podniku. To platí v různých oblastech lidské činnosti. V oblasti slévárenské výroby forem a jader lze udržitelnost výroby dosáhnout využitím materiálů s vyšší přidanou hodnotou, které mají pozitivní efekt nejen na kvalitu vyráběných komponent. Aplikace těchto materiálů má zároveň pozitivní vliv na celkovou nákladovost výroby a zároveň jsou splňovány podmínky cirkulární ekonomiky. Tento příspěvek je zaměřen na představení praktického využití nekřemenných ostřiv na bázi aluminosilikátových materiálů, které přinášejí nejen ekonomické benefity ve výrobě litých komponent, ale zároveň mohou být nápomocny k dosažení optimalizace procesu výroby forem a zejména jader. Příspěvek se rovněž zabývá porovnáním základních fyzikálně-chemických a technologických vlastností vybraných aluminosilikátových ostřiv s jinými, ve slévárenské praxi běžně používanými ostřivy. Součástí příspěvku jsou rovněž případové studie aplikace ostřiva Cerabeads ve vybraných slévárnách bez geografického omezení.

MOULD TEMPERATURE STABILITY ANALYSIS BASED ON HPDC DIE CASTING DESIGN

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Abstrakt

Mould temperature in the High Pressure Die Casting (HPDC) process is an important technological parameter that determines the stability of the process and the quality of the castings produced. Incorrect cooling strategies, the wrong amount of coolant and the failure of thermostatic systems can lead to disturbances in the thermal balance of the mould, resulting in uncontrolled temperature fluctuations. This has a direct impact on the quality of the castings, increasing the risk of defects such as thermal cracking, shrinkage porosity or microstructural inhomogeneity. Despite the importance of temperature control, its effective management throughout the lifecycle of a production project remains a constant challenge. Underestimating or downplaying temperature destabilisation events leads to a gradual loss of process control. In high-volume production, where maintaining high repeatability is critical, failure to monitor mould thermal parameters can result in significant production losses and increased tool wear. Effective temperature control requires the use of appropriate monitoring methods. Thermal imaging is an effective technique for detecting incidental temperature perturbations, but its limited ability to detect subtle accumulation changes means that it does not always allow early detection of factors affecting long-term mould stability. In such cases, it is essential to collect and analyse process data to identify trends and relationships between temperature variations and casting quality. The aim of this paper is to analyse the history of mould temperature variation in a selected HPDC project, and to identify and discuss perturbations that occur during batch production. Methods of data collection, management and analysis are also presented to enable more effective control of thermal parameters in the die casting process.

OPTIMISING SECONDARY A356 ALLOY: INFLUENCE OF FE AND MN ON MICROSTRUCTURE AND PROPERTIES

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Abstrakt

This study examines the effect of increased iron content (0.123–1.2 wt.% Fe) on the microstructure, porosity, and hardness of the A356 (AlSi7Mg0.3) alloy, comparing alloys with and without manganese (Mn) addition. A356 is widely used in the automotive and aerospace industries due to its excellent mechanical properties and castability; however, excessive iron in secondary (recycled) aluminium alloys promotes brittle Fe-rich intermetallic phases, reducing mechanical performance. Mn is expected to modify these phases, potentially enhancing alloy properties. The microstructure is analysed to evaluate the morphology and distribution of Fe-intermetallic phases and their transformation with increasing Fe content and Mn addition. Porosity, a critical casting defect affecting mechanical properties, is assessed in terms of pore type, size, and distribution to determine its correlation with Fe content. Additionally, Brinell hardness testing is conducted to evaluate the impact of Fe-induced microstructural changes on hardness. The findings provide insights into the feasibility of using secondary A356 alloys with higher Fe content while maintaining adequate mechanical properties for industrial applications. Understanding the interplay between Fe content, Mn addition, microstructure, and porosity is essential for optimising alloy composition and refining processing techniques to enhance the performance and sustainability of cast aluminium components.

MICROSTRUCTURE AND MECHANICAL PROPERTIES OF VARIOUS ALZN10SI8MG ALLOY MELTS WITH HIGH IRON CONTENT

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Abstrakt

The present study investigates the microstructure and mechanical properties of secondary AlZn10Si8Mg alloy melts with high iron content. Four different melts of the alloy with various iron content were analysed to assess the influence of iron-rich intermetallic phases on microstructure evolution, Vickers hardness (HV), and microhardness (MH). Optical microscopy was used to characterize the morphology and distribution of iron-containing phases. Results indicate that increasing iron content leads to the formation of coarse intermetallic compounds, primarily Al-Fe-Si, which significantly impact hardness of the alloy. Microhardness testing of individual phases confirmed that iron-rich intermetallic phases exhibited higher hardness compared to the aluminium matrix. Three of the melts tested were alloyed with manganese to modify the morphology of iron-rich phases. These alloys usually exhibit better mechanical properties if the required ratio of manganese to iron is maintained. The effect of the copper addition was also investigated. This study provides a basis for further research on the effect of iron on the mechanical properties of recycled aluminium alloys. Up to now, not enough research attention has been given to alloys with such a high iron content.

TIN IN SPHEROIDAL GRAPHITE CAST IRON: FRIEND OR FOE OF AUTOMOTIVE CASTINGS?

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Abstrakt

Tin is an element commonly used in grey cast iron with flake graphite. Sn is also increasingly used for ductile cast iron, but this application is very limited, especially for castings intended for the automotive industry, where the requirements for mechanical properties (R_m, $R_{0.2}$, A_5, KC) and microstructure are high. Tin is an effective pearlitizer for both types of cast iron (grey with flake graphite and spheroidal with nodular graphite), and its effect on the pearlitization of the matrix is about 10 times greater than that of copper, which, given the current prices of Cu and Sn, makes it very competitive. The use of Sn carries certain risks depending on the Sn content in the alloy. Ductile cast iron with a small addition of tin is characterized by attractive mechanical properties, but after exceeding certain critical values, it can pose a risk, especially for castings with safety characteristics. Therefore, the use of Sn in optimal values can be beneficial, and after exceeding certain limit values, it becomes a real threat (drastic decrease in mechanical properties, mainly A_5 and KC). Therefore, Sn can become a Friend or Foe of the metallurgist. The aim of the research was to determine the effect of Sn on the microstructure and mechanical properties of ductile iron. Within the scope of this work, research was carried out for castings with a wall thickness of 12.5 and 25 mm, respectively. Metallographic research included analysis of graphite in terms of the number of graphite nodules, nodularity, and the distribution of graphite particle sizes. The study of the metal matrix consisted of determining the effect of tin on the type and phases fraction. SEM-EDS studies allowed for the assessment of tin segregation. The research results indicate a safe limit of Sn use for ductile iron castings, so that the casting meets the customer's requirements in the context of the possibility of using Sn for responsible castings intended for the automotive industry.

ENVIRONMENTALLY FRIENDLY FOUNDRY MOLDING SANDS AS A PART OF GREEN DEAL POLICY

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Key words: innovative technologies, Green Deal policy, molding sand, organic binder, inorganic binder, waste management

Abstrakt

Thanks to strict environmental regulations, improvements in energy efficiency, and the trend in European industry to move away from harmful technologies over the past few decades, the negative impact of European industry on the environment has improved. In order for the European industry to become more environmentally friendly in the future, it is necessary to implement new innovative technologies.

The total production of castings in CAEF countries in 2023 amounted to over 14 million tons, and a significant part of these castings were produced using sand molds and cores. Thus, the development of environmentally friendly molding sand technologies is an important part of the Green Deal policy. The aim of the paper is to analyze modern solutions for molding sands, both with organic and inorganic binders.

In molding sands with organic binders, the innovative approach of replacing part of the binder with biodegradable additives reduces the harmfulness of molding sand at the stage of casting production and contribute to solving the problem of hazardous post-regeneration dust utilization, which is crucial from waste management point of view. Another solution are molding sands with organic binders based on modified with furfuryl alcohol resins cured by hardeners with reduced sulfur content, which are less environmentally harmful and ensure production of high-quality ductile iron castings. Molding technologies with alkyd resins hardened by catalyst based on isocyanates and alkaline phenolic resin hardened by esters are a less environmentally harmful alternative to molding sands with commonly used in foundry practice furfuryl resin.

Molding sands with environmentally friendly inorganic binders based on sodium silicates and aluminosilicates were also analyzed. Molding sands with solid and hydrated sodium silicates with additives improving their knocking out properties can be used as well as new ester hardeners based on esters of carbonic acid and their mixtures with hardeners based on acetic acid used commonly in chemically hardened molding sands with hydrated sodium silicate.

Finally, due to the harmfulness of respirable dust from silica sand for foundry workers, various sand matrixes, including advanced synthetic ones, were analyzed, also for 3D printing of sand molds and cores.

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SELECTION OF CHEMICALLY CURED MOLDING SANDS' WITH INORGANIC BINDERS DEDICATED TO 3D SAND PRINTING

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Key words: innovative technologies, 3D sand printing, molding sand, resin, inorganic binder, chemical curing

Abstrakt

Due to the high technological potential, also in thin-walled casting, 3D printing technologies in the foundry industry are developing very dynamically. Binder jetting technology is most commonly used for the production of sand molds and cores with 3D printing. The binding materials used in foundry practice are organic resins modified with furfuryl alcohol. These materials are characterized by excellent technological properties, but at the same time they are harmful to the environment. Environmentally friendly inorganic binders are an alternative to the organic binders used for the production of molds and cores, and this is the subject of research carried out at various research centers.

This work determines the influence of molding sands' with different inorganic binders composition on their chosen properties. The molding sands with 3 commercial inorganic binders used in traditional mold and core production technologies were tested as well as the molding sands dedicated to 3D printing with new binders based on them. Four types of hardener were used for chemical curing.

The molding sands' technological (strength properties, permeability, abrasion) and thermophysical (thermal deformation) tests and the physicochemical tests of binders (viscosity, wettability of the quartz substrate) have shown that inorganic binders elaborated on the basis of commercial binders can be used in 3D printing technology. The selected sands' compositions were chosen for further research.

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OPTIMISATION OF THE HIGH PRESSURE DIE-CASTING PROCESS TO REDUCE POROSITY - COSTS

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Abstrakt

Die casting is characterised by very high productivity, which depends on the type of alloy to be cast, the size of the casting (its mass) and the type of die casting machine. The cost of producing a product consists of material costs, labour costs and tooling costs. The cost of producing a casting (considering only the casting process) can be reduced by increasing the number of cavities in the pressure mold. This is not always possible without changing the die casting machine to one with a higher short-circuit force. And in view of the larger cavity volume of the mold (and thus the volume of air that has to be removed from inside the mold), it is necessary to use so-called vacuum systems.In this paper, an abbreviated cost analysis has been carried out for the production of castings in a two-cavity mold and a six-cavity mold using a Vacuum system. All of the solutions developed were implemented in the Silum foundry, resulting in a 22% reduction in the cost of castings. The project was carried out in a scientific-industrial consortium between: Łukasiewicz Research Network - Krakow Institute of Technology, Lodz University of Technology and SILUM Group. The aim of the project was to develop a technology for the production of high-tightness castings using the Vacuum Assisted High Pressure Die Casting (VADC) process, which would significantly reduce the cost of casting production. The paper is based on the results obtained under the application project number POIR.04.01.04-00-0117/18 entitled: "Innovative production line for manufacturing die castings with significantly reduced porosity". The project is co-financed by the European Union from the European Regional Development Fund under the Intelligent Development Programme 2014-2020. The project was carried out under the competition of the National Centre for Research and Development.

OPTIMIZATION OF THE HIGH PRESSURE DIE-CASTING PROCESS TO REDUCE POROSITY - PROPERTIES

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Abstrakt

The main problem with the use of pressure castings from aluminum alloys for, among others, critical parts in the automotive industry is the presence of porosity. Obtaining castings with reduced porosity is a very difficult task, requiring a number of changes in relation to the classic pressure casting process. This basic defect limits the area of application of pressure castings. In addition to reduced tightness and inadequate external surface quality, it can reduce the strength and/or plastic properties of the castings. One of the solutions to avoid problems in the production of high-quality, tight and at the same time thin-walled and durable castings from Al alloys can be the use of a special high-pressure casting solution using the so-called "vacuum". The use of the Vacuum system in pressure casting can significantly reduce the porosity of castings. The amount of gas present in the pressure casting is influenced by the geometry of the part and the process parameters. The article presents selected studies on reducing porosity in pressure castings using the Vacuum system. Microstructural tests, density tests, X-ray and CT, and a tightness test of the castings were carried out. The work uses the results obtained within the application project no. POIR.04.01.04-00-0117/18 entitled "Innovative production line for the production of pressure castings with significantly reduced porosity" co-financed by the European Union from the European Regional Development Fund under the Smart Growth Program 2014-2020. The work presents selected studies on reducing porosity in pressure castings using the Vacuum system. Microstructural tests, density tests, X-ray and CT, and a tightness test of the castings were carried out. The work uses the results obtained within the application project no. POIR.04.01.04-00-0117/18 entitled "Innovative production line for the production of pressure castings with significantly reduced porosity" co-financed by the European Union from the European Regional Development Fund under the Smart Growth Program 2014-2020.

INFLUENCE OF GRAPHITE SHAPE AND DISTRIBUTION ON GREY IRON'S PHYSICAL AND MECHANICAL PROPERTIES

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Abstrakt

Problematika výskytu degradovaných forem grafitu v odlitcích se řeší především ve spojitosti s litinou s kuličkovým grafitem. Nicméně je výrazně spojená i s výrobou litiny s lupínkovým grafitem a je tedy třeba zabývat se příčinami, které způsobují vznik nežádoucích struktur a hledat řešení, jak jim předcházet nebo je řídit. Cílem tohoto příspěvku je ověřit vliv vybraných stopových prvků na morfologii grafitu, změnu struktury a s tím spojené mechanické a fyzikální vlastnosti litin s lupínkovým grafitem. A následně zhodnotit možnosti využití takto změněných vlastností v technické praxi.

THE USE OF RECLAIMED FURFURYL RESIN-BONDED MOULDING SANDS TO MAKE CERAMIC LAYERD MOULDS

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Abstrakt

The foundry industry generates very large amounts of spent materials. In sand mould technology, the waste mainly consists of the used moulding and core sands. The increasing cost of waste storage forces foundries to intensify the search for ways to reduce material consumption, on the one hand, and to effectively re-use the waste generated in the production process, on the other hand. This article discusses the results of studies exploring the possibility of using spent moulding sand as a ceramic material for successive layers of ceramic shell moulds. Industrial regenerates from three foundries were used for the tests. The tests used regenerates from the process of dry mechanical reclamation of waste sands with furfuryl binder obtained from three foundries. Physicochemical properties of the regenerates were tested, and then experimental ceramic materials were produced using regenerates from waste masses as a topping material. The tests showed that ceramic moulds made on the basis of regenerates are characterised by very good technological parameters, and the castings made in these moulds are characterised by good surface quality and functional properties. The use of regenerate from furan masses to make multi-layer ceramic moulds.

EFFECT OF LPIC TECHNOLOGY ON MECHANICAL PROPERTIES OF DUCTILE IRON CASTING

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Abstrakt

The paper deals with the comparison of cast test specimens (tensile test specimens, notch toughness test specimens, spectral test specimens) from ductile iron cast by LPIC (Low Pressure Investment Casting) technology compared to gravity investment casting in shells made by wax melt model (GIC). A single melt of the same chemical composition for both LPIC and GIC technology is compared. A basic description of the newly developed LPIC technology is given, including the new metallurgical process and the newly developed modification method using FeNiMg modifiers, where the reaction is not as stormy as with FeSiMg, and including verification of the process parameters on a newly developed casting machine for proper casting and filling of the casting tree. Everything is compared to the results from metallographic cuttings, mechanical tests, hardness tests and SEM analysis of fracture surfaces. As a result, there was an improvement of 29% in mechanical properties, 18% in ductility, 3% in hardness and 6% in notch toughness for LPIC compared to castings made by GIC technology.

DENTAL IMPLANTS PRODUCED BY MG-ALLOY INFILTRATION OF CERAMIC SCAFFOLDS

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Abstrakt

The main focus of this study is to produce prototype two-material teeth implants with 3D-printed solid ceramic crown and skeleton roots filled with metal, characterized by good connection and acceptable thermal stability for the foreseen application. Combination of alumina and Mg-alloys together with the chosen manufacturing methods offers not only biocompatibility of the whole easily customized implant but also bioresorbability of the metal part, enabling further tissue regeneration. Joining of these components can be achieved by selected foundry techniques (e.g. squeeze or investment casting). Interface quality was established using SEM-EDS analyses, while the thermal stability of the composite and its particular constituents was assessed during thermal expansion tests in the temperature range up to 100°C and compared with the literature data. Multiple systems consisting of variously shaped ceramics, differing casting alloys and possibility of prolonging the degradation period of Mg-based part by utilization of plasma electrolytic oxidation (PEO) protective oxide layers will be presented and discussed. After fullfilling its purpose, Mg is believed to be able to be successfully metabolised without harming the human body, however alloy additives should be also taken into account by e.g. avoding of the Al content and replacing it with other elements such as e.g. Zn. This work has been developed in the frame of the CERMET project, funded by the National Centre for Research and Development POLTAJ10/2022/53/CERMET/2023 (Poland) and National Science and Technology Council 112-2923-E-027 -001 -MY3 (Taiwan).

FOUNDRY DUST - ALTERNATIVE ADDITIVE FOR GREEN SAND MIXTURES

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Abstrakt

Foundry dust is a significant component of the waste produced by the foundry industry worldwide. This waste is generated during mould making, melting, casting and discharging of moulds, where dust particles are released and subsequently captured by filters. Like most foundry waste, foundry dust usually ends up in landfills. However, this method of waste management faces problems related to environmental and economic requirements, especially in view of tightening legislation. It is important to point out that foundry dust contains components that could be reused in the production of foundry mixtures. The aim of this study is to evaluate the possible positive and negative effects of two foundry dust samples on the quality of the green sand mixtures. Basic analyses include the chemical composition of the leachate in aqueous solution and the granulometric composition of the dust particles. Furthermore, the properties of other ingredients for the preparation of green sand mixtures will be characterized. The study serves as a starting point for future research in the reuse of foundry dust in green sand mixtures, thus contributing to the sustainability of industrial processes.

THE PROBLEM OF CHUNKY GRAPHITE FORMATION IN CAST IRON WITH INCREASED SILICON CONTENT

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Abstrakt

Příspěvek se zabývá vlivem obsahu křemíku a tloušťky stěny odlitku na sklon ke vzniku chunky grafitu. Byly provedeny tři tavby s obsahem křemíku 4,0; 4,1 a 4,5 % Si. Odlity byly zkušební bloky o tloušťce stěny 25, 50, 75 a 100 mm a krychle o hraně 160 mm. V odlitcích byly pomocí termočlánků měřeny doby tuhnutí. Následně byly měřeny mechanické vlastnosti (Rm, Rp0.2 a A) v různých průřezech odlitků. Také byly odebrány vzorky pro metalografické hodnocení struktury, a to od povrchu odlitku až do jeho středu. Sledován byl zejména výskyt chunky grafitu v závislosti na vzdálenosti od povrchu, resp. na době tuhnutí. Bylo zjištěno, že všechny vzorky ze všech taveb a z odlitků všech zkoumaných tlouštěk splňují požadavky normy ČSN EN 1563 pro materiál EN-GJS-500-14 na minimální hodnoty Rm a Rp0.2. Požadavky na minimální tažnost byly splněny v případě materiálu s obsahem 4,0 % Si pouze u bloků tloušťky 25 a 50 mm. U tavby s obsahem 4,1 % Si pouze u některých vzorků z bloku tloušťky 75 a 100 mm. U materiálu s obsahem 4,5 % Si u všech vzorků ze všech zkušebních bloků, tedy 25, 50, 75 i 100 mm, pouze u vzorků z krychle o straně 160 mm byla naměřená hodnota tažnosti 11,7 %, tj. těsně pod požadavkem normy. Překvapivě, množství chunky grafitu nalezeného v odlitcích bloků všech tlouštěk bylo minimální. Místy byl pozorován výskyt vermikulárního grafitu. V odlitku krychle o hraně 160 mm byl dle očekávání nalezen chunky grafit, jeho největší výskyt byl v okolí tepelné osy. Nejvíce u materiálu s obsahem 4,0 % Si (51 %), nejméně u materiálu s 4,5 % Si (38 %). Matrice byla vždy bez výjimky plně feritická, bez přítomnosti perlitu.

CORROSION TESTING OF CAST HYPER DUPLEX STAINLESS STEEL A890 7A AND COMPARISON WITH SELECTED ALLOYS

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Abstrakt

Cílem prováděného výzkumu bylo korozní porovnání litých duplexních (austeniticko-feritických) korozivzdorných ocelí a vybraných slitin proti bodové korozi. Pomocí hodnoty PREN (pitting resistence equivalent number), je možné teoreticky určit odolnost korozivzdorných ocelí proti bodové korozi. S rostoucím množstvím legujících prvků se zvyšuje hodnota PREN a tím i odolnost proti bodové korozi. Ochranu korozivzdorných ocelí zajišťuje pasivní vrstva tvořená především . Celkem bylo korozně testováno sedm slitin. Vybrány byly čtyři zástupci litých duplexních korozivzdorných ocelí (ASTM A890 4A-standard, A890 5A-super, A890 6A-super a A890 7A-hyper) se zvyšující se hodnotou PREN. Jednou z předností duplexních korozivzdorných ocelí je vynikající korozní odolnost v prostředí mořské vody. Hlavním motivem tohoto experimentu bylo otestování korozní odolnosti nové hyper duplexní korozivzdorné oceli A890 7A pro odlitky. Hlavními přednostmi hyper duplexních korozivzdorných ocelí jsou výborné mechanické vlastnosti, které dosahují až dvojnásobku meze kluzu i meze pevnosti v porovnání s austenitickými nebo feritickými korozivzdornými ocelemi. Dalšími testovanými slitinami byly: austenitická korozivzdorná ocel 1.4301, niklová superslitina Inconel 718 a vysokoentropická slitina (HEA) CoCrFeNi. Korozní testování proběhlo podle normy ASTM G48-11 v prostředí 6% vodného roztoku při teplotě 50 °C po dobu 72 hodin. Součástí hodnocených parametrů byly hmotnostní úbytky testovaných vzorků, vizuální a metalografická analýza.

FLUIDITY ASPECTS OF THIN-WALLED AL CASTINGS IN THE INVESTMENT CASTING TECHNOLOGY

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Abstrakt

Příspěvek se zabývá moderní technologií výroby tenkostěnných odlitků v technické praxi. Dotýká se současných důvodů pro nárůst potřeby těchto typů odlitků, nastiňuje spojitost s konstrukčními a optimalizačními metodikami a rozebírá výzvy, které z jejich použití vyplývají ve vztahu k plnění dutiny keramické skořepiny. Pozornost je věnována specifickým vlivům na zabíhavost se zaměřením na povrchové napětí a zejména prodyšnost skořepiny, pro níž jsou provedeny a prezentovány experimenty s vyhodnocením plochy zaběhnutí s využitím obrazové analýzy na experimentálním odlitku. Experimenty jsou prováděny pro materiál odlitku AlSi7Mg0.3 a alumino-silikátovou skořepinu. Pro měření kontaktních úhlů mezi kovem a skořepinou je využito metodiky ležící kapky (CP sessile drop test). Povrchové napětí je počítáno na základě pendant testu. Jsou prezentovány výsledky pro několik typů materiálů skořepiny. Pro měření prodyšnosti keramické formy bylo sestaveno experimentální zařízení, které umožňuje měření prodyšností v závislosti na teplotě. Byl proveden virtuální experiment s využitím numerické simulace v programu ProCAST s využitím kritéria Misrun sensitivity. Je provedena verifikace simulace s naměřenými daty s doporučením prahových hodnot pro účely post-processingu.

POSSIBILITY OF USING HIGH TEMPERATURE RESISTANT RESIN FOR THE PRODUCTION OF VULCANIZATION MOULDS FOR SPIN CASTING

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Abstrakt

This paper focuses on the evaluation of models for the production of vulcanized rubber moulds for the spin casting technology of low-melting alloys of the ZAMAK type. The main focus is on the high temperature resistant resin produced by SLA technology, which was used to produce the main model used to prepare the mould. For comparison, brass models produced by investment casting on the melt model were used. The master models used for investment casting were created by FDM 3D printing technology from different materials with different surface finishes. The SLA model was prepared in approximately one hour, while the production of the metal models was significantly more time consuming. After the vulcanisation mould was created, test castings were produced and their quality assessed. The results thus compare the suitability of the materials and technologies used to achieve detailed and accurate castings and provide recommendations for optimizing the model fabrication process.

INFLUENCE OF HPDC PROCESS PARAMETERS ON THE INTERNAL HOMOGENEITY OF CASTINGS FOR EC ELECTRIC MOTORS

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Abstrakt

High-pressure casting results in a high quality surface and good mechanical properties of castings. Under the effect of pressure, integral and solid castings are achieved without a large number of foundry defects. The correct and proper setting of technological parameters plays a very important role in minimizing casting defects. The aim of the presented article is to determine the optimum maximum piston velocity for a casting in the high-pressure casting process with two height variants, depending on their internal quality. It is because the internal quality of particular castings is important in terms of proper functionality in operations where the biggest problem is the porosity of the casting. The main cause of porosity formation is the decreasing solubility of gases (most often hydrogen) during the melt solidification. Solubility represents the maximum amount of gas that can dissolve in a metal under equilibrium conditions of temperature and pressure. Macroporosity and microporosity were determined from the sections of the surfaces in the determined zones of the castings. Here, the results was that the macroporosity decreased with increasing piston velocity. Ideal microstructure was evaluated at a piston velocity of 3 m/s for both types of castings. On the other hand, the increase in tube size has shown that velocities of 3 m/s and higher, the tube is more prone to macroporosity formation. The highest hardness was achieved at the piston velocity of 2 m/s at both tube lengths.

THE USE OF LANTHANUM AS A CRUCIAL ALLOYING ELEMENT IN ALLOYS FOR THE DEVELOPMENT OF SUSTAINABLE ENERGY

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Abstrakt

The melting of lanthanum, a rare metal, requires a temperature of around 920 °C, which is relatively low compared to the melting points of other rare earth metals. Lanthanum is a soft, silvery-white metal that has wide industrial applications, particularly in the production of hydrogen fuel cells and other technologies. Lanthanum and its alloys, especially those combined with other rare earth elements like cerium and neodymium, exhibit excellent hydrogen absorption capabilities. This makes them ideal materials for use in hydrogen storage systems. Lanthanum alloys can efficiently store hydrogen at high pressures and low temperatures, enabling hydrogen storage for later use in energy applications. Given the growing demand for materials used in hydrogen technologies, there is an increasing focus on the recycling of these metals. Recycling lanthanum and its alloys is crucial for sustainability, as rare earth elements are limited, and their mining can have negative environmental impacts. Effective recycling not only conserves natural resources but also reduces the environmental burden associated with the extraction and production of these materials. Rare metal recycling technologies can significantly contribute to the development of sustainable energy, which is vital for the future of clean and renewable energy.

APPLYING INVESTMENT CASTING TECHNIQUE FOR MANUFACTURING THIN WALL ALUMINIUM STRUCTURES DEDICATED FOR HEAT TRANSFER ENHANCEMENT IN LATENT THERMAL ENERGY STORAGE

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Abstrakt

This research focuses on applying investment casting method for manufacturing thin wall spatial aluminum structures for enhancing heat transfer in latent heat storage. Rapid prototyping procedure was applied for manufacturing structures with use of 3D printing method for disposable patterns to create gypsum precise mould. Castings quality was evaluated in terms of possible casting defects. Moreover thermal performance was evaluated in laboratory scale heat accumulator. Four castings were connected in two heating sections and immersed in phase changing material (PCM) based on nitrate salt mixture. Testing procedure involved multiple melting and solidifying cycles of the PCM to examine long term behavior of castings in harsh molten salt environment and cyclic mechanical stress from PCM volume expansion during melting/solidifying process. It was found that implementing additional casted aluminium structures in PCM bed can significantly change melting/solidifying characteristics and improve storage charging time. This work has been developed as part of the ASTEP project, funded by the European Union's Horizon 2020. Europe research program under grant agreement No. 884411.

BINDER JETTING SAND PRINTING – RE-USING OF LOOSE SAND AND THERMAL-MECHANICAL RECYCLING OF SAND MOULDS FOR LACK OF WASTE

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Abstrakt

Additive manufacturing technologies in the foundry industry enable more efficient and optimised production processes. In particular, the use of additive manufacturing for sand moulds facilitates the creation of complex geometries that were previously unattainable using conventional methods. A key advantage of this technology is the ability to produce sand moulds directly from CAD models, eliminating the need for costly core boxes or patterns [1]. The production of no-bake casting moulds with furan resin has been well established in the industry for many years and has also proven highly effective in additive manufacturing using the Binder Jetting method. This technology fabricates sand moulds and cores layer by layer, with the binder selectively applied according to the CAD model of the printed objects. The unbound ceramic matrix can be reused, a process referred to as reclamation in studies on Binder Jetting. However, in conventional casting, reclamation involves refining the sand matrix by removing binder and catalyst residues to restore sand quality comparable to fresh material. This facilitates the implementation of sustainable production practices, promotes a circular economy, and reduces waste, thereby positively impacting the environment. Currently, limited research has been conducted on the reclamation or recycling of sand matrices in Binder Jetting technology. Therefore, leveraging their expertise in conventional foundry processes, the authors have undertaken research into the use of reclaimed sand in Binder Jetting. The study compares the technological properties of incrementally manufactured moulding sands derived from fresh sand, unbound loose sand from the printing process, and sand subjected to mechanical, thermal, and thermo-mechanical reclamation.

OPTIMISATION OF THE CHEMICAL COMPOSITION OF CAST IRON FOR HIGH WEAR RESISTANCE

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Abstrakt

Cast iron is a structural material whose properties can be controlled as required: from ductile, through high strength grades, to high hardness and wear resistance grades. Iron alloys with increased hardness are the largest group of materials used for wear resistant structural components. The most commonly used are cast steels: mainly martensitic, austenitic manganese and chromium steels and, to a lesser extent, white martensitic and chromium cast irons. Wear-resistant plastics also include a group of composites reinforced with hard ceramic phases such as nitrides, carbides, borides or oxides. This paper describes the influence of chromium, titanium and vanadium alloying additions on the properties of white cast iron. The chemical composition of the cast iron was designed to give the highest possible abrasive wear resistance at low production cost. Four grades of white cast iron were cast, thermally analysed and then heat treated. Initial and post-heat treated samples were examined for microstructural analysis (optical microscopy), chemical composition of crystallised phases (scanning electron microscopy), hardness and abrasive wear resistance. The study showed that small additions of titanium, chromium and vanadium resulted in a significant increase in hardness and wear resistance. The alloying additions also cause stabilisation of both eutectic and primary carbides.

DESIGN OF METHODOLOGY FOR STATIC AND DYNAMIC TESTS OF HYBRID CASTINGS AND THEIR COMPONENTS

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Abstrakt

This paper investigates hybrid aluminum castings produced by the overcasting method. The principle of this innovative technique is to overcast a porous cellular core, created by foaming a molten aluminum alloy. The high porosity and low density of the porous core ensure the castings are lightweight and better suited for dynamic loading. The final structure of the porous material is significantly influenced by the parameters of the foaming process. In the experimental part of this study, porous cores were foamed using various pressures. The objective was to evaluate the influence of this parameter on the mechanical properties of both the porous cores themselves and the resulting hybrid castings. Uniaxial static compression tests were performed on cylindrical cores and hybrid castings, while impact tests were conducted on prismatic cores. The results of the porous core compression tests show high variability in the maximum compression force when an uncontrolled foaming pressure is used. The highest and most consistent maximum force (Fmax) was achieved using starting pressures in the range of 0.1–0.2 MPa and stabilizing pressures of 0.05 MPa and 0.101 MPa. The compression test results of the hybrid castings were found to be dependent on the surface treatment of the porous core. X-ray tomography revealed that using a 10% H_3PO_4 acid treatment resulted in the least penetration into the core. This led to a compression strength three times higher than that of the highly penetrated hybrid castings. Furthermore, impact testing of the prismatic porous cores showed an average ductility 3.4 times higher than that of solid specimens of the same dimensions.

VPLYV NIÓBU NA MECHANICKÉ A FYZIKÁLNE VLASTNOSTI HLINÍKOVEJ ZLIATINY ALSI5CU2MG

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Abstrakt

Článok sa zameriava na skúmanie vplyvu nióbu (Nb) na vybrané vlastnosti hliníkovej zliatiny AlSi5Cu2Mg. Hlavným cieľom práce je posúdiť, ako prídavok Nb vplýva na mechanické a fyzikálne vlastnosti skúmanej hliníkovej zliatiny AlSi5Cu2Mg. V rámci výskumu bude vykonaná komplexná mikroštruktúrna analýza hliníkovej zliatiny AlSi5Cu2Mg legovanej Nb. Dôraz bude kladený na stanovenie potenciálneho očkujúceho účinku Nb. V rámci výskumu bude vykonané hodnotenie vplyvu vybraného režimu tepelného spracovania na skúmané vlastností a mikroštruktúru hliníkovej zliatiny AlSi5Cu2Mg s prídavkom Nb. Hlavným cieľom práce je vývoj hliníkovej zliatiny, ktorá by našla uplatnenie v oblasti veľkorozmerných odliatkov.

EFFECT OF HEAT TREATMENT ON THE FLOW BEHAVIOR OF ALSI9CU1 ALLOY

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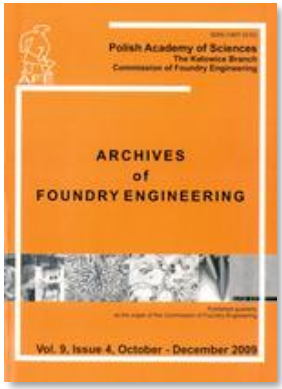
Abstrakt

This study investigates the mechanical behavior of the AlSi9Cu1 alloy after T6 heat treatment, with a focus on its strain hardening response. Uniaxial tensile tests were conducted on heat-treated specimens to determine the strain hardening exponent (n) and the strength coefficient (K) based on the Hollomon equation. These parameters were subsequently used to assess the alloy's potential for strain strengthening during mechanical surface treatments such as roller burnishing, shot peening, and grit blasting. The results indicate that the specimens aged at 160 °C for 4 hours exhibited the highest values of n and K, implying the greatest capacity for strain hardening under plastic deformation. Conversely, the lowest hardening potential was observed in specimens subjected to overaging at 240 °C for 10 hours, where both n and K were significantly reduced. These findings underscore the strong dependence of strain hardening behavior on the thermal exposure parameters applied during aging.

Mediálny partner:



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