WYDZIAŁ ODLEWNICTWA AGH
Faculty of Foundry Engineering

III INTERNATIONAL CONFERENCE OF CASTING AND MATERIALS ENGINEERING ICCME 2021

4–5 November 2021, Krakow, Poland

CONFERENCE PROCEEDINGS

www.iccme.foundry-conference.com

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WYDZIAŁ ODLEWNICTWA AGH
Faculty of Foundry Engineering

III INTERNATIONAL CONFERENCE OF CASTING AND MATERIALS ENGINEERING ICCME 2021

4 – 5 November 2021, Krakow, Poland

4th NOVEMBER 2021
Faculty of Foundry Engineering AGH, Krakow

STUDENT / PHD STUDENT SESSION

09:30 – 10:00 › REGISTRATION
10:00 – 10:15 › OFFICIAL OPENING
10:15 – 11:45 › STUDENT SESSION A
11:45 - 12:00 › COFFEE BREAK
12:00 – 14:00 › STUDENT SESSION B
14:00 - 14:45 › LUNCH
14:45 - 16:00 › PHD STUDENT SESSION
16:30 - 19:00 › STUDENT & PHD STUDENT SOCIAL MEETING

5th NOVEMBER 2021
Hotel Novotel Krakow City West

09:00 – 10:00 › REGISTRATION
10:30 – 11:00 › OFFICIAL OPENING
11:00 – 12:20 › PLENARY SESSION
12:30 – 13:30 › LUNCH
13:30 – 15:30 › SCIENTIFIC SESSION A & SCIENTIFIC SESSION B
15:30 – 16:00 › COFFEE BREAK
16:00 – 18:00 › SCIENTIFIC SESSION C
19:00 – 24:00 › BANQUET

CONFERENCE PROGRAMME

WYDZIAŁ ODLEWNICTWA AGH
Faculty of Foundry Engineering

III INTERNATIONAL CONFERENCE OF CASTING AND MATERIALS ENGINEERING ICCME 2021

4 – 5 November 2021, Krakow, Poland

4th November 2021

Faculty of Foundry Engineering AGH, Krakow

STUDENT / PHD STUDENT SESSION

09:30 – 10:00 › REGISTRATION

10:00 – 10:15 › OFFICIAL OPENING

10:15 – 11:45 › STUDENT SESSION A

› Chairmen: Paweł Żak & Julia Mioduszewska

10:15 - 10:30

G. Boroń: Optimization of the shape of the working plate of a two-piece metal mold based on virtual experiments

10:30 - 10:45

J. Marosz: Analisys of fragmentation phenomenon of composite layers reinforced by TiC obtained insitu in castings made from selected iron alloys

10:45 - 11:00

D. Halejcio: Influence of the hardening parameters on the deformation of the core in the cold box technology

11:00 - 11:15

A. Trela: Comparison of the quality of vibration and vacuum formed refractories

11:15 - 11:30

P. Grudziński: Simulation of the brake disc manufacturing process using the MAGMA 5 software

11:3 0- 11:45

A. Riasnyi: Development of industrial casting technology of iron alloys

11:45 – 12:00 › COFFEE BREAK

12:00 – 14:00 › STUDENT SESSION B

› Chairmen: Jarosław Jakubski & Zuzanna Jonkisz

12:00 - 12:30
Presentation of the Mayacast-Nokes Precision Engineering Ltd

12:30 - 12:45
P. Lara: The use of additive printing with polymers materials in metal casting process

12:45 - 13:00
A. Dul: Plasma-sprayed coatings by example of Ni-Cr-Re coating

13:00 - 13:15
M. Fic: Metallographic analysis of welds in multi-layer joints made by explosive welding method

13:15 - 13:30
A. Sepiał: WiatroŁap - a design of a wind turbine that uses the air stream of passing cars

13:30 - 13:45
S. Owarzany: AGH 3D BLDC – choosing optimal parameters for additive manufacturing of the Brushless DC Electric Motor (BLDC) in FDM technology

13:45 - 14:00
A. Nejranowski: Recovery of precious metals by recycling used auto catalytic converters

14:00 – 14:45 › LUNCH

14:45 - 16:00 › PHD STUDENT SESSION

› Chairmen: Eugeniusz Ziółkowski & Karolina Bracka

14:45 - 15:00
Presentation of the Oras Olesno Sp. z o.o.

15:00 - 15:15
S. Stąpór, M. Górny, B. Gracz: Influence of chemical composition on selected properties of high-quality alloys from the Al-Cu system

15:15- 15:30
A. R. Sheikh: Thermomechanical steel surface hardening with the help of innovative machinings

15:30– 16:00
Announcement of the laureates of Student Sessions

16:30 - 19:00 › STUDENT & PHD STUDENT SOCIAL MEETING

5th November 2021

Hotel Novotel Krakow City West

09:00 – 10:00 › REGISTRATION

10:30 – 11:00 › OFFICIAL OPENING

11:00 – 12:20 › PLENARY SESSION

› Chairmen: Jan Jezierski & Marcin Górny

11:00 - 11:20
Paolo Ferro › Padova University, Italy
Lightweight design in a critical raw materials perspective

11:20 – 11:40
Steve Wallings › Maycast-Nokes Precision Engineering, UK
High-quality precision castings for aerospace, defence, marineand premium automotive markets

11:40 – 12:00
Jerzy Sobczak › AGH UST Krakow, Poland
Cast metal matrix composites – creative materials for automotiveand aerospace engineering

12:00 – 12:20
Jerzy Rozmund › Consolidated Precision Products Poland
Equiax Investment Castings in Aerospace Turbofan Engine basedon CPP Poland Activity

12:30 – 13:30 › LUNCH

CONFERENCE PROGRAMME

WYDZIAŁ ODLEWNICTWA AGH
Faculty of Foundry Engineering

III INTERNATIONAL CONFERENCE OF CASTING AND MATERIALS ENGINEERING ICCME 2021

4 – 5 November 2021, Krakow, Poland

13:30 - 15:30 › SCIENTIFIC SESSION A

› Chairmen: Michał Szucki & Paweł Malinowski

13:30 – 13:50
A. Zaczyński, M. Królikowski, W. Kwilosz, M. Sokolnicki, A. Nowak, E. Guzik, A. Burbelko: Effect of metal matrix modification on the structure and properties of ductile ausferritic cast iron (ADI)

13:50 – 14:10
S. Sobula, J. Kozana, P. Pałka, K. Miłkowska: Structure of intermetallic CuZr phase synthesised on the surface of bronze casting

14:10 – 14:30
W. Kwilosz, M. Królikowski, A. Zaczyński, M. Sokolnicki, A. Nowak, E.Guzik: Occurrence of undesirable Chunky graphite in Solution strengthened ductile cast iron by silicon

14:30 – 14:50
E. Guzik, A. Szczęsny, D. Kopyciński, K. Piotrowski, W. Paul: The procedure of inoculation high-quality gray cast iron with precipitates of flake graphite, intended for large-size (heavy) plates manufactured in the Krakodlew S.A. foundry

14:50 – 15:10
M. Królikowski, W. Kwilosz, A. Zaczyński, M. A. Nowak, E. Guzik, A. Burbelko: Method for selecting the metallurgical quality of a liquid alloy intended for castings with different wall thicknesses, using the evaluation of the curve of crystallization and cooling of the alloy in the thermal analysis method

15:10– 15:30
P. Malinowski: Optimization of the company's key performance indicators KPI using artificial intelligence

13:30 - 15:30 › SCIENTIFIC SESSION B

› Chairmen: Jerzy Sobczak & Magdalena Kawalec

13:30 – 13:50

J. Jezierski, R. Dojka, K. Janerka, A. Studnicki, D. Bartocha, M. Jureczko, K. Piasecki: Optimization of pattern properties for Full Mold technology for manufacturing innovative new grade ductile iron castings

13:50 – 14:10

P. Tadej, C. Tuliszka: The use of sand core shooting simulation to improve the gravity casting process of cylinder heads

14:10 – 14:30

P. Tadej, C. Tuliszka: Digitization of the die-casting process

14:30 – 14:50

D. Sundaram, J. Tamás Svidró, A. Diószegi, J. Svidró: A novel approach to quantify the effect of density of sand cores on their gas permeability

14:50– 15:10

Ł. Petrus, A. Bulanowski, J. Kołakowski, J. Sobieraj, T. Paruch, M. Urbanowicz, M. Brzeżański, D. Burdzy, J. Zych, K. Janerka: The significance of the Derivative Thermal Analysis (DTA) in automated metallurgical processes

15:30 - 16:00 › COFFEE BREAK

16:00 - 18:00 › SCIENTIFIC SESSION C

› Chairmen: Dinesz Sundaram & Paweł Żak

16:00 – 16:20
H. Ando, D. Minamide, Y. Takagi, K. Yano, N. Nakamura, M. Sano, T. Aoki & Y. Nemoto: Optimization of Ladle Tilting Speed for Preventing Temperature Drop in Die Casting Process

16:20 – 16:40
P. Delimanová, M. Bartošová, V. Šabík: Influence of the amount of binder in the cores on the veinings elimination

16:40 – 17:00
K. Bracka, A. Szczęsny, D. Kopyciński: Influence of titanium on the quality of zinc coating formed on steel and cast iron surface

17:00 – 17:20
R. Dojka, M. Dojka, M. Lenert, M. Jureczko, W. Karski, K. Piasecki: Concept of a new design for separately cast ductile iron samples

17:20 – 17:40
M. Wróbel, A. Burbelko: Diffusion model of binary systems controlled by chemical potential gradient

17:40 – 18:00
A. Fijołek, P. Żak, A. Garbacz-Klempka, P. Silska, M. Stróżyk: The use of engineering software to recreate the manufacturing process of an antique cast

19:00 - 24:00 › BANQUET

organizer

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Faculty of Foundry Engineering

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Przegląd
Odlewnictwa

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Krakow – due to its demographic, economic, social and scientific-cultural strength – ranks second in Poland among cities. It has unique values that are the basis of its economic development and an increase in the quality of life. It has high-quality human capital at its disposal. It is a city people consciously choose as a place to live, work, study, spend free time in a variety of ways. Sustainable development and the ability to meet specific challenges with the skillful use of own resources are the main priorities.

The academic center, with its 650 year old University , is permanently connected with the city and builds an unrepeated resource of knowledge in a unique way. It is the key to competitiveness and innovation not only of Krakow, but also of the entire region. The intensively developing economy based on knowledge is a completely new process in the economic life of the City, which makes it part of the modern economies of the world.

Fot. Piotr Krochmal

The overriding goal for Krakow is not only to be a modern city but also to be proud of its historical heritage. It aspires to be an open, rich, friendly and safe metropolis, vibrant with culture. Smart management and strengthening the sphere of modern services and the research and development sector are the foundations for the development of Krakow - a city where innovation and effective cooperatio n between science and business are the focus.

We invite you to visit our website and learn about the possibilities offered by magical Krakow - rooted in tradition, sensitive to everyday life and open to development: **https://business.krakow.pl/.**

Fot. Piotr Krochmal

Dear Conference Participants,

This year's III International Conference of Casting and Materials Engineering ICCME 2021 will be thematically related to Casting of Lightweight Components in Automotive, Aviation and Space Technologies.

The subject of this conference is related to the latest direction of activity of the AGH University of Science and Technology and the Faculty of Foundry Engineering – the main organizer of the conference. From 2020, AGH is part of UNIVERSEH European Space University for Earth and Humanity, and the Faculty of Foundry AGH UST develops modern student education courses related to automotive and computer-aided engineering processes. In the near future, it will also start courses in two new fields ie. related to industry 4.0 and technologies and materials for aviation.

In the plenary session there will be four invited lectures. Outstanding professors will give us the results of the latest research in the field of materials selection strategies with particular references to CRMs related issues and advances in cast MMC. Prof. Paolo Ferro, from Padova University, Italy, will give a lecture on „Lightweight design in a critical raw materials perspective" and prof. Jerzy Sobczak from the Faculty of Foundry Engineering at AGH will present „Cast metal matrix composites - creative materials for automotive and aerospace engineering".

I am glad that this year we are hosting our friends from the industry.

President Steve Wallings from Maycast-Nokes Precision Engineering, UK, will deliver a speech on „High-quality precision castings for aerospace, defense, marine and premium automotive markets". Director Jerzy Rozmund from Consolidated Precision Products Poland will present a lecture entitled „Equiax Investment Castings in Aerospace Turbofan Engine based on CPP Poland Activity".

Metal Casting is still one of the leading production methods used in Automotive, Aviation and also in Space Technologies. Scientific work on structure formation and properties of castings contributes to the development of high -quality grades that are continually finding acceptance for the production of modern cast components. ICCME Conference is an opportunity for discussion and exchange of ideas of scientists with numerous representatives of industry.

This year's ICCME Conference also includes students sessions. They are concentrated on various thematic areas such as foundry processes modeling, structure formation in high-strength alloys, additive printing with polymers materials in the metal casting process, Plasma-sprayed coatings by the example of Ni-Cr-Re coating, etc.

I wish all speakers and participants fruitful discussions and unforgettable impressions.

Prof. Marcin Górny
– Dean of Faculty of Foundry Engineering
AGH University of Science and Technology

STUDENT SESSION A

4th November 2021

Abstract title:

Optymalizacja kształtu płyty roboczej dwuczęściowej formy metalowej na podstawie eksperymentów wirtualnych

Authors:
inż. G. Boroń

Tutor:
prof. dr hab. inż. A. Burbelko

Affiliation:
SKN Zgarek, Faculty of Foundry Engineering, AGH University of Science and Technology, al. A. Mickiewicza 30, 30-059 Kraków

Key words:
trwała forma metalowa, AlSi9Mg, ProCAST, porowatość, pole temperatury

Abstract:

Zastosowanie symulacji komputerowej procesów wykonywania odlewów umożliwia optymalizowanie procesów technologicznych, poprawienie jakości odlewów i polepszenie ekonomiczności produkcji na podstawie eksperymentów wirtualnych bez konieczności wykonywania kosztownego wyposażenia technologicznego. W szczególności dotyczy to wykonywania odlewów w formach metalowych.

Celem niniejszej pracy było określenie, w jaki sposób zmiany warunków chłodzenia dolnej płyty roboczej stanowiska z dwuczęściową formą metalową za pomocą żeber chłodzących zlokalizowanych na powierzchni dolnej tej płyty mogą wpłynąć na jakość odlewu kokilowego. W tym celu za pomocą oprogramowania ProCAST 2020, z wykorzystaniem środowiska graficznego Visual-Environment 15.0, ESI-Group® przeanalizowano 4 warianty konstrukcji płyty nośnej stosowanej w technologii produkcji odlewu doświadczalnego. Odlew będzie wykonywany ze stopu AlSi9Mg o składzie chemicznym określonym w normie EN 1706:2020 „Aluminium i stopy aluminium – Odlewy – Skład chemiczny i własności mechaniczne".

W analizowanej technologii ciekły metal jest wprowadzany do formy grawitacyjnie przez układ wlewowy wykonany w rdzeniu z masy furanowej. Oprócz tego stosowano metalowe rdzenie osadzone na pierścieniu osadczym. Wszystkie elementy ustawione są na płycie roboczej.

W pierwszym wariancie symulacji zastosowano płytę o grubości 30 mm. W drugim zwiększono grubość płyty. W wariancie III dodano pojedyncze żebro, biegnące przez środek płyty, a w wariancie IV zastosowano większą ilość żeber. Pokazano, jak zmiana geometrii płyty pod formą metalową wpływa na pole temperatury formy podczas jej pracy cyklicznej oraz na jakość odlewu.

Abstract title:

Analiza zjawiska fragmentacji warstw kompozytowych wzmacnianych TiC, otrzymywanych in situ w odlewach na bazie wybranych stopów Fe–C

Authors:
inż. J. Marosz

Tutor:
dr inż. S. Sobula

Affiliation:
AGH Akademia Górniczo-Hutnicza im. St. Staszica w Krakowie, Wydział Odlewnictwa, Innerco.

Key words:
kompozyty in situ, metoda SHSM, obróbka cieplna, tribologia

Abstract:

Niniejsza praca inżynierska przedstawia badania i analizę morfologii warstwy uszlachetniającej, pokrywającej powierzchnię odlewów metalowych wykonanych z żeliwa lub staliwa. Warstwa ta, wykonana jest oryginalną metodą syntezy in situ, w wyniku której na powierzchni odlewu powstaje kompozyt umacniany cząstkami TiC. Kompozyt ten, charakteryzujący się wysoką odpornością na ścieranie oraz wysoką twardością, dzięki dobrej infiltracji metalu osnowy w czasie reakcji SHS, gwarantuje dobre zespolenie krystalitów TiC z podłożem. W wyniku reakcji syntezy pomiędzy składnikami warstwy mieszaniny proszków tytanu, węgla w obecności moderatora o składzie podobnym do składu stopu bazowego, podczas procesu krzepnięcia metalu w formie, powstaje struktura pseudo gradientowa. Synteza warstwy kompozytu na powierzchni odlewu następuje w wyniku reakcji SHS (Self-propagating High-temperature Synthesis) i jest uzależniona od wartości entalpii syntezy węglika tytanu. Entalpia tworzenia TiC wynosi . Proces odlewania i krzepnięcia odlewu nie jest stabilny i nie gwarantuje, że do układu termodynamicznego, zostanie dostarczona energia odpowiednia do takiej syntezy węglika tytanu, by wydzielenia fazy wzmacniającej miały podobne wielkości, a to gwarantuje dobre właściwości tribologiczne. Przeprowadzone badania wykazały, że po wypełnieniu form ciekłym metalem, o temperaturze 1550°C dla staliwa oraz 1360°C dla żeliwa, została dostarczona odpowiednia ilości energii niezbędnej do zajścia reakcji syntezy SHS. Kompozyt TiC w którym wydzielenia cząstek węglika tytanu o twardości w skali Mohsa 8–9 jednostek, stanowić będzie warstwę uszlachetniającą powierzchnię odlewu zapewniającą zmianę fizycznych właściwości użytkowych klasycznego odlewu poprzez zwiększenie odporności na ścieranie, odporności na korozje chemiczną i elektrochemiczną. W pracy szczególna uwaga została zwrócona na morfologię i wielkość wydzieleń fazy wzmacniającej wytworzonej na staliwie i żeliwie. Przedstawione zostały mikrostruktury warstwy kompozytowej, wielkości cząstek węglika tytanu, ich udziały powierzchniowe oraz mikrostruktury warstwy pośredniej kompozyt – odlew i stopu bazowego. Przedstawiono również zmiany morfologii węglików tytanu, w wyniku obróbki cieplnej.

Abstract title:

Wpływ parametrów utwardzenia na odkształcenia rdzeni wykonanych w technologii cold box

Authors:
inż. D. Halejcio

Tutor:
dr hab. inż. J. Jakubski, prof. AGH

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Key words:
cold box, odskształcalność, rdzenie, masy rdzeniowe

Abstract:

Sypkie masy samoutwardzalne, nazywane także technologią cold box zdominowały proces produkcji rdzeni odlewniczych. Umieszczone we wnęce formy, często poddawane są różnym naprężeniom najczęściej zginającym, co prowadzi do ich odkształceń. W niniejszej pracy próbowano dobrać odpowiednie proporcje w przypadku spoiwa organicznego, oraz czas utwardzania dla obu typów spoiw. Podczas przeprowadzonych badań użyto dwóch typów spoiw: organicznego, którego użyto w różnych proporcjach dwuskładnikowego spoiwa, składającego się z żywicy fenolowo-formaldehydowej i poliizocyjanu przedmuchiwanych aminą oraz nieorganicznego, którym jest szkło wodne utwardzone dwutlenkiem węgla. Przeprowadzono badania, dzięki którym wyznaczono zależność siły od wydłużenia badanej próbki utwardzenia oraz wytrzymałość na zginanie w zależności od czasu utwardzenia. Uzyskane wyniki pozwoliły na określenie zakresu czasu utwardzania, w którym badana próbka uzyskuje odpowiednią wytrzymałość na odkształcenia.

Abstract title:

Comparison of the quality of vibration and vacuum formed refractories

Authors:
inż. A Trela, second-cycle degree, 2nd semester.

Tutor:
dr hab. inż. M. Brzeziński, prof. AGH

Affiliation:
SKN Zgarek, AGH University of Science and Technology, Faculty of Foundry Engineering

Key words:
quality, refractories, vacuum, aluminosilicate, reduced pressure

Abstract:

The aim of the work is to compare the quality of the refractory materials formed by vibration and formed by vibration under reduced pressure, and to determine whether the vacuum forming process will significantly improve the quality. During the research, a high-alumina aluminosilicate material was used, manufactured in a recfactory plant and formed in two forms: one by vibration under atmospheric pressure and the other by vibration under reduced pressure. After forming, the blocks were marked sequentially as STD and VAC and then dried. Next they were subjected to: visual evaluation, observation on an optical microscope and scanning electron microscope (SEM), tests of apparent density, open porosity and apparent specific gravity A.S.G, compressive strength, thermal shocks resistance, testing of permanent dimensional changes due to heating to a specific temperature , determination of changes in length during heating and testing of resistance to slag corrosion. After carrying out the tests and analyzing the conclusions, it was shown that the change applied during the forming process, that is vibrating uder reduced pressure, had a positive effect on the quality of the finished product.

Abstract title:

Symulacja procesu wytwarzania tarczy hamulcowej z wykorzystaniem programu MAGMA 5

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Key words:
symulacja, tarcza hamulcowa, Magma 5, symulacja odlewania

Abstract:

Tematem pracy jest symulacja procesu wytwarzania tarczy hamulcowej przy użyciu oprogramowania MAGMA 5. W celu wykonania symulacji, zaprojektowano tarczę hamulcową wraz z układem wlewowym w programie SolidWorks, a następnie wykonano szereg symulacji odlewania w różnych wariantach technologicznych w programie MAGMA 5. Elementy układu wlewowego, potrzebne do symulacji, zostały obliczone przy użyciu wzorów z literatury, po czym dobrano je z norm. W badaniach wykonano kilka symulacji dla różnych wariantów układu wlewowego, oraz z naddatkami, w celu usunięcia występujących porowatości, a następnie wybrano najlepszą technologię oraz uzasadniono wybór. Podczas analizy wykorzystano różne wyniki, które pozwala wygenerować program MAGMA na podstawie przebiegu symulacji. Wykorzystanie tych wyników pozwala zrozumieć powody powstawania wad oraz reagowanie na nie. Badania wykonane w pracy umożliwiły poznać możliwości programu symulacyjnego MAGMA 5 oraz z jego wykorzystaniem opracowanie optymalnej technologii odlewania poprzez interpretację uzyskanych wyników. Zastosowanie programu symulacyjnego pozwoliło na poznanie problemów, towarzyszących procesowi odlewania, oraz rozwiązanie ich przed rzeczywistym odlaniem.

Abstract title:

Opracowanie technologii wykonania odlewu przemysłowego ze stopów żelaza

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Key words:
odlewnictwo, technologia formy, żeliwo sferoidalne, symulacja procesu zalewania, opracowanie technologii wykonania odlewu

Abstract:

Żeliwo sferoidalne jest co raz częściej stosowanym materiałem konstrukcyjnym. Jest to spowodowane tym, że żeliwo sferoidalne posiada właściwości lepsze od żeliwa szarego, są także porównywalne do właściwości staliwa. Dodatkowo żeliwo sferoidalne jest tańsze niż staliwo.

Celem pracy było opracowani technologii wykonania odlewu przemysłowego z żeliwa sferoidalnego i weryfikacja opracowanej technologii. Do wykonania wybrano odlew „Koło II rzędu". Rysunek konstrukcyjny odlewu otrzymano od firmy Rotor-Energo Serwis. Firma również dostarczyła warunki technicznego odbioru odlewu. Na podstawie rysunku konstrukcyjnego, opracowano model 3D odlewu i wyznaczono masę odlewu która wyniosła 425kg. W kolejnym kroku naniesiono naddatki na obróbkę, pochylenia odlewnicze i zaokrąglenia a także dobrano powierzchnię podziału formy. W trakcie opracowywania technologii wykonania odlewu przygotowano trzy warianty technologii: zalewanie z boku, zalewanie syfonowe i zalewanie przez nadlew – technologia Kalpur. Aby określić maksymalny moduł odlewu, przeprowadzono symulację procesu krzepnięcia w programie NovaFlow&Solid. Zaprojektowano, a następnie wyliczono wielkość układu wlewowego. Dla wszystkich trzech wariantów wyliczono i dobrano nadlewy, filtry a także ochładzalniki. W następnym kroku, w celu weryfikacji poprawności założeń i obliczeń wykonano dla każdego z wariantów symulację procesu zalewania i krzepnięcia odlewu. Wyznaczono rozkład temperatur w trakcie procesu zalewania i krzepnięcia. Dodatkowo wyznaczono prędkość przepływu metalu w trakcie zalewania i rozkład możliwości występowania porowatości w odlewie.

Na podstawie uzyskanych wyników, a także uzysku metalu i kosztów poniesionych na zakup otulin egzotermicznych, filtrów czy kształtek ceramicznych wybrano najbardziej korzystne rozwiązanie technologii wykonania odlewu.

STUDENT SESSION B

4th November 2021

Abstract title:

The use of additive printing with polymers materials in metal casting process

Authors:
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Key words:
additive printing, metal casting, lost PLA

Abstract:

Proces drukowania techniką FDM jest obecnie stosowany przez najpopularniejsze drukarki 3D, co za tym idzie jest to też najprostsza i najtańsza technika, dlatego jej wykorzystanie może być pomocnym narzędziem w tworzeniu skomplikowanych elementów bądź części zamiennych.

W przypadku modeli drukowanych wyżej opisaną techniką jest to najczęściej jednak tylko tworzenie modeli poglądowych i prototypów, gdyż materiały polimerowe wykorzystywane do druku 3D nie posiadają jednak takich właściwości, aby tworzyć z nich gotowe części odporne na duże obciążenia lub wysoką temperaturę. Jednakże przy doborze odpowiednich materiałów i parametrów druku może być możliwe wykorzystanie modelu powstałego w tym procesie do stworzenia formy odlewniczej. Daje to możliwość odlania w prosty sposób elementu z aluminium bądź innych metali poprzez uproszczenie budowy skomplikowanych form odlewniczych używanych obecnie.

W pracy zostały zawarte założenia projektu oraz opis powstawania komputerowego modelu 3D wydrukowanego z polimeru wytworzonego na bazie surowców odnawialnych w celu zbudowania formy odlewniczej przeznaczonej do odlewania aluminium. Zostały też wykonane sprawdzone wymiary druku poprzez pomiary głównych cech elementu po drukowaniu i porównanie ich z założonymi w programie do modelowania.

Gotowy odlew otrzymany w tym procesie pomimo wad potwierdził jego możliwe zastosowanie w budowie form odlewniczych. Uwidocznił on także ograniczenia i wady, które wymagają większego dopracowania użytego materiału oraz całego procesu.

Abstract title:

Plasma-sprayed coatings by example of Ni-Cr-Re coating.

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Key words:
plasma-sprayed coatings, thermal barier coatings, coatings, plasma

Abstract:

W dzisiejszych czasach chęć zmniejszania wpływu wysokich temperatur oraz ich korozyjnego oddziaływania na wyroby jest głównym elementem napędzającym rozwój związany z nowymi materiałami oraz powłokami ochronnymi. Podstawową funkcją powłok ochronnych jest odizolowanie podstawowego materiału od środowiska zewnętrznego oraz uzyskanie lepszych właściwości wytrzymałościowych, dekoracyjnych czy fizycznych niż bez jej użycia. Natryskiwanie cieplne, w którym zawiera się natryskiwanie plazmowe, jest jednym z najprężniej rozwijających się procesów nakładania powłok mających zastosowanie głównie w energetyce i lotnictwie.

W pracy poddany analizie został proces natryskiwania plazmowego oraz powłoki wykonane za pomocą tej metody. Analiza prowadzona była na podstawie powłoki niklowo- chromowej z dodatkiem 30% renu wykonanej techniką natryskiwania plazmowego na podłożu stalowym przed procesem przetapiania oraz po procesie przetapiania laserowego, która wykorzystywana jest jako powłoka wytrzymała na wysoką temperaturę. Materiałem do badań były próbki wykonane przy użyciu trzech różnych mocy lasera – 3000W, 2000W oraz 1500W. W pracy przedstawiono badania mikrostrukturalne, skład chemiczny, rozmieszczenie pierwiastków na przekroju powłoki oraz wpływ parametrów procesu natryskiwania cieplnego oraz przetapiania laserowego na wybrane jej własności. Badania mikrostruktury przeprowadzono przy użyciu mikroskopu świetlnego oraz skaningowego mikroskopu elektronowego, a skład chemiczny określono za pomocą skaningowego mikroskopu elektronowego z detektorem EDS. Badania twardości przeprowadzono wykorzystując metodę Knoopa.

Wyniki zostały przedstawione w postaci zdjęć oraz tabel, a wnioski wynikające z ich analizy pozwoliły przedstawić zagadnienia zawarte w celu pracy w sposób logiczny.

Abstract title:

Metallographic analysis of welds in multi-layer joints made by explosive welding method

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Key words:
explosive welding, microstructure, SEM (Scanning Electron Microscopy), EDS (Energy Dispersive Spectroscopy)

Abstract:

Proces łączenia metali metodą wybuchową należy do wysokoenergetycznych metod spajania, ze względu na użyte w nim materiały wybuchowe. Z tego powodu różni się on pod względem energii od konwencjonalnych procesów, czego wynikiem jest niestandardowe zachowanie się materiałów podczas procesu łączenia. Dlatego też trudno przewidzieć jaka mikrostruktura zostanie wytworzona po procesie spajania. Jej określenie pozwala na uzyskanie informacji o użyteczności powstałych złączy jak i doborze optymalnych parametrów łączenia poszczególnych materiałów.

Procesom łączenia wybuchowego poddano cienkie blachy metalowe o czystości technicznej, z których w procesie zgrzewania uzyskano połączenia trimetalowe: tytan-aluminium-nikiel oraz żelazo-aluminium-tytan. Należy nadmienić, że połączenia metali Ti-Al, Fe-Al oraz Al-Ni są uznawane jako trudno osiągalne w procesie łączenia w tym także zgrzewania wybuchowego.

W pracy dokonano analizy mikrostruktury dwóch kompozytów złożonych z trzech warstw różnych metali otrzymanych metodą wybuchową, ze szczególnym uwzględnieniem zgrzein.

Badania mikrostrukturalne powierzchni zgrzanych wybuchowo materiałów wykonano przy użyciu mikroskopu świetlnego oraz skaningowego mikroskopu elektronowego. Miały one na celu ocenę mikrostruktur powstałych w wyniku zastosowanej technologii zgrzewania oraz wpływu procesu łączenia na morfologię powierzchni materiałów w miejscach zgrzein oraz w materiale rodzimym blach. Liniowa analiza składu chemicznego obszarów łączenia, została przeprowadzona w celu próby określenia charakteru i rodzaju powstałych faz w obrębie wytworzonych zgrzein. W zależności od rodzaju stykających się ze sobą płyt, zmieniał się charakter połączenia metali w tym obszarze, natomiast każdorazowo dochodziło do powstawania nowych faz.

Abstract title:

WiatroŁap – projekt turbiny wiatrowej wykorzystującej strumień powietrza przejeżdżających samochodów

Authors:
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Projekt został zrealizowany przez członków SKN ZGAREK, w ramach Grantu Rektora 2021/IDUB.

Key words:
odnawialne źródła energii, turbina Savoniusa, druk 3D, prototypowanie CAD

Abstract:

Referat związany jest z realizacją przez studentów SKN Zgarek projektu, którego celem było było skonstruowanie działającego prototypu turbiny wiatrowej. Dodatkowym celem projektu było zwrócenie uwagi na alternatywne źródła energii, szukaniu nowych i niekoniecznie korzystnych dla innych rozwiązań miejsc do pozyskiwania energii z wiatru, potencjalne zaistnienie w mediach, spełnienie programu Priorytetowych Obszarów Badawczych obowiązujących w AGH.

Źródła energii takie jak paliwa kopalne, mają szkodliwy wpływ na środowisko. Powszechność pojazdów samochodowych napędzanych tego typu paliwami ma znaczący udział w zanieczyszczaniu środowiska. Projekt zakłada posłużenie się strumieniami powietrza wytwarzanymi przez przejeżdżające pojazdy, by zasilić turbinę wiatrową. Przetworzenie energii strumienia powietrza na energię elektryczną zmniejszy negatywny impakt spalin na środowisko, również dzięki zmniejszeniu zapotrzebowania na energię produkowaną w wyniku spalania np. węgla. Jednym z założeń projektu było również dostosowanie prototypu do aktualnej infrastruktury drogowej.

Do wykonania prototypu wykorzystano turbinę Savoniusa, która mimo tego, że charakteryzuje się niskim współczynnikiem mocy jak i niskim współczynnikiem szybkobieżności, posiada inne zalety, takie jak prosta konstrukcja i możliwość pracy przy wysokich prędkościach wiatru, które niewątpliwie będą obecne w przewidywanych okolicznościach i w środowisku, w jakim znajdzie się skonstruowany prototyp. Łopaty turbiny oraz wał zostały wykonane w technologii druku 3D, po przestudiowaniu znacznej ilości artykułów naukowych i literatury, w celu wybrania najlepszego ich kształtu. Odbiega to od standardowego sposobu wykonywania łopatek, ponieważ zamiast kompozytów GFRP wykorzystano termoplastyczny filament ASA, odporny na promieniowanie UV i znaczną ilość czynników chemicznych.

Abstract title:

Dobór parametrów wydruku części elektrycznego silnika bezszczotkowego

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Key words:
druk 3d, maszyny elektryczne, filament, przenikalność elektryczna, przenikalność magnetyczna, tomografia rentgenowska

Abstract :
Prezentowana praca przedstawia proces badań i porównanie sposobu druku 3D elementów przeznaczonych do pracy jako części bezszczotkowego silnika elektrycznego. W tym celu w pierwszym etapie prac zrobiono przegląd literatury pod kątem właściwości elektrycznych i magnetycznych dostępnych na rynku filamentów do drukarek 3D. Następnym krokiem było przeprowadzenie potrzebnych badań, które pozwoliły na wyznaczenie parametrów potrzebnych przy projektowaniu maszyn elektrycznych w zależności od sposobu i rodzaju druku 3D. Gotowe wydruki w postaci płytek o wymiarach 100x100x2 [mm] o różnych stopniach i kształtach wypełnienia zostały poddane tomografii rentgenowskiej w celu porównania struktury przedstawionej w oprogramowaniu z rzeczywistą, następnie wydrukowane elementy zostały przebadane w otoczeniu wysokiego napięcia w celu wyznaczenia napięcia progowego, przy którym zaczęły pojawiać się wyładowania niezupełne w inkluzjach gazowych powstałych na skutek druku 3D. Ostatnim etapem było porównanie przenikalności elektrycznej i magnetycznej dla różnego stopnia wypełnienia wydruków. Zastosowanie wielu technik pomiarowych pozwoliło na pomniejszenie marginesu błędu przy doborze parametrów wydruku oraz na poszerzenie wiedzy odnoście struktury fizycznej i właściwości elektrycznych wydruków 3D. Dzięki przeprowadzonym badaniom możliwe było ograniczenie masy wydruku do minimum przy zachowaniu najlepszych parametrów elektrycznych.

Abstract title:

Odzysk metali szlachetnych na drodze recyklingu zużytych katalizatorów samochodowych

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Key words:
recycling, metale szlachetne, metody odzysku metali, hydrometalurgia

Abstract:

Zużyte katalizatory samochodowe zawierają metale szlachetne grupy platynowców. Istnieje wiele metod odzysku tych metali, m.in. metoda Rose'a, ekstrakcja cyjankiem, chlorowanie, segregacja, metody topienia, przedmuchiwanie parami metali, metoda kolektora metali. Opierają się one na procesach piro- i hydrometalurgicznych. W wyniku takiej obróbki uzyskuje się roztwór lub kolektor metaliczny z metalami grupy platynowców. Następnie istotnym zadaniem jest oddzielenie poszczególnych metali szlachetnych.

Praca przedstawia przegląd takich metod wraz z krótką charakterystyką.

Do omawianych metod należą: klasyczna metoda strąceniowa, metoda ekstrakcji rozpuszczalnikowej, metoda ekstrakcji z fazy stałej, separacja chromatograficzna.

Obecnie platyna, pallad i ruten są najczęściej stosowane w produkcji katalizatorów samochodowych. Każdy nowy samochód powinien posiadać takie wyposażenie. Katalizator może zawierać do 2g x kg^{-1} metali PGM w nośniku ceramicznym. Jest to znacznie więcej niż zawartość złota i metali szlachetnych grupy platynowców w rudach pierwotnych (średnio < 0,01g x kg-1. Dlatego też recykling zużytych katalizatorów samochodowych staje się coraz bardziej popularny.

Z ekonomicznego punktu widzenia recykling jest bardzo opłacalny ze względu na wysoką wartość wewnętrzną metali, a dodatkowo pozwala chronić środowisko przed wieloma odpadami powstającymi podczas wydobycia rud i ich przetwarzania.

PHD STUDENT SESSION

4th November 2021

Abstract title:

Influence of chemical composition on selected properties of high-quality alloys from the Al-Cu system

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Key words:
Al-Cu alloys, primary grains, SEM

Abstract:

The aim of this work is the assessment of the impact of the variable molybdenum content on selected parameters of high-quality alloys from the Al-Cu system. The tests included the preparation of melts in which the molybdenum content was 0 - 0.5 wt. %, and the base alloy contained 4.45 wt. % Cu, 0.46 wt.% Mn, 0.39 wt.% Mg, 0.19 wt.% Ti. The research concerned the evaluation of the micro and macrostructure of alloys with different molybdenum content. The grain size of the α (Al) primary phase was determined by measuring their mean diameter. It has been shown that molybdenum does not play a significant role in changing of α (Al) primary phase grain size. Using a scanning electron microscope, the presence of manganese and iron-containing phases was observed in the samples. The shape of these phases indicates that molybdenum may contribute to changing the morphology of the unfavorable needle-shaped iron phases into more coagulated phases which is a desired phenomenon. Tensile strength, yield strength and elongation tests were also carried out. The addition of molybdenum improves tensile strength. On the other hand a significant elongation was achieved.

Abstract title:

Thermomechanical steel surface hardening with the help of innovative machining

Authors:
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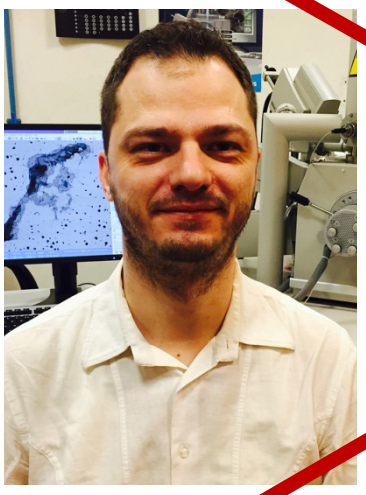
Key words:
knee type vertical milling machine, mild steel, high speed steel, iron carbon phase diagram

Abstract:

Following work is an experimental study of thermo-mechanical surface hardening of steel. This is somewhat an advanced technique used to harden steel surface which can be hardened in many typical ways. The concept is combining the thermal as well as mechanical technique to attain better results. It is quite obvious that mechanical refers to the compressive loading during machining and thermal refers to producing heat on the surface of work piece. The ideal conditions are when the heat produced is enough to achieve austenite and then subsequent quick cooling helps in the formation of martensite, which is metallurgically the highly strong phase of steel, in terms of hardness. The coolant used preferably is the emulsified oil, which flows on the surface during machining with variable rate of flow as the optimum effect is. This process hardens the surface of steel and increases its resistance against wear and abrasion. Preference is to achieve surface hardening using the conventional equipment so that operational cost is kept low, and better results attained. This technique has been pretty successful in the laboratory. It can be termed as friction hardening. Some improvements in the process scheme and working environment can be made to get even better results.

PLENARY SESSION

5th November 2021



PAULO FERRO, PADOVA UNIVERSIRTY, ITALY

Paolo Ferro is born in 1972 and is actually associate Professor of Metallurgy and Materials Selection at the University of Padua (Italy). After the degree in Materials Engineering (Summa Cum Laude) he received the Ph.D. degree from University of Padua in Metallurgical Engineering. He was scientific director of the research program 'Numerical and Experimental Determination of Residual Stresses in Welded Joints and their Influence on Fatigue Strength. He won the prize for young researchers 'Aldo Daccò' 2002. He is a member of CMBM (Centre for Mechanics of Biological Materials), ExCo's member of Italian Group of Fracture, member of ESIS TC15 (Structural Integrity of Additive Manufactured Components), principal chairman of ESIS TC18 (Structural Integrity of Welded Joints), scientific coordinator of the Italian research program about mechanical characterization of heavy section ductile irons and finally coordinator of the European project on Critical Raw Materials called DERMAP (Design of components in a critical raw materials perspective). He published about 200 works. His research is mainly focused on the analytical and numerical modelling of welding, heat treatment and additive manufacturing processes with particular attention to residual stresses assessment and their influence on the structural integrity of metallic components.

STEVE WALLINGS, MANAGING DIRECTOR OF MAYCAST-NOKES PRECISION ENGINEERING LTD

Steve started an apprenticeship in Foundry Practice with a local Iron Foundry from school in 1980 and joined Maycast-Nokes (at the time Nokes Foundry) after finishing this in 1983, starting a long and successful career with the company.

After his apprenticeship, Steve started his career as a skilled moulder in the sand foundry, before moving across into the pressure die/gravity die foundry, getting involved in all aspects of foundry practices such as core-making, using furnaces and understanding metals, as well as moulding. This multi-skilled start to his career has become one of the ways that Maycast-Nokes functions today, with all employees encouraged to develop and challenge themselves in a number of disciplines.

In the early part of his career, Steve worked with experienced members of the company, building on the knowledge he'd gained during his apprenticeship, always looking to take on more to further improve his skills.

His work ethic, skill and commitment to the company led to him working alongside department supervisors early in his career, and Steve's first position of responsibility was as sand foundry Foreman, leading a team of his peers to achieve a balance between fulfilling production demands and maintaining quality standards. Principles that he took into the pressure die/gravity die shop as supervisor, constantly improving the quality of product that Nokes Foundry were producing.

Steve became Works Manager in the early 1990's and oversaw the acquisition of Maycast Precision Products, forming Maycast-Nokes. The company continued to go from strength-to-strength under Steve's guidance, this was recognised in 2000 with his appointment as Works Director and again in 2004 with his appointment as Managing Director.

Steve enjoys building skills of others through apprenticeships and still plays a huge role in the company bringing through apprentices to secure the future, not only of the company, but of the sector too.

In December 2019, Steve and the other 2 Directors completed a management buy-out, becoming a shareholder of the company and ensuring that the company stays independently owned and moving the company into the new markets and sectors, while maintaining his focus on building and retaining core skills in the foundry sector.

PROF. JERZY J. SOBCZAK, DHC, AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KRAKÓW, POLAND

Professor Jerzy Józef SOBCZAK earned a doctor degree in high temperature metallurgy from Technical University in Sankt Petersburg, habilitation from Technical University in Poznan and title of full professor from the President of the Republic of Poland. Doctor honoris causa of the Technical University of Varna (Bulgaria). Distinguished Worker of Motor Transport Institute (Warsaw) and Foundry Research Institute (Cracow). Visiting professor at foreign universities, including University of Wisconsin-Milwaukee, Osaka University and Tohoku University (Japan), visiting scientists and scholar at plenty of European and US research and development institutions as well as industrial companies. Member of numerous technical associations and scientific societies in Poland and abroad (including AFS, TMS, ICCE). Founder of the Polish Society of Composite Materials and its Vice-Chairman. Vice-President of the Polish Foundrymen's Association (Honorary Member), Chairman of the Committee of Metallurgy of Polish Academy of Sciences (until 2019), Vice-Chairman of the Committee of Materials Engineering and Metallurgy PAS (from 2020). The main field of his studies and R&D activity: special casting techniques of manufacturing theory and practice of alloys and composites (liquid metal engineering), and synthesis of high-performance advanced materials. Winner of numerous national and international awards (Maestro in Science-2012, Honorable Research Fellow-2014, Tribi Polonia Per Scientiam–2016) and honorable mentions in the field of science and technique, author of 62 books, brochures and more than 500 scientific, research and technical papers, especially in the field of materials engineering and foundry science. Holder of 34 national and foreign patents, including US ones.

Former Executive Director of the Foundry Research Institute in Cracow (2007-2017); currently expert of the Institute of Metal Science, Equipment and Technologies of Bulgarian Academy of Sciences, full professor at AGH University of Science and Technology, Faculty of Foundry Engineering.

JERZY ROZMUND, EQUIAX FOUDRY DIRECTOR AT CONSOLIDATED PRECISION PRODUCTS POLAND (CPP POLAND)

Jerzy Rozmund runs W50 Equiax Foundry for last 12 years of his 23-year career, first as a manager and last 6 years as a director of the foundry. Prior to that Jerzy has worked in customer support, was leading continuous improvement, leading new product introduction and managing two machining shops: welded and machined fabrications as well as gear machining at WSK "PZL-Rzeszow"/Pratt&Whitney. Jerzy has an MBA from Kozminski University in Warsaw and a master's degree in economy and management from Cracow University of Economics.

SCIENTIFIC SESSION A

5th November 2021

Abstract title:

Effect of metal matrix modification on the structure and properties of ductile ausferritic cast iron (ADI)

Authors:
A. Zaczyński[1], M. Królikowski[1], W. Kwilosz[1], M. Sokolnicki[1], A. Nowak[1], E. Guzik[2], A. Burbelko[2]

Affiliation:
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[2]AGH Akademia Górnicza-Hutnicza w Krakowie, Wydział Odlewnictwa AGH

Key words:
Ductile ausferritic cast iron, known in the literature as ADI, graphitization modification, metal matrix modification, hybrid modification

Abstract:
Austempered Ductile Iron (ADI) casting technology is a combination of the smelting process, its post-furnace treatment and the heat treatment of castings. Maintaining the process parameter stability of this innovative high quality cast iron with high Tensile Strength UTS and ductility properties is the aim of a number of studies on the control of graphitisation inoculation and modification the metal matrix. The ability to graphitise the liquid alloy decreases with its holding in the furnace, time of pouring into moulds from pouring machines. The tendency to dendritic crystallization and the segregation of elements such as Si, Ni and Cu decrease the ductile properties. The austenitizing process can introduce austenite grain growth negatively affecting of the ausferrite morphology. The modifying effect of small amounts of additives on the metal matrix in steel and low alloy cast steel, well known in materials engineering, has been applied to ADI. The addition of cast iron chips and Fe-V to the liquid alloy in the first inoculation is an example of a hybrid interaction. The introduction of graphitisation nucleus particles and austenite crystallisation nucleus particles resulted in a stabilisation of the ductility of ADI and an increase in mechanical properties. Grain refinement of the primary austenite grain and precipitation hardening of ausferrite stabilise the mechanical properties of cast iron ADI. As a result of graphitisation and additive structure modification, graphite and ausferrite morphology is improved. The obtained results point the way to further research in the field of hybrid modification of ductile cast iron.

Abstract title:

Structure of intermetallic CuZr phase synthesised on the surface of bronze casting

Authors:
S. Sobula, J. Kozana, P. Pałka, K. Miłkowska

Affiliation:
AGH University of Science and Technology

Key words:
CuZr intermetallics , surface, casting, synthesis

Abstract:

The surface treatment of alloys provides a set of unique properties such as excellent hardness, wear resistance, corrosion resistance and more. In the field of casting techniques there is a commonly used method, based on exothermic reactions or self-propagating high temperature synthesis, which improves surface hardness of castings. In this work, surface strengthening with intermetallic phase Cu-Zr in castings made from the Cu-Si-Zn-Mn alloy is presented. It was found that synthesis of intermetallic Cu-Zr phase, directly in the mould, via exothermic reaction is possible. The microstructure, phase composition and properties of the obtained layer was examined through scanning electron microscopy (SEM), X-ray diffraction (XRD) and Vickers hardness testing. XRD results reveal that the intermetallic layer consists of a minimum of three phases: Cu, Cu_5Zr and $Cu_{51}Zr_{14}$. A microstructural examination has shown that the interface was not contaminated with oxides and was composed of mixture of base alloy and Cu-Zr phases. The thickness of the synthesized layer was about 5 mm and the outer zone was porous. The results indicates that the hardness of the intermetallic layer was 2-3 times greater than the hardness of the base alloy.

Abstract title:

Occurrence of undesirable Chunky graphite in Solution strengthened ductile cast iron by silicon

Authors:
W. Kwilosz[1], M. Królikowski[1], A. Zaczyński[1], M. Sokolnicki[1], A. Nowak[1], E. Guzik[2]

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Key words:
Solution strengthened ductile irons by silicon, Chunky graphite, elemental segregation in cast iron, hybrid modification

Abstract:

Solution strengthened ferritic cast iron is characterised in EN 1563:2018 (and also in ISO 1083:2018) as grades EN-GJS-450-18, EN-GJS-500-14 and EN-GJS-600-10. Machine and plant builders have been using this material in new designs since 2011. The strength and ductile properties, competitive in comparison with the previous classical ductile cast iron grades, make it possible to reduce the weight of castings. Particularly preferred is grade EN-GJS-600-10 with UTS min. 600 MPa and A min. 10%. Strengthening of the ferritic matrix is possible due to the content of approximately 4.2% of silicon in the cast iron. In casting practice, this material is difficult to produce in a stable manner due to the frequent occurrence of degenerate Chunky graphite in the casting structure, resulting in a loss of ductile properties of the cast iron. In this article, an analysis has been made, based on literature, of the occurrence of strong negative segregation of silicon in classical ductile cast iron. Own research has confirmed the occurrence of chunky graphite in the cast. Dendritic crystallisation of austenite and strong segregation of silicon favours the formation of Chunky graphite. A much stronger proportion of silicon was found in the Chunky graphite zone, compared to the adjacent ball graphite zone. The introduction of micro-additives into the liquid melt eliminated the presence of Chunky graphite in the casting. The applied modifiers of graphite and metal matrix (hybrid modification) seem to be an effective method to stabilise the technological process of this innovative casting material.

Abstract title:

The procedure of inoculation high-quality gray cast iron with precipitates of flake graphite, intended for large-size (heavy) plates manufactured in the Krakodlew S.A. Foundry

Authors:
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Key words:
heavy casting, large-size casting, plates, inoculation, cast iron

Abstract:

In the research, the chemical composition of cast iron was selected, which ensures the lowest possible tendency to the appearance of shrinkage defects in the large-size vertical plate. The casting temperature was set at 1257°C. For the final removal of shrinkage defects in the massive castings , detailed studies of the modification procedure were carried out, including the analysis of the method of measuring the quality of the physicochemical state of the liquid alloy. The inoculation temperature was set at a reduced level, i.e. 1400°C. An optimal modification procedure was then developed which allows to keep the amount of undesirable D-type graphite precipitation in the microstructure as low as possible. The conducted research and analysis of the results allowed for the development of an innovative method of inoculation of high-quality cast iron with flake graphite in the scope of; modification of the graphite eutectic and modification of the austenite dendrites of preutectic grains. These studies have shown that the proposed treatment method, two-stage modification of the molten alloy, is more effective in reducing the undesirable D-type interdendritic graphite. A significant decrease in the volume fraction of this type of graphite was observed, to the level of 5% in the microstructure, in favor of evenly distributed graphite type A in the metal matrix. The work was carried out as part of the project of the Regional Operational Program of the Lesser Poland Voivodeship (Regionalny Program Operacyjny Województwa Małopolskiego), with the number: RPMP.01.02.01-12-0055/18.

Abstract title:

Method for selecting the metallurgical quality of a liquid alloy intended for castings with different wall thicknesses, using the evaluation of the curve of crystallization and cooling of the alloy in the thermal analysis method

Authors:
M. Królikowski[1], W. Kwilosz[1], A. Zaczyński[1], M. Sokolnicki[1], A. Nowak[1], E. Guzik[2], A. Burbielko[2]

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Key words:
ductile cast iron, ATAS thermal analysis, eutectic crystallization, crystallization assessment method

Abstract:
Thermal analysis systems are used to assess the metallurgical quality of the liquid alloy for ductile iron castings. Commonly used samplers in these systems are characterised by a constant volume with a modulus of 0.65 cm. Ductile iron materials engineering recommends that in castings, the iron should crystallise with the separation of eutectic. This crystallisation is ensured by selecting a liquid alloy with the appropriate carbon equivalent, indicated in ATAS as ACEL (Active Carbon Equivalent). ACEL is selected for each casting in subsequent implementation melts. In this article presents the developed method for selecting the eutectic crystallization for the implemented casting, indicating the kind of cast iron crystallization in the ATAS sampler, parameterized by the ACEL value. A technological sample consisting of castings with the following moduli: 0.95, 0.85, 0.65, 0.55 i 0.25 cm was used in the methodology. The results of tests carried out for 3 test melt were presented, representing thin-wall castings, of medium wall thickness and castings representing thick walls, produced in the OPSA. Eutectic crystallization was obtained in a wall thickness with a modulus corresponding to the active carbon equivalent of the melted cast iron. Cast iron crystallisation deviating from eutectic in the ATAS thermal analysis sampler indicated the parameterised value of ACEL, as a process parameter for a casting with the indicated thermal modulus. The developed method enables the design of metallurgical technology for a casting with a specified module (wall thickness), as well as process control in production, using the thermal analysis method.

Abstract title:

Optimization of the company's key performance indicators KPI using artificial intelligence

Authors:
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Key words:
Key Performance Indicators, artificial intelligence

Abstract:

Key Performance Indicators are very important parameters in production. There are several groups of KPI's which we can measure, control and optimize. The most important factor is OEE – Overall Equipment Effectiveness, which tells about the use of the entire machine park. To determine OEE factor we need to multiply three parameters: Availability, Performance, Quality. These parameters we can measure and optimize in different ways. To improve availability we can use predictive maintanance, which is a proactive maintanance strategy to avoid unnecessary stops. To do so we need to implement time series forecasting using historical data embedded in time. To optimize performance we can reduce the cycle time of the machine while maintaining high quality. To optimize quality we need to improve the ratio of good castings to all castings. Improving performance and quality is possible with the use of traditional machine learning algorithms. Based on historical data including production parameters and information whether the casting is defective or not, using machine learning algorithms, we can reduce the cycle time and improve quality. Predictive maintenance is a very important issue, especially in pressure foundries, where there are many pressure machines, CNC machine tools, robots, etc.

SCIENTIFIC SESSION B

5th November 2021

Abstract title:

Optimization of pattern properties for Full Mold technology for manufacturing innovative new grade ductile iron castings

Authors:
J. Jezierski[1], R. Dojka[2], K. Janerka[1], A. Studnicki[1], D. Bartocha[1], M. Jureczko[1,2], K. Piasecki[1,2]

Affiliation:
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Key words:
Full Mold, ductile iron casting, pattern, Lost Foam, cast iron

Abstract:
The study covered pattern materials for Full Mold technology for heavy DI castings manufacturing. They were: 2 types of EPS, XPS, 2 types of EPP, 3 types of EPE, and a mixture of EPS and PMMA. Tensile, compression, and bending strength were tested. Gluing trials were performed for 3 selected types of glue, their impact on the environment was analyzed. The volatile matter content in the materials was determined. In terms of strength EPE materials turned out to be inferior, it was impossible to obtain the required stiffness and dimensional stability of the pattern. In terms of machinability for materials from the EPP group and XPS, it was impossible to obtain the proper surface quality. Trial castings were made to assess their quality. Construction grade EPS contributed to a significant number of surface defects. Foundry grade EPS and the mixture of PMMA and EPS facilitated the production of castings of acceptable quality. These materials additionally present low dust emissions. Due to the high price of the material that was a mixture of PMMA and EPS, it was decided to continue further research based on foundry grade EPS.

Acknowledgment:
The research results described in this article were created in connection with the implementation of a research and development project entitled “Development of an innovative manufacturing technology for large-size castings made of nodular iron with special properties in Full Mold technology, dedicated to the production of stamping tools in the automotive sector” for which ODLEWNIA RAFAMET Sp. z o. o. signed a co-financing agreement number: POIR.01.01.01-00-0013 / 20-00 under the Intelligent Development Operational Program 2014-2020, Sub-action 1.1.1.

Abstract title:

The use of sand core shooting simulation to improve the gravity casting process of cylinder heads

Authors:
P. Tadej, C. Tuliszka

Affiliation:
Volkswagen Poznan Foundry

Key words:
Volkswagen Foundry Poznan, Volkswagen Group Components, sand cores, cylinder heads, simulation

Abstract:

The quality of gravity cast cylinder heads not only depends on the correct setting of the casting process. It is also dependent on the quality of the sand cores used in the casting process. One of the most difficult problems to solve when shooting sand cores, especially in the anorganic technology used in the Volkswagen Poznan Foundry, is the elimination of chips both outside and inside the sand cores. Without elimination of sand core chips, it is practically impossible to cast the cylinder heads with the appropriate quality. This problem can be mainly solved by the correct structure of sand core mould, in which shooting nozzles, purgers, gassing nozzles, etc. must be properly arranged. But how to check if the construction of the core shooting mould is correct before it is actually manufactured? The answer to this question can be found in the sand core shooting simulation, in which you can thoroughly analyze the entire sand core manufacturing process, where we will also see some problematic places like where the chips may occur etc. Based on the analysis of the core shooting simulation, we are able to implement such changes in the structure mould, which can help us to eliminate future quality problems while manufacturing of the cylinder heads.

Abstract title:

Digitization of the die-casting process

Authors:
P. Tadej, C. Tuliszka

Affiliation:
Volkswagen Poznan Foundry

Key words:
Volkswagen Foundry Poznan, Volkswagen Group Components, digitalization, die-casting

Abstract:

Does ubiquitous digitization in the manufacturing industry help to improve the die-casting process? In the Volkswagen Poznan Foundry, we prove that it is possible. At present, in the Volkswagen Poznan Foundry, we are introducing a lot of new projects related to high pressure die-casting. These are housings for the most modern electric motors installed in the electric cars of the Volkswagen concern, such as Volkswagen ID.3 and ID.4. To be able to meet this challenge, in the Volkswagen Poznan Foundry we had to approach the process of the die-casting of these projects in the same modern way. Therefore, we decided to digitize the high pressure die-casting production process in order to be able to read, analyze and correct the most important parameters of the casting process, which affect both the quality and the quantity of components produced by the Volkswagen Poznan Foundry. Thanks to the digitization we were able to link the particular quality problems of the components with the specific parameters of the die-casting process. This allowed us to quickly determine not only the causes of the casting shortages, but also introduce appropriate optimization of casting parameters.

Abstract title:

A novel approach to quantify the effect of density of sand cores on their gas permeability

Authors:
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Key words:
compaction, density, furan sand, gas permeability, porous media

Abstract:

The density of moulding mixtures used in the foundry industry plays a significant role, since it influences the strength, porosity, and permeability of moulds and cores. The latter is routinely tested in the foundries using different solutions to control the properties of the moulding materials that are being used to make moulds and cores. In this paper, the gas permeability of sand samples was measured using a custom-made setup to obtain the gas permeability in standard units instead of the usual permeability numbers (PN) with calibrated units. The setup works based on the Darcy's law and the numbers obtained from the measurements can be used to deduce the permeability, K of a sample. Two furan bonded mixtures with the same grain size distribution were hand-rammed with varying compaction forces to obtain a variation in density. Cylindrical samples (50×50 mm) were prepared using a silica sand aggregate sourced from a Swedish lake. The results of the measurement provided the difference in permeability between the samples that have varying densities. The results of permeability were then extrapolated by modifying the viscosity value of the air passed through the sample. In order to find the effect of apparent density variation on the pore characteristics of the samples, mercury intrusion porosimetry (MIP) was also performed. The results were in line with the permeability measurements.

Abstract title:

The significance of the Derivative Thermal Analysis (DTA) in automated metallurgical processes

Authors:

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Key words:

ductile cast iron, grey cast iron, derivative thermal analysis, automation of melting process

Abstract:

The production of high-quality complex shape castings free of defects requires modern equipment to be used directly in the manufacturing process (melting furnaces, spheroidisation and modification stations, forming stations) and the quality assessment systems at each stage of production (chemical analysis, derivative thermal analysis, mechanical properties, metallographic tests). This paper shows the significance of these factors in terms of the results of works related to the implementation of the research project POIR.01.01.01-00-0120/17 co-financed by National Centre for Research and Development (NCBiR) "An innovative, DTA thermal analysis-based, technology for the production of high-quality self-feeding cast iron for the production of a new generation of castings with improved quality parameters". In many foundries, it is no longer in doubt that the chemical analysis itself is not sufficient for the assessment of melted cast iron. A very good tool is the Derivative Thermal Analysis (DTA), which allows the physical and chemical properties of cast iron to be assessed once it is still in the melting furnace or in the ladle, before being poured into the mould. This enables a significant improvement in metallurgical quality of alloy by introducing alloying agents, carbonaceous additives or modifiers into the furnace during the conditioning or modification that takes place still in the metalwork furnace, or at a later stage by carrying out the primary or secondary modification in the ladle. The foundry's machinery park (modifier dispensers and spheroidisation towers) is of great importance for these operations. Only full synergy between the modern machinery and the modern technology provides high quality and repeatability of the casting process. This paper mainly focuses on the achieved DTA parameters (using the ITACA system) at each stage of melting and the methods for their improvement by using modern and fully automated dosage systems (ITACA OptiDose, ItacaWire and ItacaStream). These results will be related to those of the metallographic and mechanical tests.

SCIENTIFIC SESSION C

5th November 2021

Abstract title:

Optimization of ladle tilting speed for preventing temperature drop in die casting process

Authors:
H.Ando[1], D.Minamide[1], Y.Takagi[1], K.Yano[1], N.Nakamura[2], M.Sano[2], T.Aoki[2], Y. Nemoto[3]

Affiliation:
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Key words:
temperature drop, die casting, optimization, pouring

Abstract:

In the die casting, molten metal poured into the shot sleeve is pressed into a mold by the plunger at high speed. The temperature drop during the pouring of molten metal from the ladle to the shot sleeve is large, which results in casting defects such as misrun flow line. Although it is important to control the temperature at all stages of the process, the method for improvement has not been clarified so far. In this study, the cause of the temperature drop in the shot sleeve was clarified, and the optimum design method of the ladle tilting speed was proposed to prevent the temperature drop. First, experiments were conducted to measure the decrease in molten metal temperature in the shot sleeve during pouring. These experiments revealed that the temperature of the molten metal drops significantly from the moment the molten metal touches the shot sleeve. Therefore, the time from the first contact between the shot sleeve and the molten metal to the start of pouring was set as the objective function. A genetic algorithm was then used to derive the optimal ladle tilt speed pattern to suppress the temperature drop.As a result of the analysis, it was confirmed that the molten metal was poured without flowing out or running ahead, and that the immediate liquid level vibration after pouring was suppressed to ensure stable pouring.

Abstract title:

Influence of the amount of binder in the cores on the veinings elimination

Authors:
ing. P. Delimanová; ing. M. Bartošová, PhD.; ing. V. Šabík

Tutor:
doc. ing. I. Vasková, PhD.

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Key words:
core, cold-box, veinings, binder

Abstract:

In the preparation and production of molds and cores, in order to achieve a reduced occurence of casting defects, a higher quality of input material is often used, which can be provided by different types of sand, modified resins, additives, etc. However, it is still necessary to choose a suitable combination of input materials with a suitable production method together, because even the use of the most expensive input materials does not guarantee high casting production without defects. One of the main components of molding and core mixtures is also a binder. The result of the sand-binder interaction is generally the strenght of the moulding compounds, which is characterized by bonding, strenght, strenght at elevated and high temperatures, and residual strenght. The processes occuring in the initial stage of casting are another interesting and most common problem associated with cold-box method. They can cause thermal deformation of manufactured cores, even the occurence of irreparable defects.There are a number of ways how to eliminate the formation of veinings, for example by using non-silica sands and/or special additives. These procedures can have a negative impact not only on the economic cost of production, but can also affect the technological properties of the core mixture. In this study five core mixtures with different binder levels were studied. All five consisted of foundry purpose silica sand, foundry grade phenolic resin, polymeric isocyanate and amine vapour as catalyst.

Abstract title:

Influence of titanium on the quality of zinc coating formed on steel and cast iron surface

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Key words :
zinc coating, hot dip galvanizing, titanium addition, colour coating, galvanizing

Abstract:

It is possible to obtain zinc coatings with titanium additives for steel and cast iron products not only to protect them from corrosion but also to give them an attractive appearance. The aim of this study was to investigate the influence of titanium addition to the zinc bath on the surface formation of the coating. The study showed that titanium content as low as 0.01% has a very significant effect on the final appearance of the surface. The process was carried out for steel and cast iron. In the case of cast iron products, problems with the occurrence of diffusion reactions on the surface were much more frequent and thus the obtained coating was discontinuous. When increasing the metallization time the problem decreased, but for 1% Ti addition to the zinc bath an increase in process temperature to 600°C was required. The surface of the obtained coatings changes depending on the concentration of Ti in the bath. At higher concentration the coating becomes more and more rough and non-uniform. However, it turns out that such a high concentration is unnecessary to obtain colored zinc coatings. It was possible to obtain coatings in shades of purple and blue with less titanium added to the zinc bath. As the titanium content increased, the formation of a different coloured oxide layer was observed on the mirror surface of the zinc bath, which hindered the correct immersion metallization process. It was also observed that the formation rate of this oxide film increases with increasing temperature.

Abstract title:

Concept of a new design for separately cast ductile iron samples

Authors:
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Key words:
ductile iron, cast samples, bifilms, gating system

Abstract:

Continuous improvement in the quality of castings is a vital issue. This goal can be obtained by various methods including changes in the chemical composition, crystallisation process and heat treatment. Nevertheless, in order to conduct a reliable assessment of the effects of undertaken actions the repeatability of the manufactured samples should be as high as possible. Authors have noticed that during the manufacturing of ductile iron separately cast samples according to PN-EN 1563 the filling conditions cause variation of the results. The typical top pouring through the feeder causes numerous splashes and turbulence which translate into decreased stability of the results. That is why a new concept for manufacturing separately cast samples was designed. The new concept is compliant with the provisions of the PN-EN 1563 standard. At first, the design was validated by filling and crystallisation simulation in MAGMASOFT. Afterwards, experimental patterns were constructed and a series of GJS-400-15 melts was conducted in which samples were cast in two types of moulds, one with traditional design and one with the proposed design. The analysis of mechanical properties allowed the authors to state that the proposed concept allows obtaining reduced result scatter as well as enhanced mechanical properties in reference to the traditional method. Additionally SEM analysis of the fracture surfaces was performed to identify the bifilms - microstructure components responsible for the difference in mechanical properties.

Abstract title:

Diffusion model of binary systems controlled by chemical potential gradient

Authors:
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Key words:
diffusion, modelling, CALPHAD, chemical potential

Abstract:

The paper presents model of diffusion in a single phase with chemical potential gradient as a driving force of the process. Fick's laws are strictly empirical and the assumption that the concentration gradients are the driving forces of diffusion is not precise. Instead, the gradient of chemical potential μi of component i is the real driving force. Governing equations of the model that incorporates this approach will be brought up. One of more important features of this way is ability to acquire results where diffusion against the concentration gradient may occur.

Presented model uses Finite Difference Method (FDM). It employs CALPHAD method to obtain chemical potentials. Calculations are carried out for instant conditions – temperature and composition – in entire task domain by Thermo-Calc via TQ interface. Then the heterogeneity of chemical potentials is being translated into mass transfer for each individual element.

Calculations of two modelling tasks for one-dimension diffusion field were carried out. First: isothermal conditions with linear initial composition distribution and second: constant temperature gradient with uniform chemical composition in the specimen. Results for two binary solid solution: Fe-C and Fe-Si, in FCC phase for given tasks will be presented.

Modelling allows to estimate time needed to reach desired state in particular equilibrium or quasi-equilibrium state. It also shows the path of composition change during the process. This can be used to determine whether the system at some point is getting close to formation of other phase due to significant deviation from initial conditions.

Abstract title:

The use of engineering software to recreate the manufacturing process of an antique cast

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Key words:
Archaeometallurgy, cooper alloys, casting technology, CAD design, CAE software

Abstract:

Research methods in the field of material engineering provide the possibility of non-destructive analysis of artefacts, and with the extensive methodology taking into account the experiment, computer techniques, knowledge and experience of engineers, they also allow for detailed analyzes and reconstruction of old technological processes. They also allow to confirm the history of product use and the resulting degree of destruction.

The aim of the work was to design the pouring technology for the casting of the antique necklace in the CAD software and their subsequent analysis of the prepared projects in the CAE software. The artefact comes from the village of Przybysław in Greater Poland. The design of the 3D model of the necklace was obtained on the basis of previously taken photos. Then, the photos were imported into CAD software, in which a 3D model of the necklace and individual casting technologies were made. Then, the MAGMASOFT software was used to perform a numerical simulation of the casting and solidification process. The performed numerical simulations showed where the casting defects could arise in the proposed casting technologies.

The research is carried out in an interdisciplinary team composed of employees AGH University of Science and Technology and the Archeological Museum in Krakow.

The financial support of the National Science Centre, Poland under the grant numbers 2017/26/E/HS3/00656.

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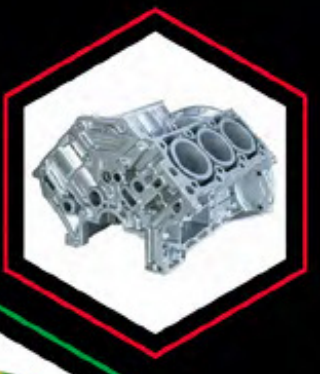

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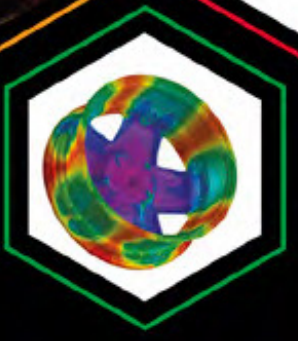

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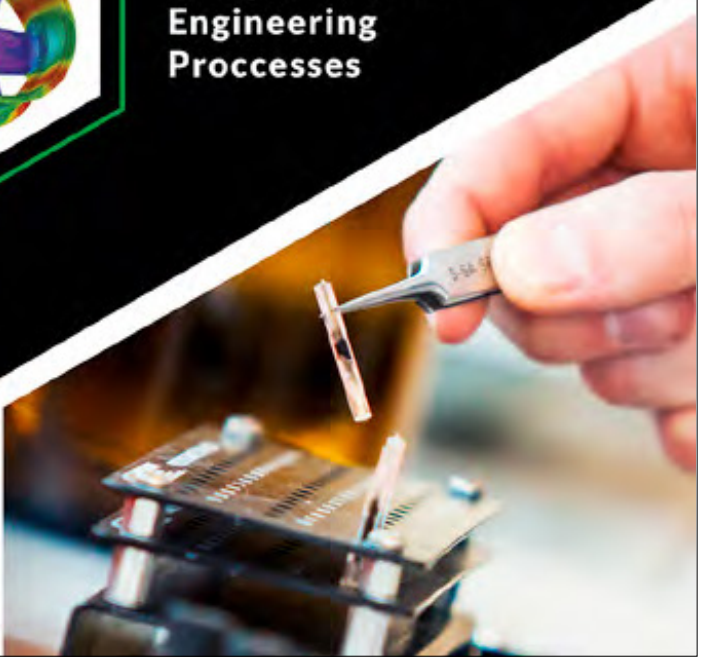

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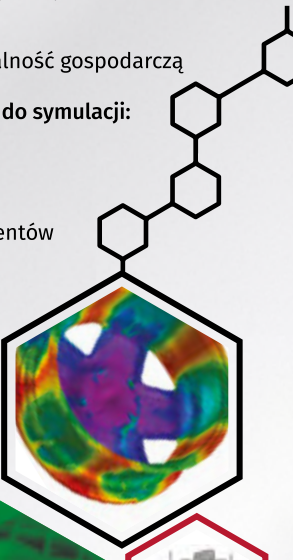

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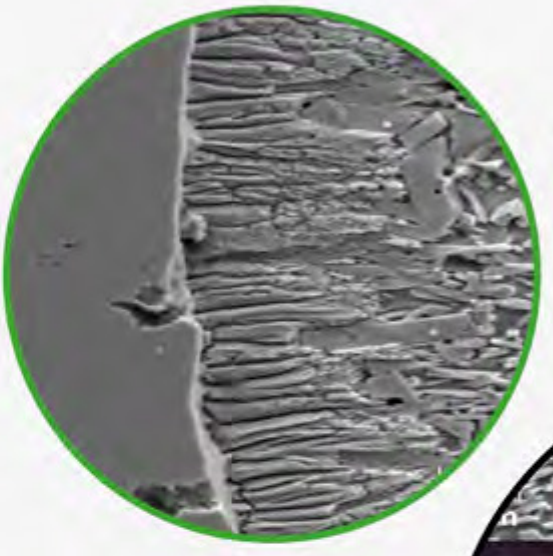

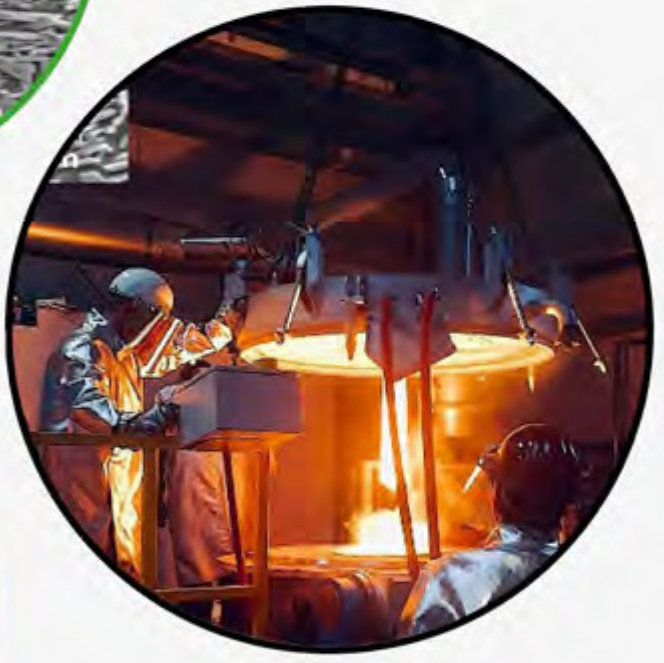

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The Polish Foundrymen's Association is engaged in the organization of workshops, training, conferences, symposia, competitions, technical trips, etc. The main goal of the association is the promotion of the Polish foundry industry.

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