EURO PM2024 CONGRESS & EXHIBITION

Technical Programme Committee
8th of February 2024

ABSTRACTS BOOK

GROUP 7 - APPLICATIONS

EPMA
european powder metallurgy association

EURO PM2024

CONGRESS & EXHIBITION

Technical Programme Committee

8th of February 2024

APPLICATIONS

AEROSPACE

EPMA

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A01
ID : 6202996

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Aerospace

Author : Mr Eonta Christopher (MolyWorks, USA)

Co-author(s) :

Title : Airworthy Landing Gear Components By Additive Manufacturing

Keyword(s) :
Landing gear, Aerospace, Additive Manufacturing, Metal Powders, Powder Production Equipment, Fatigue, Airworthy

Abstract :
MolyWorks is producing landing gear components by additive manufacturing. The development provides a determination of design values for derived mechanical properties of Ti 10-2-3 powder produced by the Greyhound. The process under development conforms to material specifications required for airworthiness certification and is a solution to supply chain challenges including obsolescence (availability) and diminishing manufacturing sources. The landing gear components have been down-selected as non-critical, non-load-bearing parts that fit the criteria of high geometric complexity and irregularly procured. Research and development presented will included material coupons and test results.

Innovative Aspect(s) :
Powder production, powder qualification, additive manufacturing landing gear components, specimen testing, part testing, and airworthiness qualification

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A02
ID : 6280887

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Aerospace

Author : Ms Sahin Gül Çagri (Istanbul University - Cerrahpaşa, Turkey)

Co-author(s) : Prof Dr Mutlu Ilven (Istanbul University - Cerrahpaşa, Turkey)

Title : Production And Characterization Of Novel Superalloys By Powder Metallurgy Method

Keyword(s) :
Novel Nickel-based Superalloys, Powder Metallurgy Method, Non-Destructive Test, Destructive Test

Abstract :
In this study, novel nickel-based superalloys have been produced by using mechanical alloying-powder metallurgy method. The superalloys were produced as an alternative turbine blade material for military aircraft engine applications. Initially, superalloy powders were prepared by mechanical alloying in a ball mill. Then, the superalloy powder mixtures were compacted in a hydraulic press, and then the green specimens were sintered in a vacuum environment. Properties of the superalloys were studied by nondestructive eddy current test and ultrasonic test. Elastic modulus of the sintered superalloys was characterized by destructive compression tests and non-destructive ultrasonic tests comparatively. Effect of the alloying elements on elastic modulus and corrosion behaviours of the superalloys were studied. Microstructure and electrical conductivity properties of the sintered alloys were studied by eddy current tests. Effect of alloying elements on the electrical conductivity properties were determined. Electrochemical corrosion behavior of the superalloys was studied in NaCl solution.

Innovative Aspect(s) :
The superalloy specimens were manufactured by mechanical alloying-powder metallurgy. The traditional casting based superalloy production methods are not suitable to obtain a homogenaeous compositions because of the segregation due to the density differences of the alloying elements. Segregation in the mechanical alloying-powder metallurgy based alloys is small. Superalloy was usually prepared by arc-melting, vacuum-induction-melting and drop-casting. Due to the wide range of alloying elements, it is difficult to obtain superalloy with uniform composition. Mechanical alloying-powder-metallurgy method could reduce the segregation. As Ni-based superalloys have high hardness and low heat conduction, machining of the Inconel 718 is difficult. Superalloy parts with complex geometries, and enhanced mechanical properties are challenging for aircraft applications. In addition modification of the composition of the superalloys is challenging.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A03
ID : 6282608

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Aerospace

Author : Prof Nyborg Lars (Chalmers University of Technology, Sweden)

Co-author(s) : Dr Riabov Dmitri (Höganäs AB, Sweden); Dr Schwerz Claudia (Chalmers University of Technology, Sweden); Prof Gulisano Vincenzo (Chalmers University of Technology, Sweden)

Title : Role And Assessment Of Spatter Formation In Defect Formation During Powder Bed Fusion Laser Beam Processing

Keyword(s) :
Process Monitoring, Powder Bed Fusion Laser Beam

Abstract :
Powder bed fusion laser beam (PBF-LB) is a key manufacturing technology within the field of metal additive manufacturing. Today, reaching nominally full density in processing is a common practice for many alloys provided they do not possess metallurgical constraints. An inherent and common characteristic of PBF-LB is however the generation of process by-products called spatter. Frequently, such spatter comprises hot particles that are ejected from the melt pool, oxidized and redeposited on the powder bed including locations where samples or component are being built. This leads to lack-of-fusion defects despite that the processing is optimised in terms of volumetric eneregy density to reach full density. One way of monitoring spatter is by advanced on-line monitoring. This report tells how we can succesfully apply this approach and how we boost manufacturing speed while monitoring defect formation. Results will cover fundamental spatter particle characteristics and effect of mechanical properties of LBF-PBNi-base alloys.

Innovative Aspect(s) :
The paper addresses state-of-the art technology to monitor spatter and associated defect generation in PBF-LB correlated with materials performance.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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EURO PM2024

CONGRESS & EXHIBITION

Technical Programme Committee

8th of February 2024

APPLICATIONS

AUTOMOTIVE

EPMA

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A04
ID : 6278564

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Automotive

Author : Dr Karlsson Henrik (Volvo AB, Sweden)

Co-author(s) : Dr Alkaisee Rasha (Volvo AB, Sweden); Dr Harlin Peter (Sandvik AB, Sweden); Mr Kristensen Rasmus (Volvo AB, Sweden)

Title : Assessment Of Residual Stresses And Microstructure Of Additively Manufactured Components In Structural Steel

Keyword(s) :
PBF-LB, Heat Treatment, SEM, Microstructure, 42CrMo4, AISI 4140, Residual Stresses

Abstract :
Additive manufacturing has developed and expanded into new segments the recent years. Nonetheless, the automotive industry has so far not implemented AM to any larger extent, one reason being that the availability of materials has been limited. However, recently several low-alloyed carbon-containing steels suited for the automotive segments have been developed for AM. This paper addressed the heat treatment of 42CrMo4 and its effect on microstructure and residual stresses. The tests have been carried on an engine component manufactured by the PBF-LB process and varying subsequently heat treatments.It was found that in a regular quench and temper cycle the parts achieved similar residual stress state as conventionally manufactured 42CrMo4. Samples tempered directly after PBF-LB showed promising results in terms of residual stresses. From the results it is concluded that this investigation can serve as a basis to further optimization of heat treatment cycles to better utilize PBF-LB|42CrMo4 for automotive sector.

Innovative Aspect(s) :
This paper addresses the utilization of AM in the automotive sector. Despite being a large industry segment, so far AM has not been used to that large extent within the automotive industry. The innovative aspect of this paper is mainly: - to understanding post-processing (heat treatment) and its response to the recently introduced material for AM (42CrMo4) to enable an efficient process route for AM-components. - to provide example of a component-group where AM can be an alternative to conventional manufacturing. The research is part of a fruitful collaboration between companies from different ends of the value chain (material supplier and end-users) and the work is a spin-off from a project carried out at a competence centre with universities, institutes, and industry. The project participants have all gained increased knowledge about the needs for the different stakeholders - by this possible implementation of AM into automotive sector may be eased.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A05
ID : 6281537

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Automotive

Author : Dr Ing Lindemann-Geipel Inge (Fraunhofer IFAM, Germany)

Co-author(s) : Dr Ing Reuter Kay (Fraunhofer IFAM, Germany); Mr Simon Tillmann (Fraunhofer IFAM, Germany); Dr Ing Weise Bruno (Fraunhofer IFAM, Germany); Dr Mix Torsten (Fraunhofer IFAM, Germany); Dr Studnitzky Thomas (Fraunhofer IFAM, Germany); Prof Dr Weißgärber Thomas (Fraunhofer IFAM, Germany); Prof Dr Weißgärber Thomas (University of Technology, Germany)

Title : Low Loss Electrical Steel Packages Manufactured By Screen Printing

Keyword(s) :
Multimaterial Screen Printing, Soft Magnets, Co-Sintering, Electrical Steel

Abstract :
Screen printing offers great potential to print electrical steel sheets directly in desired shapes with exceptional low thickness (d < 350 µm) without typical constraints regarding materials ductility. Therefore, current demands in electric motor design can by addressed with the manufacturing of very thin sheets and high alloying contents. Furthermore, materials waste is neglectable using screen printing which is a crucial benefit as electrical steel is already a critical raw material. In this contribution, additive manufacturing of electrical motor components from isolated electrical steel sheets will be shown. Multimaterial printing of metal and ceramic is used to shorten the manufacturing process avoiding elaborate multistep packaging process and negative influence of mechanical processing of each electrical steel sheet. Additionally, the effects of the powder properties on the magnetic characteristics will be elucidated.

Innovative Aspect(s) :
Multimaterial screen printing; Additive manufacturing of soft magnetic electric steel packages; Effect of powder properties on the co-sintering of metal and ceramic; Effect of powder properties on the soft magnetic properties

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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EURO PM2 24
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A06
ID : 6281384

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Automotive

Author : Dr Ing Schoeffmann Wolfgang (AVL List GmbH, Austria)

Co-author(s) : Dipl-Ing Knollmayr Christof (AVL List GmbH, Austria); Dr Ing Mehrabi Kambiz (AVL List GmbH, Austria)

Title : Additive Manufactured Components In Engine And Fuel Cell From Prototyping To Dedicated Production Design

Keyword(s) :

Abstract :
The goal of zero carbon operation of powertrain systems requires compatibility for Ethanol, Methanol and in particular Hydrogen as future energy carriers for internal combustion engines (ICE) as well as Fuel Cell systems. Future AM applications will include complex components in combination with high grade materials, such as high temperature, alcohol and hydrogen resistant steel and nickel alloys, for low and medium volume production.Multi-material AM processes, combining multi-metal manufacturing, are subject of research programs and will support the mobility change by extending the applications to E-Motors, Fuel Cell systems and battery components.Focus of the paper is on the application of metal-AM for prototype and small series of appropriate powertrain components providing material compatibility for CO2 neutral fuels. The motivation for the conversion from conventional to additive manufacturing is discussed in regard of functional optimization with AM-process related production design, as well as economically to achieve higher profitability.

Innovative Aspect(s) :
AM-based optimization of appropriate powertrain components, Engine as well as Fuel Cell system components, based on different materials, combining functional optimization with AM-process related production design architecture: Functional Optimization, Weight Reduction, Component Cost and Process cost reduction.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

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Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024

CONGRESS & EXHIBITION

Technical Programme Committee

8th of February 2024

APPLICATIONS

BIOMEDICAL

EPMA

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A08
ID : 6280888

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Biomedical

Author : Ms Temiz Cihan (ISTANBUL UNIVERSITY-CERRAHPASA, Turkey)

Co-author(s) : Prof Dr Mutlu Ilven (ISTANBUL UNIVERSITY-CERRAHPASA, Turkey)

Title : Production And Nondestructive Characterization Of Novel Beta Type Ti-Mo-Sn Based Alloys

Keyword(s) :
Biomaterials, Beta-Titanium, Metastable-beta Titanium, Powder Metallurgy Method, Non-destructive Tests, Ti-Mo-Sn based Alloys, Destructive Tests

Abstract :
In this study, novel Ti-Mo-Sn-X alloys for biomedical applications was produced and investigated. Precipitation hardenable beta-titanium and metastable-beta titanium alloys, which having lower elastic modulus, were produced by mechanical alloying-powder metallurgy method. Mo, Co, Sn, Ta, Mn, Al, Cu and Nb were added to obtain suitable molybdenum equivalency, which is necessary for metastable beta-Ti phase. Ti alloy powders were prepared by mechanical alloying method in a ball mill and the powders compacted. The green specimens were sintered in a vacuum environment. Properties of the Ti alloys were studied by nondestructive eddy current test and ultrasonic test. Effect of the alloying elements on elastic modulus and corrosion behaviours of the specimens were studied. Microstructure and electrical conductivity properties of the sintered alloys were studied by eddy current tests. Effect of alloying elements on the electrical conductivity was determined. Electrochemical corrosion behavior of the specimens was studied in simulated body fluid solution.

Innovative Aspect(s) :
Although there are studies on metastable-beta-Ti and beta-Ti alloys, there is no study on the low-modulus precipitation hardenable Ti-Mo-Sn alloy in the literature. Mechanical properties of the beta-Ti and metastable-beta-Ti alloys can be increased by aging. Ti alloys exhibit high biocompatibility, high corrosion resistance and low density. But, their wear resistance is low for the implant applications. In this study, titanium alloys were alloyed to enhance the wear resistance. In addition, nondestructive characterization of the microstructure and mechanical properties of the Ti alloys is novel.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A159
ID : 6281669

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Biomedical

Author : Dr Ing Nidadavolu Eshwara (Helmholtz-Zentrum Hereon GmbH, Germany)

Co-author(s) : Dipl-Ing Wolff Martin (Helmholtz-Zentrum Hereon GmbH, Germany); Dr Ebel Thomas (Helmholtz-Zentrum Hereon GmbH, Germany); Prof Dr Willumeit-Römer Regine (Helmholtz-Zentrum Hereon GmbH, Germany)

Title : Effect Of Powder Surface Oxides In Ensuring A Reproducible Homogenous Microstructure In Powder Processed Mg-0.6Ca Alloy

Keyword(s) :
Magnesium-Calcium, Sintering, Grain Growth, Surface Oxides, Reproducibility

Abstract :
Abstract: Liquid phase sintered biodegradable Mg-0.6Ca alloy generally exhibits an isotropic microstructure with homogenously restricted grain size of 30 µm, even after long sintering durations of 60 h at 625 °C. Such sintered microstructures reveal the presence of numerous impurity oxide particles at the grain boundaries, which are evident also on the initial gas atomized powder surfaces. However, after a mechanical powder sieve treatment for 20 min, the surface SiO2 concentration dropped from initially 220 ppm to 85 ppm, resulting in heterogeneous grain coarsening after sintering for 18 h at 625°C. For the use of Mg-Ca materials as biodegradable implants, reproducibility of in vitro degradation results is a prerequisite, for which a homogenous grain structure is desired. However, the lowered oxide-pinning effect at certain grain boundaries created heterogeneous grain coarsening and this indicates the necessity for the careful handling of fine powders to ensure repeatability in degradation and mechanical properties.

Innovative Aspect(s) :
Magnesium and its alloy are regarded as potential candidates for orthopedic implant applications. Their mechanical properties match to that of human cortical bone and they degrade in physiological human body conditions eradicating the need for a second surgery. Addition of calcium to oxygen-sensitive pure magnesium innovates the fabrication of near-net shape magnesium materials by powder metallurgy route. Our previous results have shown that powder processed Mg-0.6Ca alloy exhibits a very low in vitro degradation rate nearing 0.3 mm|year until specimen porosities of 10%. A fine-grained homogenous microstructure is contributing to this reproducible degradation behavior. A similar microstructure is evident in additively manufactured viz 3D printed magnesium materials which innovates further the tailoring of material degradation and mechanical properties to suit patient-specific bone fracture needs.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A101
ID : 6269857

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Biomedical

Author : Prof Dr Afonso Conrado Ramos Moreira (Department of Materials Engineering DEMa), Brazil)

Co-author(s) : Mr Mattos Felype N. (Department of Materials Engineering (DEMa), Brazil); Prof Dr Figueiredo Roberto Braga (Universidade Federal de Minas Gerais (UFMG), Brazil); Prof Dr Caram Rubens (State University of Campinas (Dema|FEM|Unicamp), Brazil); Prof Dr Afonso Conrado Ramos Moreira (Universidade Federal de São Carlos (UFSCar), Brazil)

Title : Selective Laser Melting And High Pressure Torsion Of Beta Ti Micrometric Powders For Implant Applications

Keyword(s) :
Selective Laser Melting, High Pressure Torsion, Elastic Modulus, Beta Ti Alloys, Atomized Powders, Implant Applications

Abstract :
ß Ti alloys are acclaimed for biomedical applications due to their mechanical properties, good biocompatibility and corrosion resistance. For orthopedic applications, there is a considerable difference between elastic modulus of Ti and a+ß alloys, from E = 100 to 110 GPa, and that of human bone (E = 30 GPa). In this context, the selective laser melting (SLM) of ß Ti-15Nb (wt%) appears, since it shows lower Young modulus. Another route is the HPT of ß alloy Ti-42Nb (wt%) atomized powder in order to obtain near net shape nanocrystalline structure. Characterization of SLM of Ti-15Nb and HPT of Ti-42Nb alloys was done by optical microscopy, XRD, SEM and TEM coupled to ASTAR technique. Elastic modulus via impulse excitation were evaluated for SLM of Ti-15Nb alloy with a´+ ß microstructure and for HPT of stable ß Ti-42Nb, showed, respectively, elastic modulus of around 60 and 62 GPa for biomedical applications.

Innovative Aspect(s) :
The LPBF process successfully obtained in-situ alloying of Ti-15Nb from pure powders. Martensitic alda' and beta phases were found by XRD, SEM, and TEM analysis, depicting a homogenous and dense Ti-15Nb alloy manufactured using high energy density, exhibiting fractions of porous and unmelted Nb particles below 0.5 %. Vickers hardness measurements show low dispersion and consistent values with a martensitic a' phase of about 318 HV, corroborating with microstructural characterization. A low Young's modulus of about 64 GPa was found for denser sample and these findings highlight a promisor in-situ laser alloying of Ti-15Nb for biomedical applications. HPT at 6 GPa of stable β Ti-42Nb after 10 turns with nanocrystalline grain size of ~50 nm showed compression stremght of 1400 MPa, Vickers microhardness of 300 HV and elastic modulus of E= 62 GPa suitable for biomedical applications.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A140
ID : 6280993

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Biomedical

Author : Ms Azadi Chegeni Ava (University College Dublin, Ireland)

Co-author(s) : Dr O'Cearbhaill Eoin (University College Dublin, Ireland); Dr Celikin Mert (University College Dublin, Ireland)

Title : Sintering Of Novel Bioresorbable Mg-Sr-Ca Alloys For Biomedical Applications

Keyword(s) :
Low Temperature Additive Manufacturing, Sinterability, Bioresorbable Magnesium Alloys, Powder Metallurgy, Mg Alloy Development

Abstract :
Magnesium (Mg) alloys have been receiving increased attention as an emerging class of biomedical metallic materials due to their outstanding combination of biocompatibility and bioresorbability. The customisation of biomedical Mg-based alloys via additive manufacturing (AM) technologies has remarkably enabled patient-specific designs over a short period of time. However, the low sinterability of Mg-based alloys is a key issue limiting the efficiency of post-processing required for the low temperature AM techniques (i.e., extrusion-based techniques). Hence, the aim of this work is to fundamentally evaluate the sinterability of the thermodynamically designed Mg-Sr-Ca based alloys processed by powder metallurgical routes in terms of porosity level and|or wettability of the target alloys. Differential scanning calorimetry (DSC) was used to select the sintering parameters. Materials characterisation was employed (Scanning Electron Microscopy (SEM|EDS) and X-ray Computed Tomography) to determine the porosity level and the effects of powder size|morphology on sinterability.

Innovative Aspect(s) :
Intrinsic properties of magnesium (Mg), such as high oxygen affinity, low ignition temperature and high vapor pressures, lead to safety concerns as well as lower mechanical performance when high temperature AM techniques (i.e., selective laser melting) are used. The use of low temperature AM techniques are more compatible with the aformentioned Mg inherent challenges. However, poor sinterability of Mg alloys is the main issue related to the low temperature AM techniques. Based on the literature, there are limited Mg-based alloys (mainly commercial series) for biomedical applications.Therefore, Mg alloy development by thermodynamic calculations and the choice of proper alloying additions are the first innovation in this work. Also, liquid phase sintering (LPS) was employed in this project to improve Mg sinterability. A dedicated powder (as the starting material for the sintering)preparation process was used, and the fundamental investigations of liquid-solid interactions during LPS was studied proving the novelty of this work.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A106
ID : 6268362

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Biomedical

Author : Dr Weinmann Markus (Taniobis GmbH, Germany)

Co-author(s) : Dr Stenzel Melanie (Taniobis GmbH, Germany); Mr Johannsen Jan (Fraunhofer IAPT, Germany); Dr Lauhoff Christian (University of Kassel, Institute of Materials Engineering, Germany); Prof Dr Niendorf Thomas (University of Kassel, Institute of Materials Engineering, Germany)

Title : Development, Structural Characterization, And Laser Beam Powder Bed Fusion Of Ti|Nb|Ta Alloy Powders

Keyword(s) :
Electrode Induction-Melting Gas Atomization (EIGA), Titanium|Niobium|Tantalum, Pre-Alloyed Refractory Metal Powder, Laser-Beam Powder Bed Fusion, Biomedical Alloy

Abstract :
The development of spherical Ti|Nb|Ta alloy powders in a wide composition range by electrode induction-melting gas atomization (EIGA) and their processing by laser beam powder bed fusion are reported. Microstructure investigations by X-ray diffraction, scanning electron microscopy including energy dispersive X-ray spectroscopy and electron backscatter diffraction reveal a significant impact of the composition on the structural properties, i.e., phase evolution of the materials, and the possibility for a direct microstructure design. Ti-rich alloys preferably solidify in the orthorhombic a”-phase, whereas in Nb|Ta-rich alloys the body-centered cubic ß-phase is observed. The alloys possess a very broad processing window and can be printed to full density over a wide range of printing parameters. Additively manufactured Ti-27Nb-6Ta shows a unique behavior, since strength and elongation at failure strongly depend on the printing parameters applied. The underlying microstructural mechanisms, i.e., the influence of the laser energy on texture effects and phase formation, are discussed.

Innovative Aspect(s) :
The paper describes Ti|Nb|Ta alloys for use in orthopedic and dental implants. The materials have the highest level of biotolerance, are non-toxic and non-allergenic. Compared to standard materials, they have very high elasticity and high strength. The microstructure can be specifically adjusted by varying the chemical composition. The mechanical properties of one of the alloys presented can be varied in a targeted manner by using different 3D-printing parameters. Even when printing at full density, strengths and elongation at failure can be specifically adjusted over a larger range, which enables the production of implants with graded mechanical properties.

Reviewer’s name : ……..

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : P-A09
ID : 6282461

Requested presentation type : Poster Presentation

Topic : Applications **Subtopic :** Biomedical

Author : Prof Dr Lee Jiwoon (Kongju National University, Korea, Republic of)

Co-author(s) : Prof Dr Hong Soonjik (Kongju National University, Korea, Republic of); Prof Dr Lee Jin-Kyu (Kongju National University, Korea, Republic of); Prof Dr Song Gian (Kongju National University, Korea, Republic of); Prof Dr Moon Jongun (Kongju National University, Korea, Republic of); Prof Dr Choi Hong-Kyoon (Kongju National University, Korea, Republic of)

Title : Additive Manufacturing Of Polycaprolactone (PCL) Scaffolds Produced By Materials Extrusion

Keyword(s) :

Abstract :
Materials extrusion-based additive manufacturing is known as a promising technique to fabricate the scaffolds due to affordability, versatility, and wide acceptance of various materials. The reliability and controllability of the printing process are necessary to produce scaffolds with desired properties for tissue engineering. Analytical models are developed in this study to simulate the geometric characteristics of cylindrical polycaprolactone (PCL) scaffolds produced by the materials extrusion-based additive manufacturing technique using fluid mechanics. The geometric characteristics of the PCL scaffold can be predicted by using extrusion pressure, temperature, nozzle diameter, nozzle length, and printing speed. The effectiveness of models is verified through comparison with the experimental results. Simulation results show that geometric characteristics have a strong relationship with processing parameters, and the developed models are useful in predicting the geometric characteristics of the scaffold structure produced by the materials extrusion-based additive manufacturing technique.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2024

CONGRESS & EXHIBITION

Technical Programme Committee

8th of February 2024

APPLICATIONS

ENERGY

EPMA

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A10
ID : 6277219

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Energy

Author : Mr Lindroos Tomi (VTT Technical Research Centre of Finland Ltd., Finland)

Co-author(s) : Mr Kinos Timo (VTT Technical Research Centre of Finland Ltd., Finland); Mr Antikainen Atte (VTT Technical Research Centre of Finland Ltd., Finland); Mr Riipinen Tuomas (VTT Technical Research Centre of Finland Ltd., Finland); Mrs Manninen Aino (VTT Technical Research Centre of Finland Ltd., Finland); Mr Odden Jan Ove (Elkem Silicon Product Development AS, Norway); Mr Bertinetti Andrea (Gemmate Technologies s.r.l., Italy); Dr Pippuri-Mäkeläinen Jenni (VTT Technical Research Centre of Finland Ltd., Finland)

Title : Lessons Learnt - Development Of Additive Manufacturing For Soft Magnetic Electric Motor Components

Keyword(s) :
Additive Manufacturing, Soft Magnetic, Electrification, Electric Motor, Gas Atomization, Laser Powder Bed Fusion

Abstract :
Clean electrification is pivotal in the European Green Deal for effective decarbonization and climate change mitigation. The shift towards electrification in processes and mobility is driving a surge in demand for components like electric machines. This necessitates innovations to meet future requirements, including higher efficiencies, power densities, lighter weights, and customized solutions. Additive Manufacturing (AM) emerges as a crucial enabler for producing components with unprecedented designs and performance. This study summarizes development of the Laser Powder Bed Fusion (L-PBF) route for soft magnetic electric motor components. It encompasses the customization of Fe-Si soft magnetic material for the L-PBF process, culminating in the demonstration of electric motor stator and rotor components. The paper highlights key findings and challenges, addressing the impact of alloying elements, L-PBF parameters, and post-processing routines on magnetic performance.

Innovative Aspect(s) :
Novel Fe-Si-X tailored for additive manufacturing Methods to suppres eddy currents; Demonstration of real stator and rotor component

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A11
ID : 6278417

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Energy

Author : Dr Ing de Nicolás-Morillas María (IMDEA Materials Institute, Spain)

Co-author(s) : Dr Ing Meza Alberto (IMDEA Materials Institute, Spain); Ing Kumaran Venkatesh Sivagnana (IMDEA Materials Institute, Spain); Ing Cotobal Adrián (IMDEA Materials Institute, Spain); Mr Iriarte Diego (IMDEA Materials Institute, Spain); Dr Ing Milenkovic Srdjan (IMDEA Materials Institute, Spain); Prof Dr Torralba José Manuel (IMDEA Materials Institute, Spain)

Title : High Entropy Alloys Resistant To Hydrogen Embrittlement: Influence Of Composition, Microstructure And Processing Route

Keyword(s) :
High Entropy Alloy, Additive Manufacturing, Spark Plasma Sintering, Laser Powder Bed Fusion, Hydrogen Embrittlement

Abstract :
The battle against climate change requires alternative and renewable energy supplies, where hydrogen has emerged as an excellent candidate. Its most cost-effective storage is in its gaseous form, with the use of metallic pressure vessels. Compared to traditional compositions, such as austenitic steels, novel High Entropy Alloys (HEAs) have demonstrated to attain stable phases resistant to the phenomenon of embrittlement in presence of hydrogen. In this investigation, two HEAs compositions have been studied: CoCrFeNiMo2.1, a monophasic (FCC) alloy, and AlCoCrFeNi2.1, a biphasic-eutectic (BCC+FCC) one. They were processed by two powder metallurgy routes: Spark Plasma Sintering (SPS) and Laser Powder Bed Fusion (LPBF). Moreover, an annealing thermal treatment was applied to LPBF samples, seeking to study the variation of the microstructural scenario and its effect in hydrogen diffusion. Resultant samples were tested in terms of their mechanical properties –bending and tensile strength in a hydrogen atmosphere– as well as hydrogen permeability.

Innovative Aspect(s) :
This investigation brings together two critical challenges. The first pertains to the urgent need for the development of materials resilient to hydrogen embrittlement, an area where conventional alloys –notably those based on Fe– have demonstrated inherent limitations. Concurrently, it encompasses the implementation of new high entropy alloy variants, tailoring both monophasic and biphasic structures. These new compositions are crafted through different powder metallurgy methodologies, such as field-assisted sintering and laser-based 3D printing. The main objective is to assess the influence of the present phases and processing stage on the mechanical properties exhibited by metallic materials exposed to hydrogen. This comprehensive assessment not only aims to address the immediate challenge of hydrogen embrittlement but also seeks to pave the way for the development of materials with enhanced resilience and tailored mechanical characteristics for a wide array of applications in diverse industrial sectors.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A12
ID : 6280837

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Energy

Author : Mr Razavi Seyed Ali (Universitat Politècnica de Catalunya, Spain)

Co-author(s) : Prof Morales Comas Miguel (Universitat Politècnica de Catalunya, Spain); Mrs Serrano Carreno Maria Isabel (Universitat Politècnica de Catalunya, Spain); Prof Llanes Pitarch Luis Miguel (Universitat Politècnica de Catalunya, Spain); Prof Llorca Pique Jordi (Universitat Politècnica de Catalunya, Spain); Prof Fargas Ribas Gemma (Universitat Politècnica de Catalunya, Spain)

Title : Co-3YSZ Functional Layers On Monoliths Produced By Direct Ink Writing For Catalytic Applications

Keyword(s) :
Direct Ink Writing, Ethanol Steam Reforming, Zirconia Stabilized with 3 mol% yttria, Cobalt, Catalytic Applications, Dip Coating

Abstract :
Direct Ink Writing(DIW) is an innovative technique for fabricating complex ceramic catalysts with several advantages compared with traditional catalysts. However, these catalysts still face challenges in achieving exceptional catalytic performance and structural integrity. This study focuses on DIW-fabricated 3mol% yttria-stabilized zirconia(3YSZ) monoliths coated with a cobalt-3YSZ catalytic functional. The fabricated monoliths, after sintering, were coated by dip-coating method, using inks based on cobalt(II) acetate-tetrahydrate and 3YSZ, and re-sintered. The microstructure of coated monoliths was characterized by field-emission-scanning-electron-microscopy equipped with an EDX detector, and focused-ion beam, Raman spectroscopy. Finally, the catalytic performance of monoliths was investigated by conducting the Ethanol Steam Reforming reaction. Results show that the dip-coating process uniformly coated the monoliths. The coated monolith significantly enhanced catalytic performance and reduced the complete ethanol conversion temperature compared with the uncoated. The catalytic activity of the coated monolith was close to the Co-3YSZ DIW-fabricated monolith and additionally enhanced its structural integrity.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A13
ID : 6274627

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Energy

Author : Ing Baret Paul (Université Paris-Saclay, CEA, Service de Recherche en Matériaux et procédés Avancés, France)

Co-author(s) : Dr Ing Boulnat Xavier (Université Lyon, CNRS, INSA-Lyon, MATEIS UMR551, France); Dr Ing De Carlan Yann (Université Paris-Saclay, CEA, Service de Recherche en Matériaux et procédés Avancés, France); Dr Ing Fabrègue Damien (Université Lyon, CNRS, INSA-Lyon, MATEIS UMR551, France); Dr Ing Malaplate Joel (Université Paris-Saclay, CEA, Service de Recherche en Matériaux et procédés Avancés, France)

Title : Elaboration Of ODS Austenitic Steel From High Energy Horizontal Attritor

Keyword(s) :
Austenitic Steel, ODS, Mechanical Alloying, Attritor, Cryomilling

Abstract :
In France, fast neutron nuclear reactors used austenitic steel as cladding material. These alloys exhibit good high temperature mechanical properties and they can withstand very high irradiation doses. To further increase the performance of these alloys, recent studies have indicated that a dense, uniform particles dispersion, along with a high dislocation density, could delay or even prevent irradiation damage in austenitic steel. One proposed method to achieve this is through oxide dispersion strengthened austenitic steel. However, the high ductility of austenitic steel significantly reduces the yield of powder production during mechanical alloying. To overcome this issue, multiple batches were produced and consolidated using high-energy horizontal attritor at times ranging from 5 to 40hours. Powder characteristics were tracked (granulometry, morphology…) as well as the SPS compacts (grain size, precipitation, microhardness…). In perspective, a cryo-milling campaign is about to commence to assess its ability to inhibit the prominent coldwelding of austenitic steels.

Innovative Aspect(s) :
The paper focus on the elaboration of austenitic steel ODS using a very high energy horizontal attritor which isn't commonly used. Moreover, following the evolution of the powder as well as the SPS compacts over time allows us to determine the optimal parameters of mechanical alloying.

Reviewer's name : ……..

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A14
ID : 6281948

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Energy

Author : Miss Tuneskog Erika (Chalmers University of Technology, Sweden)

Co-author(s) : Prof Nyborg Lars (Chalmers University of Technology, Sweden); Dr Nogenmyr Karl-Johan (Siemens Energy AB, Sweden)

Title : Assessment Of Surface Roughness In Additively Manufactured Channels For Fluid Applications

Keyword(s) :
Metal Additive Manufacturing, Fluid Applications, Powder Bed Fusion-Laser Beam, Surface Roughness

Abstract :
Metal additive manufacturing (AM) enables intricate designs, particularly beneficial for complex fluid applications in gas turbines. Despite its advantages, AM introduces higher surface roughness compared to conventional technologies. In the powder bed fusion–laser beam (PBF-LB) process, surface roughness elements can create blockages in small channels, leading to increased friction. Understanding how features like adhering powder particles, spatter, and melt tracks interact with fluid flow is essential for modeling friction in channel flows. This study statistically characterizes surface roughness variation, considering printing parameters and orientation, utilizing optical profilometers and microscopy. Test samples in stainless steel 316L include flat surfaces and channels oriented from 0° to 90° with 20° intervals. Adhering powder particles are primary inducers of channel roughness, exhibiting positive skewness and high slopes. The density of powder particles on flat surfaces is significantly lower. Therefore, other variables including melt tracks, printing direction, and power input, influence surface characteristics more.

Innovative Aspect(s) :
Presently, there exists limited literature concerning Additively Manufactured (AM) surface roughness in small channels for fluid applications. Empirical evidence suggests that surface roughness may elevate pressure loss by up to 40% in some gas-turbine components. To effectively model this roughness, a comprehensive foundation of statistics and data is imperative. Our research is focused on filling this gap in the literature.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A15
ID : 6283660

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Energy

Author : Dr Srinivasan Suresh (University of Warwick, United Kingdom)

Co-author(s) : Mr Gillham Joe (University of Warwick, United Kingdom); Dr Marshall Jessica (University of Warwick, United Kingdom)

Title : High Density Radiation Shielding Of CWC-RSB Composite For Fusion Reactor: A Critical Review

Keyword(s) :
Cemented Tungsten Carbides, Reactive Sintered Borides, Radiation Shielding Materials, Nuclear Energy, Nuclear Fusion

Abstract :
Development of high-density radiation shielding is one of the key aspects in nuclear future reactors to decarbonize global energy production. The current candidate materials based on refractory metals and tungsten-based alloys do not yet meet the engineering requirements of a practical power generating compact spherical tokamak (cST) reactor. Radiation shielding materials must fulfil not only the materials challenges and radiological safety requirements, but also the regulatory requirements in the case of accidents. Cemented tungsten carbide (cWC)-reactive sintered boride (RSB) composites are recently considered as a promising candidate as compact radiation armour for proposed spherical tokamak. This review presents the synthesis and characterization of cWC-RSB composites under various processing conditions for nuclear radiation shielding. The prediction of compositions and synthesis parameters of cWC-RSB composites using the CALPHAD method is also discussed. The radiation attenuation capabilities, radiation damage and mechanical properties of cWC-RSP composites under various scenario, simulations and conditions are discussed.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A16
ID : 6283792

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Energy

Author : Dr Srinivasan Suresh (University of Warwick, United Kingdom)

Co-author(s) : Mr Gillham Joe (University of Warwick, United Kingdom); Dr Marshall Jessica (University of Warwick, United Kingdom)

Title : Development Of High Temperature Brazing Of CWC|RSB To Steel Joints For Fusion Reactor

Keyword(s) :
Cemented Tungsten Carbides, Reactive Sintered Borides, Brazing, Nuclear Energy, Nuclear Fusion

Abstract :
First wall (FW) materials for future fusion reactors have tungsten (W) and ferritic|martensitic steel (FMS) as prime materials. The significant difference in thermo-physical properties of W-FMS joints, specifically, high ductile-brittle transition temperature (DBTT) in W making it brittle at low temperatures and embrittlement due to recrystallization. Cemented tungsten carbide (cWC)-reactive sintered boride (RSB) composites are considered as promising candidate to develop reliable joining technology albeit cWC-RSB to steel joint is challenging. Brazing is a prospective technology; brazing experiments were conducted using Cu-based and FeCr-based interlayers|foils with low-activation elements and high Z-materials. This study compares the effect of brazing compositions, temperature and holding time. The microstructures, mechanical properties, and the strength of brazed joints were investigated using SEM, EDS and EBSD analysis with microhardness and fracture toughness. The results show that cWC-RSB to steel successfully joined by brazing, achieved like W-steel joints and boron in cWC-RSB suppresses the thermo-physical property mismatch.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A150
ID : 6283206

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Energy

Author : Ing Azurmendi Naiara (Tecnalia, Spain)

Co-author(s) : Dr Agote Iñigo (Tecnalia, Spain); Ing Gómez Xabier (Tecnalia, Spain); Dr Lores Asier (Tecnalia R&D, Spain)

Title : Study Of The Feasibility Of Processing P91 Steel Alloy Via Binder Jetting For Energy Sector Applications

Keyword(s) :
Binder Jetting, P91, Microstructure, Fusion Energy

Abstract :
In response to the recent demand for innovation in new sustainable energy sources, nuclear fusion emerges as a highly relevant and significant process. Given the international effort invested in manufacturing functional reactors, Additive Manufacturing (AM) stands out as a technology that can contribute to meeting the challenges and objectives of applications requiring advanced designs. This study explores the manufacturability of P91 alloy using Binder Jetting (BJ) for high-pressure applications, including those within prospective fusion reactor systems. Following the optimization of the AM process, subsequent adjustments in sintering, Hot Isostatic Pressing (HIP), and various required heat treatments have resulted in excellent material quality in terms of microstructure. Therefore, this study validates the successful use of BJ technology for employing P91 alloy.

Innovative Aspect(s) :
This study presents, for the first time in the literature to the best knowledge of the authors, the exploration of the P91 alloy through Binder Jetting, yielding excellent microstructural results. Validating this alloy for this manufacturing technology opens numerous possibilities for future applications across various sectors and industries, particularly in the development of components for the future energy landscape. This contribution aligns with ambitious decarbonization goals and environmental improvement efforts.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A158
ID : 6281370

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Energy

Author : Dr Ing Raveu Gaelle (Framatome, France)

Co-author(s) : Dr Ing Bischoff Jérémy (Framatome, France); Ing Kandeepan Keerthanan (Framatome, France); Ing Collin de l'hortet Adrien (Framatome, France); Ing Namy Patrick (Simtec, France); Ing Bruyère Vincent (Simtec, France)

Title : Modelling Of The Fuel Sintering Process

Keyword(s) :
Sintering, Modelling, Parametric Studies

Abstract :
Framatome manufacturing plants use walking-beam furnaces to sinter large productions of fuel pellets. The sintering process of different products in the same equipment is complex with sublimation and reduction reactions involved, but also densification and grain-growth. Hence, Framatome started to model it with several benefits: - Increase reaction knowledge- Perform parametric studies without using the production equipment- Increase performance by process optimisation- Compare the different equipment within Framatome and use the best developments - Create teaching tools through theoretical description of the process and its key influencing parameters.The modelling is a step-by-step approach: first the geometry, gas flows and temperature were established, then adding more detailed pieces. Validation of the model is then done with experimental data from production campaigns. Afterwards, parametric sensitivity calculations can be performed to evaluate the influence of different parameters such as gas mixture, temperatures and therefore optimize the sintering.

Innovative Aspect(s) :
Use modelling to perform parametric testing, better knowledge of the equipment, improve product quality.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A131
ID : 6281691

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Energy

Author : Dr Ing Marie Antoine (Framatome, France)

Co-author(s) : Dr Ing Bischoff Jeremy (Framatome, France); Ing Nicollet Cedric (Framatome, France); Dr Ing Viry Frederic (Simtec, France); Dr Ing Namy Patrick (Simtec, France)

Title : Modelling Of The UF6 To UO2 Conversion Process

Keyword(s) :
Nuclear Fuel Manufacturing, Ceramic Grade Powder Production, Fuel Pellets, Process Modelling

Abstract :
The ceramic-grade nuclear powder can be produced under two main routes, dry or wet "reconversion" processes, consisting in transforming crystalline UF6 as UO2 powder usable to produce fuel pellets. The dry conversion processes, used in Framatome, are divided in two steps: pyrohydrolysis and reduction by thermal treatments. The process used in Romans manufacturing plant has been studied years ago, but the improvements applied since and the product evolution associated have not been modelled.First, the UF6 to UO2F2 reaction and vessel are being modelled, with as benefits: Better understanding of the process, Set-up parametric tests without using industrial equipment, Development of a numerical twin to be used as a training tool.In a further extent, the purpose is to be able to model the whole reaction vessel and calciner, including the chemical and thermic reactions, in order to correlate the final UO2 properties to the process parameters.

Innovative Aspect(s) :
Chemical reaction modelling; Improvement of process understanding; Set-up of numerical parametric tests

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2024

CONGRESS & EXHIBITION

Technical Programme Committee

8th of February 2024

APPLICATIONS

TOOLING

EPMA

european powder metallurgy association

EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A17
ID : 6278227

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Tooling

Author : Mr Khorasani Farshad (Chalmers University, Sweden)

Co-author(s) : Prof Cao Yu (Chalmers University, Sweden); Dr Selte Aydin (Uddeholm, Sweden)

Title : Hybrid Tool Steel Produced Via Hot Isostatic Pressing

Keyword(s) :
Hybrid Tool Steel, Hot Isostatic Pressing (HIP), Tool Steel

Abstract :
Hybrid materials boast appealing characteristics that align well with various design requirements. By merging the attributes of constituent components, hybrid tool steels possess unique properties including enhanced fatigue life, improved toughness, and superior abrasive wear resistance. However, manufacturing hybrid tool steels that integrate two distinct materials through traditional methods presents significant challenges. This study focuses on the consolidation of one cold work tool steel powder on a hot work tool steel via hot isostatic pressing (HIP). Microstructure, defects and mechanical characteristics in terms of microhardness have been investigated. The microstructural evaluation, conducted using scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS) and X-ray diffraction (XRD), yielded results that correlate well with computational simulations. The findings in this study conclusively demonstrate a robust bond between the two tool steels and successfully manufactured hybrid material through HIPing.

Innovative Aspect(s) :
Our project introduces a pioneering approach to manufacturing hybrid tool steel, which will aid the tool-making industry in several ways. Firstly, by combining the properties of cold work and hot work tool steels, we can open up new opportunities that significantly enhance fatigue life, toughness, and abrasive wear resistance. This innovative product not only meets design requirements but also reduces processing steps and costs, contributing to sustainability within the manufacturing sector. Furthermore, our utilization of Hot Isostatic Pressing (HIP) offers a game-changing advantage. HIP not only consolidates high-alloyed tool steels but also enables the cladding of two distinct materials, resulting in a finer and more homogeneous microstructure. This process ensures the production of fully dense, pore-free materials, setting a new standard for tool steel manufacturing. With these techniques, our research promises to shape the future of tool steel production, meeting industry demands for higher performance and sustainability.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A18
ID : 6281685

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Tooling

Author : Mr Tegeder Frederik (Institute for Materials Applications in Mechanical Engineering (IWM), Germany)

Co-author(s) : Dr Wieland Sandra (Fraunhofer Institute for Manufacturing Technology and Applied Materials Research (IFAM), Germany); Mr Eckel Julius (Fraunhofer Institute for Manufacturing Technology and Applied Materials Research (IFAM), Germany); Mrs Reineke Lea (Fraunhofer Institute for Manufacturing Technology and Applied Materials Research (IFAM), Germany); Prof Dr Broeckmann Christoph (Institute for Materials Applications in Mechanical Engineering (IWM), Germany)

Title : Processing Of Ledeburitic Cold Work Steel A11 Using Metal Binder Jetting

Keyword(s) :
Carbide-rich Tool Steel, Carbide Structure, Additive Manufacturing, Metall Binder Jetting

Abstract :
Additive manufacturing offers numerous possibilities for toolmaking, such as the integration of internal cooling structures. Another important aspect is minimizing the necessary post-processing steps through near-net shape manufacturing, which allows for significant cost savings, particularly with hard-to-machine carbide-rich tool steels. Previous research projects have examined processing using laser-based methods (PBF-LB|M). Due to locally high cooling rates and associated residual stresses, cracks often occur in high-strength tool steels. In this study, the cold work steel AISI A11 X245VCrMo10-5-1 was successfully fabricated using Metal Binder Jetting and sintered under two different conditions. The resulting microstructure was examined to establish a correlation between the sintering conditions and mechanical properties. The mechanical properties are compared with those from the conventional manufacturing route. The study demonstrates that the production of tools from high-strength tool steels using Metal Binder Jetting represents a promising alternative to the conventional manufacturing route.

Innovative Aspect(s) :
The innovative aspects of this study lie in the application of metal binder jetting for the production of high-strength tool steels, in particular the cold work tool steel AISI A11 X245VCrMo10-5-1. By demonstrating that metal binder jetting can be a promising alternative to conventional manufacturing processes for the production of tools made of high-strength tool steels, the study underlines the potential for significant advances in toolmaking. In addition, the focus on near-net-shape manufacturing and the minimization of post-processing steps underlines the potential for cost savings and efficiency gains in toolmaking through additive manufacturing processes.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A19
ID : 6282624

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Tooling

Author : Dr Ing Herzog Simone (RWTH Aachen University, Institute for Materials Applications in Mechanical Engineering (IWM), Germany)

Co-author(s) : Mr Gertlowski Leonhard (Institute of Applied Powder Metallurgy and Ceramics at RWTH Aachen University e.V., Germany); Dr Ing Fries Sofia (Institute of Applied Powder Metallurgy and Ceramics at RWTH Aachen University e.V., Germany); Mr Wilhelm Dennis Patrick (RWTH Aachen University, Laboratory for Machine Tools and Production Engineering (WZL), Germany); Dr Ing Grunwald Tim (Fraunhofer Institute for Production Technology IPT, Germany); Prof Dr Bergs Thomas (RWTH Aachen University, Laboratory for Machine Tools and Production Engineering (WZL), Germany); Prof Dr Broeckmann Christoph (RWTH Aachen University, Institute for Materials Applications in Mechanical Engineering (IWM), Germany)

Title : Ti3SiC2 Composites With Adjustable Coefficient Of Thermal Expansion For Precision Glass Molding

Keyword(s) :
MAX-Phase, FAST, Precision Glass Molding, Thermal Expansion, Composite

Abstract :
Precision molding is an established technology for producing aspherical lenses by forming a glass blank with high-precision tools. Tungsten carbide is currently used as the tool material due to its stiffness, temperature stability, and high heat conductivity. However, the low coefficient of thermal expansion (CTE) limits the range of possible optical glasses, since CTE differences between glass and tool increase the risk of glass breakage or undesired geometry deviations.In this study, TiC reinforced Ti3SiC2 is assessed as a possible new generation tool material allowing the CTE to be adjusted by the degree of TiC filling. These MAX-phase composites are produced by field-assisted sintering in two different routes: (i) using commercial Ti3SiC2 powders and (ii) the in-situ formation of Ti3SiC2. It is systematically investigated how the filling degree of the carbide phase and the sintering parameters influence thermal expansion, microstructure, and machining process.

Innovative Aspect(s) :
MAX phases are materials with a unique combination of metallic and ceramic properties. However, no industrial application of these materials has yet been established. Our investigations in the field of material development and production technology show to what extent MAX phase composites are suitable as forming tools for precision glass molding and which deficits still need to be overcome.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A107
ID : 6281567

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Tooling

Author : Dr Riabov Dmitri (Höganäs AB, Sweden)

Co-author(s) : Dr Frisk Karin (Innomat AB, Sweden); Prof Dr Bengtsson Sven (Höganäs AB and Chalmers University of Technology, Sweden)

Title : Novel Co-free Precipitation Strengthened Tool Steel For Additive Manufacturing - Properties And Microstructure

Keyword(s) :
LB-PBF, Tool Steel, Cobalt, Precipitation, Mechanical, Powder, Microscopy, Xrd, Processing

Abstract :
This work presents the alloy TS-CF1, a new cobalt-free stainless maraging steel designed specifically for laser-based powder bed fusion using a computer-based alloy design approach. The aim was to create a material that easily printable, while performing similarly to the common maraging variant 18Ni-300. After exploring various compositions, we settled on Fe-13.2Cr-9.1Ni-1.1Al-0.6Mo-0.5Nb-0.23Ti-0.5Mn-0.5Si (wt.%). This composition exhibited excellent printability at 40, and 80 µm layer thicknesses with minimal porosity. The precipitation response was assessed by aging at 500 °C, in both as-printed and solutioned conditions. A balanced set of properties was reached after aging between 3 and 6 hours, reaching 50 HRC. Different conditions were microstructurally characterized using EBSD and XRD, showing a mostly martensitic structure with some retained austenite. The tensile strength was between 1560 and 1700 MPa, where higher strength was reached by performing a solutioning heat-treatment. Long-term high temperature exposure tests showed good resilience against precipitate coarsening.

Innovative Aspect(s) :
The innovation is that it is a Co-free stainless, printable, age-hardenable alloy that was developed using the CALPHAD methodology. The alloy reaches relatively high hardness of 50 HRC and retains it after pro-longed exposure to higher temperatures, which is otherwise difficult to accomplish using carbon alloyed steels without cracks or defects. Effects of microstructural constituents on mechanical performance are explored and elucidated.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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EURO PM2024
CONGRESS & EXHIBITION
Malmö, Sweden
29 September - 02 October 2024

Paper Number : A109
ID : 6281702

Requested presentation type : Oral Presentation

Topic : Applications **Subtopic :** Tooling

Author : Dr Guimarães Bruno (Palbit S.A., Portugal)

Co-author(s) : Dr Fernandes Cristina (Palbit S.A., Portugal); Mr Figueiredo Daniel (Palbit S.A., Portugal); Prof Dr Miranda Georgina (CICECO - Aveiro Institute of Materials, Portugal); Prof Dr Silva Filipe (CMEMS - University of Minho, Portugal)

Title : WC-Co Smart Cutting Tools With 3D Printed Embedded Thermocouples For Real Time Cutting Temperature Measurement

Keyword(s) :
WC-Co Smart Cutting Tools, Additive Manufacturing, Multi-Material Laser Powder Bed Fusion, 3D Printed Embedded Thermocouples, Cutting Temperature Measurement

Abstract :
In the scope of Industry 5.0 applied to the cutting tools industry, the advent of smart cutting tools consisting in the integration of sensors in cutting tools to monitor, and thus help control and adjust in real time different aspects of a machining process, arises as a unique opportunity to achieve unprecedent levels of operational efficiency and productivity. Therefore, this work focuses on the incorporation of temperature sensors in WC-Co cutting tools for measuring cutting temperature, through the fabrication of 3D printed K-type embedded thermocouples by multi-material laser powder bed fusion. The thermocouples powder composition was prepared through high-energy ball milling and properly characterized to guarantee the characteristics for laser powder bed fusion. Validation in an industrial environment during turning of different alloys revealed that the developed 3D printed embedded thermocouples can measure precisely and accurately cutting temperature in real time, as well as withstand the demanding turning process.

Innovative Aspect(s) :
To the authors best knowledge, the present study is the first reporting the fabrication of 3D printed embedded thermocouples by additive manufacturing technologies for cutting temperature measurement during machining applications. Moreover, a multi-material laser powder bed fusion approach was employed for the fabrication of the embedded thermocouples, which allied to the high fabrication freedom of this technology, allows the development of smart cutting tools with an extraordinary level of functionality, adaptability and tailorability.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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Paper Number : P-A310
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Topic : Applications **Subtopic :** Tooling

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Co-author(s) : Dr Ing Pereira Pedro (DURIT, Portugal); Dr Ing Sacramento Joaquim DURIT, Portugal); Dr Ing Oliveira Filipe (University of Aveiro, Portugal)

Title : Corrosion And Wear Resistance Of Hardmetals With Alternative Binders For Metal Forming Applications

Keyword(s) :
Hardmetal, Metal Forming Tools, Alternative Binders, Corrosion Resistance, Wear Resistance

Abstract :
The corrosion behaviour of some hardmetal compositions is a main drawback for many applications. In wear parts operating in acidic media, cobalt is (Co) usually partially or totally substituted by nickel (Ni) and chromium (Cr), to increase the corrosion resistance of the binder.In hardmetals for metal forming tools, where high-volume fractions of binder are needed, the use of alternative binders, namely CoNiCr, is practically unexplored. The study of corrosion and wear behaviour of hardmetals with high contents of these compositions is increasingly necessary in these applications. The degradation of mechanical properties induced by corrosion and wear damage can decrease the service time of forming tools being an additional motivation for this research.This work studies the influence of binder composition in the performance of hardmetals with binder contents from 20 to 30 wt.%, in different tribological and corrosive environments, assessing the effects of adding Ni and, simultaneously, Cr.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

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