EURO PM2023 CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

ABSTRACTS BOOK – GROUP 2

MATERIALS

EPMA
european powder metallurgy association

EURO PM2023

CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

MATERIALS

FERROUS MATERIALS

EPMA
european powder metallurgy association

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235746422

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Mr Vikner Peter (Aubert&Duval, France)

Co-author(s) : Mr Egea Philippe, Mr Michel Loic, Mrs Legay Florence (Aubert&Duval, France), Dr Joffre Thomas (IPC, France), Mr Garabedian Stephane (IPC, France), Dr Langer Lukas (Fraunhofer IGCV, Germany)

Title : Influence Of Different Heat Treatments On Mechanical Properties, Corrosion Resistance And Polishability For LPBF Manufactured Stellar® X15TN Stainless Tool Steel

Keyword(s) :
Additive Manufacturing; Parameters Optimization; Martensitic Stainless Steel; Plastic Injection Mold; Tooling; Heat Treatment Development; Mechanical Properties; Corrosion Resistance

Abstract :
Stellar® X15TN (Euro number 1.4123) is a cobalt free 0,4% C martensitic stainless steel which is easy to print by LPBF despite its relatively high carbon content. The steel combines a capability to be heat treated to over 58 HRC with a good corrosion resistance and an excellent polishability. Therefore, Stellar® X15TN is suitable for plastic injection molds with conformal cooling, surgical tools, cutting tools for food processing but also other parts and tools where a combination of high hardness and corrosion resistance is requested. Different heat treatments are presented to achieve a final hardness in the range 36-58 HRC, whilst also providing a lower intermediate hardness needed for machining operations. The effects on the impact toughness, the corrosion resistance and the polishability are also presented.

Innovative Aspect(s) :
Stellar®X15TN is the first easy to print high carbon martensitic stainless steel with a hardness of +58 HRC that is commercially available. The high cleanliness in combination with the good printability ensures an optimal polishability. Being magnetic and relatively soft in its as-built and stress relieved state makes it easy to machine, which is necessary for example for drilling and threading of fixation holes. The fact that it is cobalt free is another important feature. Previous studies have exposed the printing parameters. This work proposes some optimized heat treatments and their impact on the main usage properties

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235749781

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Dr Giroud Tiphaine (Aubert & Duval, France)

Co-author(s) : Mr Egea Philippe, Mr Vikner Peter, Dr Mayer Charlotte (Aubert & Duval, France), Dr Vivès Solange (Aubert & Duval, Spain)

Title : Development Of An Invar Strengthened By Ni3Nb-Gamma" Phase Precipitation Suitable For Additive Manufacturing

Keyword(s) :
Additive Manufacturing; Nickel-Iron Alloy; Stellar® InvHard; Alloy Design; Low CTE

Abstract :
Stellar® InvHard is a Nb-enriched Invar designed for additive manufacturing (LPBF). It will be launched on the market in 2023. Compared to Invar 36, Stellar® InvHard exhibits increased mechanical strength while maintaining a low coefficient of thermal expansion. The hardening of this alloy is inspired by superalloys 706 and 718 strengthened by Ni3Nb-γ" phase that precipitates in the austenitic matrix; also containing carbides and Nb-rich δ phase. The precipitation of the γ" phase can be controlled through annealing and aging treatment's optimization, leading to a hardness in a range: 300-420 HV. Insights on microstructure and processability will also be presented along to coefficient of thermal expansion and tensile strength results.

Innovative Aspect(s) :
Stellar® InvHard is the first high strength alloy with low coefficient of thermal expansion designed for the additive manufacturing process that is commercially available. This work presents the development of this low CTE grade where the chemical composition has been optimized to offer printability and increased mechanical strength. The combination of dimensional stability and high strength with the design freedom of additive manufacturing enables the production of complex and lightweight parts for aerospace, cryogenic and precision instruments.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235756038

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Dr Andersson Michael (Höganäs AB, Sweden)

Co-author(s) :

Title : Modelling Of Fatigue Strength Of Astaloy CrS

Keyword(s) :
Fatigue Strength; Fracture Mechanics

Abstract :
Astaloy(R) CrS is a water atomized iron powder, alloyed with 0.85%Cr and 0.15%Mo, recently developed to meet increasing demands for sustainability. For many applications, fatigue strength is a limiting factor, why reliable fatigue models and data are keys to using materials to their best potential. Not least for sustainability reasons. This paper focuses on the fatigue strength of Astaloy CrS, where the performance of this new material is compared to more traditional alloying systems, such as FeCuC. In parallel, a fracture mechanics fatigue model is developed to predict the strength of the material. With this model, it is possible to simulate both the effect of density as well as stress concentrations to estimate component strength under different conditions.

Innovative Aspect(s) :
The paper presents material data for a new material as well as an innovative way to model fatigue strength of sintered steels.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235756235

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Dr Lindsley Bruce (Hoeganaes Corporation, USA)

Co-author(s) : Mr Kraus Neal (Hoeganaes Corporation, USA)

Title : Comparison Of Soft Magnetic Composites And Lamination Assemblies

Keyword(s) :
Soft Magnetic Composites; Lamination Steels

Abstract :
Lamination sheet steel used for magnetic stator cores have excellent magnetic properties within individual sheets. The comparison of these individual sheet properties, such as maximum saturation and permeability, with powder-based soft magnetic composites appears unfavorable for SMC use. The properties of lamination assemblies, however, is lower than individual sheets due to stacking factor and the presence of insulation layers. Further, it is commonly understood that these stacks tend to work best at lower frequency, whereas SMC is more suited to higher frequency. The number of direct comparisons of SMC and lamination steel stacks is limited in the literature, resulting in broad generalizations. In this study, test rings made with assemblies of 3 lamination steel grades and 2 grades of SMC will be evaluated under different test conditions. The direct comparison will enable users of the technology to understand the benefits and limitations of each approach.

Innovative Aspect(s) :
Understanding behavior of SMC and laminate assemblies in a direct evaluation, and identifying operating conditions where each best performs.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235760998

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Mrs Junghetu Corina (Hoeganaes Corporation Europe S.A., Romania)

Co-author(s) : Mrs Junghetu Corina (Hoeganaes Corporation Europe S.A., Romania), Dr Ing Schade Chris, Mrs Horvay Kerri, Mr Murphy Tom (Hoeganaes Corporation, USA)

Title : Influence Of Heat Treatment On Mechanical Properties Of Parts Produced By Laser Powder Bed Fusion From Wear Resistant Alloys

Keyword(s) :
Wear Resistant Steels; Additive Manufacturing

Abstract :
Applications that require wear resistance use hard materials which are difficult to machine. The most common forming method is by grinding but that limits the part geometry that can be achieved. Using additive manufacturing to form parts will open the range of possible geometries and functionalities that have never been explored. In this study, the microstructures and mechanical properties were evaluated for as-built and heat treated samples for a series of wear-resistant alloys developed to provide a range of properties for different tooling applications. The samples were prepared by printing with the laser powder bed fusion technique and then heat treated in different conditions. Standardized wear testing and the toughness of the material were evaluated as well.

Innovative Aspect(s) :
Evaluates the properties of the wear resistance steels developed for Additive Manufacturing function of the heat treatment performed. It presents the correlation between heat treated microstructure and mechanical properties as well as abrasion resistance properties.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235762746

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Prof Dr Gierl-Mayer Christian (Technische Universität Wien, Austria)

Co-author(s) : Dipl-Ing Geroldinger Stefan, Dr De Oro Calderon Raquel, Prof Dr Danninger Herbert (Technische Universität Wien, Austria)

Title : Comparison Of Low Alloyed Cr-Mo PM Steels By Thermoanalytical Techniques

Keyword(s) :
PM Steel; Themoanalysis; Dilatometry, DTA

Abstract :
Low alloyed steel powder Fe-0.85Cr-0.15Mo-C is dedicated to substitute Fe-Cu-C for PM steel precision parts. It is known from previous research that the introduction of oxygen sensitive elements like chromium leads to a change in deoxidation behaviour during the sintering process of PM steels compared to classical alloying elements like copper, nickel or molybdenum. This behaviour strongly depends on the chromium content of the powder. DTA|MS and DIL|MS experiments of this powder in different atmospheres are compared to classical Fe-Cu-C and higher chromium alloyed powders to reveal significant changes during the heating stage of the sintering process and to show if special measured are needed to sinter these steels compared to Fe-Cu-C. Thermal treatment to simulate dewaxing is performed to investigate the change in surface chemistry of the pressed compacts. The thermoanalytical experiments are accompanied by analysis of carbon and oxygen content and by microstructural characterization.

Innovative Aspect(s) :
Thermoalytical experiments on new powder grade Astaloy CrS are poerformed and compared to other PM steels. Variations of atmosphere and processing conditions will give insight in the sintering behavior of the new material.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235762969

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Ms Yöyler Sibel (Tallinn University of Technology, Estonia)

Co-author(s) : Dr Surzhenkov Andrei, Dr Antonov Maksim, Mr Viljus Mart, Mr Traksmaa Rainer, Dr Juhani Kristjan (Tallinn University of Technology, Estonia)

Title : Analysis Of Microstructure And Abrasive Wear Of Fe-based Hardfacings With TiC, In-situ Synthesized From TiO2

Keyword(s) :
Hardfacing; PTA Welding; Stainless Steel; Abrasion Test

Abstract :
Fe-based hardfacing with TiC reinforcement receives considerable attention due to the increasing demand for protective hardfacings. The present research focuses on the investigation of microstructure and abrasive wear behavior of Fe-based hardfacing with TiC, in-situ synthesized from TiO2. The plasma transferred arc (PTA) welding method was used for in-situ synthesis of TiC on the S235 substrate using 72 h ball-milled AISI 316L stainless steel (ss), TiO2, and graphite powders. Scanning electron microscopy (SEM) was used to analyze the microstructure, and energy dispersive spectroscopy (EDS) analysis was used to determine the distribution of TiC. XRD analysis was used to define the phases. Vickers hardness was measured, and ASTM G65 abrasion test was applied to evaluate the wear resistance of the hardfacings. Wear mechanisms were studied under SEM.

Innovative Aspect(s) :
The main innovation of this research is the wear testing of Fe-based hardfacings with TIC reinforcement. There were several attempts to synthesize TiC from TiO2, however, the wear resistance of specifically these hardfacings was almost never tested.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764026

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Dr Olsson Fredrik (Höganäs AB, Sweden)

Co-author(s) : Dr Vattur Sundaram Maheswaran, Ing Johansson Pernilla (Höganäs AB, Sweden)

Title : Evaluation Of Prior Austenite Grain Size On Heat Treated Low Pressure Carburized Chromium P|M Steels Using EBSD

Keyword(s) :
PAGS; EBSD; PM Steel; LPC

Abstract :
The martensite phase is of vital importance in PM steels thanks to its ability in enhancing mechanical properties and increasing component performances. The component behavior can be further improved by the addition of Ni and heat treatment after sintering in form of casehardening by low-pressure carburizing (LPC). Time and temperature of the sintering process determines the austenite grain sizes, which in turn have large impact on the martensitic transformation. Knowing the prior austenite grains sizes (PAGS) is crucial for better understanding the influence from the sintering process conditions on the martensite formation during LPC. However, the PAGS are difficult to reveal for evaluation by conventional light optical methods, which favors analytical approaches based on Electron Backscatter Diffraction (EBSD) measurements. This paper investigates the effect from different sintering temperatures on PAGS and related martensitic microstructure in a chromium pre-alloyed PM steel with and without Ni additions after LPC utilizing EBSD.

Innovative Aspect(s) :
The impact of PAGS on martensite formation in low pressure carburisation of Cr-containing steel by means of EBSD is important in understanding optimal sintering process and heat treatments. An EBSD approach can simplify the procedure of evaluating PAGS.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764029

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Mr Lindroos Tomi (VTT, Finland)

Co-author(s) : Mr Lagerbom Juha, Dr Tervo Jyrki, Dr Jokiaho Tuomas, Mr Antikainen Atte (VTT, Finland)

Title : Nitrogen Alloyed Austenitic Ni-free Stainless Steel For Additive Manufacturing

Keyword(s) :
Ni-Free; Additive Manufacturing; Nitrogen Alloying

Abstract :
Nitrogen alloyed Austenitic Nickel-free Stainless Steel (ANFSS) is one of the most promising group of materials for consumer and health care products. They can be used to substitute not only conventional AISI 316L, but also Titanium and Co-Cr alloys. Previously the utilization of Nitrogen alloyed materials has been limited due to high work hardening rate. Recent developments in powder metallurgy, e.g. Additive Manufacturing (AM), are offering economically feasible net shape manufacturing routes to go around machining related problems. In the present study a viable processing route for ANFSS powder is introduced. It includes gas atomization and AM of test specimens by laser- and sinter-based methods. Special attention is paid on controlling the nitrogen content in different processing steps including solution annealing. The results show that by proper selection of processing parameters, the nitrogen content can be kept in desired level, thereby controlling the mechanical and corrosion properties of ANFSS alloys.

Innovative Aspect(s) :
Use of abundant alloying elements to realize high performance alloy.
Benefit from additive manufacturing to realized materials hard to machine.
Utilization of nitrogen alloying to control final properties of alloy.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764056

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Mrs Olsson Elin (Erasteel, Sweden)

Co-author(s) : Dr Lardon Jean-Marc (Aubert&Duval, France), Mr Stern Nicolas (Erasteel, France), Dr Sundin Stefan (Erasteel, Sweden)

Title : Effect Of Cleanliness On Corrosion And Toughness Of Powder Metallurgical Martensitic Stainless Steels

Keyword(s) :

Abstract :
Martensitic stainless steels are highly alloyed in C, Cr and Mo for hardness and corrosion resistance and often in V for increased wear resistance. Due to the high alloying content, powder metallurgy (PM) including gas atomization and hot isostatic pressing (HIP) can be used to increase properties such as strength, fatigue resistance etc., thanks to almost elimination of segregations. However, further improvement of properties is made possible thanks to the recent developments of gas atomization process, which give very low levels of non-metallic inclusions. High cleanliness of PM material is well known to be critical for good polishing ability, fatigue resistance, strength etc. This paper describes results regarding the effect of cleanliness, composition and heat treatment on the impact toughness and salt spray corrosion resistance of different PM martensitic stainless grades containing 14 to 20% Cr, more than 1% C and Mo + V.

Innovative Aspect(s) :
The influence from amount of non-metallic inclusions on corrosion properties of PM martensitic stainless steel has to the best of our knowledge not been presented before. The effect is clearly there, which is probably not self-evident for the general audience. The paper and presentation will also show detailed SEM study on how the type of corrosion differs for the different materials and heat treatments. In addition, some results on toughness will be shown and how it is influenced as well from cleanliness.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764243

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Mr Radtke Felix (Institute of Applied Powder Metallurgy and Ceramics (IAPK), Germany)

Co-author(s) : Mr Becker Louis, Dr Ing Lentz Jonathan, Prof Dr Weber Sebastian (Chair of Materials Technology (LWT), Germany), Dr Ing Herzog Simone, Prof Dr Broeckmann Christoph (Institute of Applied Powder Metallurgy and Ceramics (IAPK), Germany)

Title : High Nitrogen Steels Produced By PBF-LB|M - Process Strategy And Properties For Ceramic Additivated Metal Powders

Keyword(s) :
Ceramic Additivated Metal Powder; High Nitrogen Steels; PBF-LB|M; Powder Properties; Recycling; Humidity; Si3N3

Abstract :
Additivated powders for the powder bed fusion – laser beam (PBF-LB|M) process allow to innovative materials, which can not be produced by conventional manufacturing techniques. In this study, Si3N4 powder is added to austenitic steel powder for the manufacturing of high nitrogen steels (HNS). Therefore, two different types of additivation are investigated using tumbling mixers with and without grinding balls. Variations in the oxygen content and particle size distribution of the ceramic powder are analyzed to gain knowledge regarding influences on the rheological and reflective properties of the additivated powder. The flowability and packing density are determined as a function of humidity and drying parameters of the powder. First samples of the investigated powders were processed by PBF-LB|M. Microscopic investigation reveals new insights inton the melting mechanisms of metal|ceramic mixtures. An analysis of the residual powder gives first indications regarding recyclability.

Innovative Aspect(s) :
The formation of HNS via additive manufacturing is limited by the nitrogen solubility of the steel melt. In contrast, the austenite phase shows a significantly increased solubility for nitrogen, which increases mechanical properties and corrosion resistance. For this reason, an accumulation of nitrogen in the steel matrix within the solid phase is aimed. Shaping is provided by the PBF-LB|M process assuming that only the steel melts while the Si3N4 particles only partly dissolve into the melt. The undissolved Si3N4 particles are dissolved by a subsequent HIP treatment, allowing nitrogen to diffuse into the component. In addition HIP brings the advantages of densification and homogenization.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765115

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Prof Dr de Oro Calderon Raquel (TU Wien, Austria)

Co-author(s) : Dr Hojati Milad, Mr Geroldinger Stefan, Prof Dr Gierl-Mayer Christian, Prof Dr Danninger Herbert (TU Wien, Austria), Dr Hellein Robert (Miba Sinter Austria GmbH, Austria)

Title : Sustainable Hybrid Alloyed PM Steels

Keyword(s) :
Sintered Steels; Hybrid Alloying; Masteralloys; Sinter-Hardening

Abstract :
The use of recyclable, non-toxic and non-critic alloying elements is becoming increasingly important in the last years. In particular, the unstable prices of Ni and Cu, and the increasing demand for these elements from the electromobility sector can eventually increase the prices, eliminating the price-competitiveness advantage of PM-steels. This work shows the newest advances in the investigation of PM-steels produced from more sustainable base powder alternatives (as AstCrS), combined with FeMnSi-based masteralloys (i.e. hybrid-alloy approach). Chemical analysis, CCT diagrams and mechanical properties will be presented for steels with different hybrid compositions, sintered and heat-treated under different conditions. The results show how, by properly adapting the sintering conditions and by combination with sinter hardening treatments, the use of more sustainable alloy compositions could be extended to additional PM application areas.

Innovative Aspect(s) :
Ni, Cu free PM-steels - Use of newly developed enviromentally friendly base powders (as Ast CrS).
Use of newly developed Ultra High Pressure water atomized masteralloys (FeMnSi-based).
CCT-diagrams of newly developed Hybrid-alloyed PM steels- Mechanical properties of as sintered and sinter hardened materials.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765422

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Ms Sweeney Fort Natasha (University of Sheffield, United Kingdom)

Co-author(s) :

Title : Producing Functionally Graded Precious Metal Doped Stainless Steels By Field Assisted Sintering Technique

Keyword(s) :
Cathodic Modification; Platinum Group Metals; Field Assisted Sintering Technique (FAST); Corrosion Prevention

Abstract :
Stainless steels' ability to resist corrosion is improved via cathodic modification. This is achieved through coating or bulk alloying with precious metals. However, this approach to the enhancement of stainless steels has yet to find commercial success due to its high costs and the propensity for precious metal coatings to debond. This project aims to make cathodic modification more economical by incorporating precious metals into stainless steels by functional grading. In this study, Ru- and Pd-doped 316L and 17-4PH stainless steel powders were sintered using FAST and corrosion tested. Near full density was attained and elemental segregation was not observed in the sintered samples. This new approach shows potential for reducing the volume of precious metals used in cathodic modification while improving long-term corrosion performance.

Innovative Aspect(s) :
Research has shown that cathodic modification of stainless steels can be achieved by bulk alloying and coating. However, the powder metallurgy approach to cathodic modification remains unexplored, as does using functional grading as a means of incorporating precious metals using metal powders. To the best of the author's knowledge, FAST has not before been used to produce precious metal-doped stainless steels nor undoped 17-4PH stainless steels.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765450

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Ing Reis Cruz Francisco (Univ. Coimbra, Portugal)

Co-author(s) : Dr Santos Rúben F. (University of Porto, Portugal), Ing C. Silva Pedro (Ramada Aços S.A., Portugal), Dr Ramos Ana Sofia, Prof Dr Vieira Teresa (Uniersity of Coimbra, Portugal)

Title : Powder Bed Fusion For Chemical Composition Optimization Of Tool Steel

Keyword(s) :
Hardening Mechanism; Powder Bed Fusion (PBF); Nanoprecipitates; Tool Steel; Properties Gradient; Steel Nanocomposite

Abstract :
Powder Bed Fusion (PBF) of tool steels as AISI H13 could contribute to a significant improvement of hardness by the presence of nanometric carbides. Moreover, new chemical compositions could be in gradient from top to inside 3Dobject. During additive manufacturing suitable powder mixtures of steel and vanadium&carbon allow the formation of nanocarbides. These elements are selected regarding the exceptional behavior of nanosized vanadium carbides in hardening. The cooling rate in the top surface of melt pool in PBF reaches 106 K|s, inducing low size carbides, from nanometric to micrometric, as the deepness of the analysis increases. In the present study, vanadium and graphene were added to AISI H13 powder. The possible carbon in excess, dissolved in the matrix, must be similar to the previous carbon percentage of H13 (0.35 %wt.). Microstructural analyses were carried out mainly by HRTEM of FIB samples acquired in top surfaces and middle of 3Dobjects.

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 PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235762245

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Prof Dorofeyev Vladimir (Platov South-Russian State Polytechnic University (NPI)), Russia)

Co-author(s) : Dr Sviridova Anna, Dr Berezhnoi Yury, Dr Bessarabov Eugene (Platov South-Russian State Polytechnic University (NPI)), Russia), Miss Sviridova Svetlana (Derzhavin Tambov State University, Russia), Dr Vodolazhenko Roman (MIREA - Russian Technological University, Russia)

Title : High-Temperature Heating Effect On The Transformation Of Non-Metallic Inclusions, The Structure And Properties Of Hot-Deformed Powder Steel

Keyword(s) :
Hot Forging; Porous Preforms; Mechanical Properties; Brittle and Ductile Fracture; Interparticle Jointing; Cohesion; Contact Interaction; Particle Surface; Alloying; Microalloying; Vanadium; Oxidation; Iron Powder; Dispersion Hardening; Dissolution - Prec

Abstract :
In order to decrease the negative impact of non-metallic inclusions on the properties of powder steels, the possibility of their diffusion dissolution during long-term high-temperature vacuum sintering or post-deformation annealing was studied. In the production of steels, iron powders with various contents of impurities were used. To decrease the tendency of austenite grains to grow, vanadium was added to the mixture composition. The content of carbon and vanadium was varied, as well as the modes of sintering and annealing. Heat treatment was performed after hot forging or annealing. The performance of high-temperature sintering or annealing causes a decrease in the size of non-metallic inclusions. Near the former particles of inclusions finely dispersed particles of secondary precipitates ("satellites") precipitate during the cooling process, which do not have a softening effect on the material. The modes of sintering are determined, which provide the minimum sizes of inclusions and vanadium-bearing carbides.

Innovative Aspect(s) :
A decrease in size of non-metallic inclusions during high-temperature sintering reduces the risk of formation of micropores and microcracks at the sites of localization of these inclusions during hot repressing porous preforms. On the contrary, in the case of post-deformation annealing, micropores and microcracks that have arisen during hot repressing near large inclusions are practically not healed.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235765561

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Ferrous Materials

Author : Dr Ing W. Sequeiros Elsa (LAETA|INEGI, Portugal)

Co-author(s) : Dipl-Ing M. Costa José, Dr Ing F. Santos Rúben, Prof Dr F. Vieira Manuel (LAETA|INEGI, Portugal)

Title : A Benchmarking Case Study And Comparison Of Die Specimens' Production Thru L-PBF Systems For Industry: Dimensional, Surface, Microstructural, And Mechanical Characterization

Keyword(s) :
Metal-Based Additive Manufacturing; Laser Powder Bed Fusion; Maraging Steel

Abstract :
Additive Manufacturing (AM) has become an emerging technology for the mass-production industry , with cost reduction and process improvement potential. This study aims to evaluate the production of dies through Laser Powder Bed Fusion (LPBF) technology, manufactured with different LPBF systems, well-established in the global market. The selected material was maraging steel powder EN 1.2709, and each supplier chose the process parameters according to their experience and systems parameterization. Different tests were performed on the dies to compare them: microstructure characterization, SEM|EDS and EBSD analysis, microhardness tests, surface analysis, and 3D dimensional measurements. Although the material and technology were the same, distinct characteristics were found in the evaluated parts. Based on the main results, one part was selected and tested successfully in an industrial production environment. This work has shown that different LPBF equipment, although using identical powder alloy , technology principles, and part requirements, originate distinct alloy characteristics.

Innovative Aspect(s) :
This study aims for an industrial application through producing maraging steel parts with LPBF. Different equipment manufacturers were used, and an extensive characterization was performed, mainly in the final parts. Although maraging steel parts produced by LPBF are well reported in the bibliography, there isn't any study that compares the output of different LPBF equipment from the standpoint of the powder and final part properties. LPBF systems are complex and require several operational conditions: system configuration, parameters, and powders assume a relevant character, making process optimization difficult. As well, the main LPBF systems are closed, which means different parameters for the same purpose. This was a study focused on the selection of the best final part, with industrial application, produced by LPBF considering the main well-established systems on the market.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023

CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

MATERIALS

NON FERROUS MATERIALS

EPMA
european powder metallurgy association

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235768755

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Non ferrous Materials

Author : Ing Fayanás Aintzane (Ceit-BRTA and Tecnun (Universidad de Navarra), Spain)

Co-author(s) : Dr Ordás Nerea, Dr Urionabarrenetxea Ernesto, Dr Iturriza Íñigo, Dr Veiga Ángela (Ceit-BRTA and Tecnun (Universidad de Navarra), Spain), Ing Valls Isaac (Rovalma, S.A., Spain)

Title : Development Of Nickel Aluminium Bronzes By Powder Metallurgy For Marine Applications

Keyword(s) :
Nickel Aluminium Bronze (NAB); Erosion-Corrosion; Prealloyed Powder; Mechanical Strength

Abstract :
Nickel aluminium bronze alloys (NAB) are commonly used to manufacture components for marine industry, like valves, bearings or hubs, due to their high mechanical strength and excellent corrosion resistance in seawater. Powder Metallurgy (PM), in contrast to conventional production processes, offers a more efficient use of raw materials and near-net-shape (NNS) components with fine and isotropic microstructures with improved performance.In this work, conventional PM (compaction and sintering) and PM-HIP (Hot Isostatic Pressing of encapsulated powder) have been explored to obtain fully dense NAB from gas atomised powder with Cu-9Al-4.5Ni-0.9Mn (wt.%) composition. The results show that an adequate selection of process parameters leads to fully dense materials with a microstructure suitable for exposure to marine environments. Final heat treatments are responsible for further microstructural refinement and dissolution of detrimental brittle phases, like martensitic ß or coarse rosette ?l, resulting in enhanced mechanical strength, ductility and resistance to erosion-corrosion in seawater.

Innovative Aspect(s) :
The conventional manufacturing processes to obtain NAB components for the marine industry include casting, rolling, extrusion or wrought, followed by machining. In contrast, Near-Net-Shape (NNS) processes, including PM and PM-HIP, minimise the need for machining operations, which results in energy savings and minimisation of waste material. In addition, R&D activities in PM of NAB alloys are limited and usually report final relative densities below 92%, leading to poor behaviour against erosion-corrosion. The results presented in this work demonstrate the feasibility to achieve 100% dense NABs by PM. Finally, the use of pre-alloyed powder has a positive impact on the sustainability and circularity of the components developed through the route here proposed. Component, can be recycled and used as raw material for the production of new powder once they reached the end of their useful life, provided the chemical composition and uptake of contaminants like C or O is controlled.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235754770

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Non ferrous Materials

Author : Miss Charteau Mélanie (Université de Poitiers - Institut Pprime, France)

Co-author(s) : Prof Joulain Anne, Prof Brunet-Gauthier Véronique, Prof Audurier Valérie (Université de Poitiers - Institut Pprime, France)

Title : Study Of The Mechanical Properties Of A Cu|C Composite With ZrC Interphase

Keyword(s) :
Metal matrix composite (MMC); Interphase; Microstructure; Mechanical properties, Carbon fiber; Copper matrix

Abstract :
Electronic devices present a large coefficient of thermal expansion (CTE) mismatch between the copper thermal drain and the ceramic and silicon parts. This causes thermomechanical stresses at the interfaces resulting in component failure. Copper composites reinforced with carbon fibers are materials of choice to overcome this drawback due to their expected adaptive CTE. To ensure good transfer of properties, chemical bonding between the matrix and reinforcement is necessary.The challenge of this work is to synthesize these composites, by hot isostatic pressing or hot uniaxial pressing, with a 2D or 3D orientation of carbon fibers respectively, and to produce in-situ a Zr-based interphase during the densification step. The microstructure and chemistry of the matrix, and those of the interphase, will be finely characterized by transmission and scanning electronic microscopy. The mechanical properties will be studied at room temperature at different scales.

Innovative Aspect(s) :
The synthesis of a composite with a copper matrix and randomly oriented carbon fiber reinforcement by powder metallurgy.
The multi-scale study of the mechanical properties of Cu(CuZr)|Cf composite and the relationship with the microstructure.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235762996

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Non ferrous Materials

Author : Dr Lorenzon Ivan (Pometon SpA, Italy)

Co-author(s) :

Title : Development Of Pure Copper Premixes For The Production Of Sintered Components With High Density And Electrical Conductivity

Keyword(s) :
Pure Copper Powder; Sintered Copper Components; Sintering of Pure Copper

Abstract :
In the heart of the EV but also of electronic components, copper is used throughout because of its high electrical conductivity, durability and malleability.EV use more than double the copper of an internal combustion engine automobile and it is also used heavily in EV-infrastructure like charging stations and in electrical grid infrastructures.Sintered Copper components could be cornerstone not only for the Powder Metallurgy future in automotive applications but also for the EV revolution.Pometon, by the experience on production of ECP and WA copper, is developing some ready to press products to meet the needs of the classical sintering production process for the fabrication of copper components. This study shows the developing a high purity and highly densifying copper powder given fundamental guidelines to facilitate the classical sintering to obtain the chemical, physical and mechanical characteristics needed for E-automotive and electronic applications.

Innovative Aspect(s) :
Production of sintered parts, via classic sintering, with high density and high conductivity for the EV and electronics market.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763056

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Non ferrous Materials

Author : Dr Romero Carlos (Universidad Carlos III de Madrid, Spain)

Co-author(s) : Mr Villemur Juan, Prof Gordo Elena (Universidad Carlos III de Madrid, Spain)

Title : Effect Of C Additions On The Sintering And Properties Of Titanium Hydride And Ti-6Al-4V

Keyword(s) :
Titanium; Sintering; Properties

Abstract :
Still considered a very damaging impurity whose content needed to be minimized, C could become an alloying element for Ti for non-critical applications if the standards are relaxed, especially given the importance of MIM and binder-based AM technologies. In the literature, the C content is dependent on the binder used, the debinding method and the sintering, but these parameters can also affect others, like the density of the part. Therefore, the aim of this work is to isolate the effect of the C content on titanium alloys and study its effect on the sintering behaviour and its properties. This is done adding carbon black to titanium hydride and to Ti-6Al-4V powder blends processed by pressing and sintering, and assessing changes in the thermal behaviour prior to sintering, the density of the material, the microstructure, composition and mechanical properties.

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 PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764660

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Non ferrous Materials

Author : Ms Goettgens Valerie (Univeristy of Innsbruck, Austria)

Co-author(s) : Dr Braun Jakob, Dr Kaserer Lukas, Prof Dr Leichtfried Gerhard (University of Innsbruck, Austria)

Title : Eutectoid ? -Ti Stabilizers In Ti-6Al-4V Leading To High Strength: A Comparison Of Copper And Chromium Addition In Laser Powder Bed Fusion

Keyword(s) :
Ti-6Al-4V; Laser Powder Bed Fusion; Additive Manufacturing; Alloy Development; Titanium Alloys; Intermetallic Compounds

Abstract :
Laser Powder Bed Fusion (LPBF) is the most frequently used additive manufacturing (AM) method for metals and alloys. It enables the production of near-net shape parts with high geometric complexity, which is impossible with conventional manufacturing methods. The most commonly used Ti alloy in LPBF is Ti-6A-4V, which shows unfavorable martensite formation due to the extremely high cooling rate in this process. This work presents the further development of Ti-6Al-4V to avoid martensite formation by stabilizing primary ß-Ti. This was achieved by adding 2.88 wt% Cr and 3.5 wt% Cu, both eutectoid alloying elements forming intermetallic strengthening compounds with Ti. The tensile strength was 1450±26 MPa by Cr and 1362±14 by Cu addition. Martensite was effectively avoided. This work compares the theoretical, microstructural, and mechanical differences between adding Cu and Cr.

Innovative Aspect(s) :
Ti-6Al-4V is the most frequently used Ti alloy in LPBF but exhibits martensite formation due to an extremely high cooling rate of up to 10/8 K|s in this process. Martensite leads to severe embrittlement, and costly post-process heat treatments, in which martensite decomposes, are essential for industrial applications. Post-process heat treatments could become redundant with the presented alloying concept, where the eutectoid alloying elements Cr and Cu stabilize primary β-Ti. At the same time, in situ precipitated intermetallic compounds of Ti-Cr or Ti-Cu lead to ultra-high-strength properties compared to pure Ti-6Al-4V. This work presents two approaches for an easy-to-process LPBF-specific alloy that exhibits excellent mechanical properties.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764683

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Non ferrous Materials

Author : Dr Ing Deirmina Faraz (Siemens Energy, Sweden)

Co-author(s) : Dr Ing Adegoke Olutayo (Siemens Energy, Sweden), Ing Del Col Matteo, Prof Dr Pellizzari Massimo (Trento University, Italy)

Title : Effect Of Layer Thickness And Laser Energy Density On The Recrystallization And Grain Growth In A Single-phase Ni Superalloy Fabricated By Laser Powder Bed Fusion

Keyword(s) :
Additive Manufacturing; Productivity; Ni Superalloy; Recrystallization; Grain Growth

Abstract :
Recent advances in design and manufacture of laser powder bed fusion (L.PBF) equipment capable of providing larger laser powers, has led to the utilization of larger powder bed layer thicknesses aimed at improving the productivity. The change in the effective heat input to the powder bed, as a result of increasing the layer thickness affects the thermal history, and constitutional supercooling and, leading to the development of different grain morphologies at different layer thicknesses. In this communication, we report on the influence of the initial as built microstructure, with a particular focus on the layer thickness and laser energy density, on the recrystallization and grain growth behavior of the L-PBF processed Hastelloy X. It was shown that the as-built (AB) microstructure and grain morphology were systematically dependent on the laser energy density, and the kinetics of the recrystallization was significantly increased by increasing laser energy density.

Innovative Aspect(s) :
The work contains systematic investigation of the dependency of heat treatment response of Laser Powder Bed Fusion (L-PBF) processed single phase austenitic Ni superalloy on the layer thickness and laser energy density. for this purpose, parts having layer thicknesses up to 120 micormeters were studied. From an industrial perspective, even if larger layer thicknesses significnatly improve the productivity in AM processes, given the thermal stabity of the microstructure, difficulties in achieving a full recrytallization and efficient grain growth, hence reducing the anisotropy in mechanical properties, might become a challanging and interesting topic to be investigated.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235748755

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Non ferrous Materials

Author : Prof Dr Nagode Ales (University of Ljubljana, Faculty of Natural Sciences and Engineering, Slovenia)

Co-author(s) : Mr Velikajne Nejc, Dr Paulin Irena (Institute of Metals and Technology, Slovenia), Mr Zorc Matija, Mrs Veber Anemarie, Prof Dr Bizjak Milan (University of Ljubljana, Faculty of Natural Sciences and Engineering, Slovenia)

Title : Process Optimisation And Microstructural Development Of SLM Fabricated AlSi10Mg Alloy

Keyword(s) :
AlSi10Mg; Selective Laser Melting; Laser Power; Scanning Speed; Thermoelectrometry; Microstructure and Mechanical Properties

Abstract :
AlSiMg10 is a heat-treatable hypoeutectic alloy with good castability and weldability, which makes it interesting for additive manufacturing (AM).In the present work, selective laser melting (SLM) technology was used to fabricate samples of AlSi10Mg alloy. However, one of the main challenges is to produce an alloy with good microstructural homogeneity and as little porosity, residual stresses or even cracks as possible.The main objective of the experimental research was to find the optimal process parameters for the fabrication of AlSiMg10 samples by SLM, which have a suitable microstructure and mechanical properties. Since defects in the microstructure are usually due to inadequate process parameters, the effect of laser power and scanning speed were investigated. Microstructural analysis was performed using SM and SEM|EDS|EBSD. The changes in microstructure during post-processing heat treatment were followed in-situ by thermoelectrometric measurements based on electrical resistivity.

Innovative Aspect(s) :
As part of our research, we investigated the influence of laser power and scanning speed on the microstructural and mechanical properties of AlSi10Mg alloy produced by SLM. For highly reflective materials, it can be challenging to achieve suitable properties with as few defects as possible. Microstructure was characterized by SM and SEM with EDS and EBSD; however, the changes in microstructure were tracked by thermoelectrometric measurements based on electrical resistivity, allowing in situ monitoring of microstructure evolution.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763901

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Non ferrous Materials

Author : Dr Ing Kołacz Dariusz (Łukasiewicz Research Network - Institute of Non-Ferrous Metals, Poland)

Co-author(s) : Dr Ing Kulasa Joanna, Dipl-Ing Lis Marcin, Dipl-Ing Brudny Anna, Dipl-Ing Krukowski Karol, Dipl-Ing Hury Anna, Dipl-Ing Muzia Grzegorz (Łukasiewicz Research Network - Institute of Non-Ferrous Metals, Poland)

Title : Tribological Tests Of CuSn10 Composites With The Addition Of Rhenium

Keyword(s) :
Tin Bronze; Rhenium; Composite; Pressing; Sintering; Hot Isostatic Pressing; Microstructure; Electrical Conductivity; Hardness; Tribological Tests

Abstract :
The article presents the results of tribological tests of composite materials based on CuSn10 with the addition of rhenium. The tested sinters were made by powder metallurgy. In the first stage, powder mixtures were prepared according to the scheme (mass chemical composition): 99% CuSn10 + 1% Re, 90% CuSn10 + 10% Re. Tin bronze (CuSn10) was used as a reference material. Samples for testing were obtained in two ways. In the first, powder mixtures were sintered directly under pressure using the SPS technology, in the second, compacts were initially produced in the process of double-sided axial pressing in steel dies, and then sintered and densified using the HIP method. Microstructure, electrical conductivity, hardness and tribological tests were performed on the obtained sinters. Tribological tests were conducted at elevated temperatures for selected sinters. A positive effect of the addition of rhenium on the sliding properties of the tested composites was observed.

Innovative Aspect(s) :
Tribological tests of CuSn10 composites with the addition of Re indicate a positive effect of rhenium on the sliding properties of these materials. Moreover, the addition of rhenium increases the hardness of the composite. Tin bronze with CuSn10 is used for example for machine parts such as bearings, bushings and drives which must sustain heavy loads. Increasing the sliding properties of materials with an increase in their hardness at the same time can positively affect the possibilities and scope of the use of tin bronzes, for example in bearings or sliding sleeves, by reducing operating costs and increasing the service life of sliding bearings.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

MATERIALS

HIGH TEMPERATURE MATERIALS

EPMA
european powder metallurgy association

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763879

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Dr Gauthier-Brunet Véronique (Institut Pprime, France)

Co-author(s) : Dr Zuber Axel, Prof Dubois Sylvain (Institut Pprime, France), Dr Roger Jérôme (Laboratoire des Composites ThermoStructuraux, France), Prof Dr Gonzalez-Julian Jesus (Institute of Mineral Engineering, RWTH Aachen University, Germany), Prof Dr Ouisse Thierry (Laboratoire des Matériaux et du Génie Physique, France)

Title : High-temperature Oxidation Of Cr2AlC MAX Phase Produced By Different Powder Metallurgy Routes: Study Of The Relationship Between Microstructure And Oxidation Resistance

Keyword(s) :
MAX Phase; Hot Isostatic Pressing; Spark Plasma Sintering; Microstructure Effect; High-Temperature Oxidation Resistance; Grain Size; Grain Orientation; Roughness

Abstract :
MAX phases are a family of nanolayered carbides and nitrides widely studied for their unique properties cumulating those of ceramics and metals. Cr2AlC is considered as one of the most promising MAX phase for its corrosion resistance properties. In this study, fine and coarse-grained Cr2AlC samples were respectively synthesized using spark plasma sintering and hot isostatic pressing techniques. The operating parameters were varied to optimize the purity and the density of the end-product.Oxidation tests were carried out on polycrystalline and single crystal samples in the temperature range 800-1500 ?C. Thermodynamic calculations were also performed to give further analysis of the experiments and to better understand the oxidation mechanisms. The effect of both the oxidation conditions and the MAX phases microstructural characteristics (grain size and orientation, roughness…) were studied via the observation of the oxide layers morphology, the analysis of the oxidation products and the study of the oxidation kinetics.

Innovative Aspect(s) :
Optimization of the Hot Isostatic Pressing (HIP) operating parameters and optimization of the starting powders characteristics to produce dense and highly-pure Cr2AlC coarse-grained samples.
Comparison of the oxidation resistance of Cr2AlC polycristalline samples (made by powder metallurgy techniques) and single crystals.
Long-term oxidation tests (up to 1000h) under dry air, for temperatures as high as 1500°C.
Clarify the influence of grain size, grain orientation and surface roughness on the oxidation of Cr2AlC- Compare experimental data with thermodynamic calculations to propose an oxidation mechanism.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764049

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Prof Dr Dubois Sylvain (Université de Poitiers, France)

Co-author(s) : Dr Zuber Axel, Dr Brunet Véronique, Prof Dr Coupeau Christophe, Prof Dr Renaut Pierre Olivier (Université de Poitiers, France), Prof Dr Gonzalez Julian Jesus (Aachen University, Germany), Prof Dr Ouisse Thierry, Prof Dr Parry Guillaume (Université Grenoble-Alpes, France)

Title : Evidence For Plastic Deformation Of The Alumina Scale During High Temperature Oxidation Of Cr2AlC

Keyword(s) :
Cr2AlC; Buckling; Plastic Deformation; XRD Strain Measurements; Oxydation

Abstract :
Single-crystal and fine-grained samples of Cr2AlC were oxidized during isothermal oxidation treatment performed under dry air flow at temperature in the 1000-1400°C range during 100 h. A continuous alumina layer forms on top of the Cr2AlC surface whereas a Cr7C3 sublayer also appears. in-lab characterization of oxidized Cr2AlC samples shows that alumina buckles are formed. In-situ XRD measurements under synchrotron radiations were performed to measure the lattice strain during the oxidation process and deduce the stress value in the Al2O3 and Cr7C3 layers. Both layers undergo tensile stress during the isothermal oxidation, showing that the alumina doesn't buckle due to growth stress. During cooling, the tensile stress decreases and compressive stress appears due to the differences in thermal expansion coefficient; buckling of the alumina layer thus occurs. Finally, by coupling those results with finite element calculations allows demonstrating that alumina is plastically deformed.

Innovative Aspect(s) :
Evidence for tensile stress during oxide growth.
Evidence for compressive stress due to mismatch between thermal expansion coefficient.
Characterization of alumina bucklesFinite element calculations.
Evidence for plastic deformation of the alumina scale.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764254

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Dr Dopler Martin (Metalpine GmbH, Austria)

Co-author(s) : Mrs Koell Anna (Metalpine GmbH, Austria)

Title : From Raw Material To 3D-Printed Parts: Ways To Reduce Energy Consumption In LPBF-Processes

Keyword(s) :
Gas Atomization; Linear Stability Analysis; Inconel 718; Layer Thickness; Yield Strength

Abstract :
Additive Manufacturing via Laser Powder Bed Fusion has become an important production route for many materials such as Titanium or Nickel-based alloys. However, energy consumption of the process chain is high. On the one hand, the product yield of the powders is low in relation to the material put into the atomization process, while the necessary inert gas consumption is high. On the other hand, the laser melting process is limited by a combination of powder quality and printing parameters, which also results in a high energy need.In this study, examples are discussed, how energy efficiency throughout the 3D printing process chain can be increased. Amongst others, 3 main examples were identified:- nozzle geometry optimization to increase powder product yield- production parameter optimization to decrease gas consumption- printing parameter optimization to increase printing speed, accompagnied by using perfect powders.For all aspects, theoretical analysis are followed by practical test results.

Innovative Aspect(s) :
The innovation of the paper lies in the identification of the main energy consumers in the whole 3D-printing production. Optimisation steps are examined on the one hand by a theoretical analysis (e.g. linear stability approach for gas atomization), on the other hand we can also show practical achievements (higher product yield by nozzle optimization, high strength of the printed part despite doubling layer thickness, etc.)Hence, new ways can be suggested to optimise the energy efficiency of the whole process chain.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764657

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Mr Ariza Galván Enrique (RHP-Technology GmbH, Austria)

Co-author(s) : Mr Curti Pier Paolo, Dr Neubauer Erich (RHP-Technology GmbH, Austria), Dr Bača Ľuboš, Dr Ing Scheerer Michael, Dr Stelzer Nils (Advanced Aerospace and Composites GmbH, Austria)

Title : Improvement Of Thermal Mechanical Properties Of Inconel 718 Reinforced With Ceramic Particles Manufactured By Plasma Metal Deposition (PMD)

Keyword(s) :
Additive Manufacturing; Plasma Metal Deposition; Nickel Alloy; Mechanical Properties

Abstract :
Nickel superalloys due to their good thermal mechanical properties and corrosion resistance are widely used for high performance on high demanding applications and industries as space, aviation or (petro-) chemistry. Moreover, the processing of this material class is costly due to the raw material and problems related to traditional processing techniques as casting, forging or milling (hot cracking, porosity, work hardening or wear on milling tools).Within this study the alloy Inconel 718 is processed with Plasma Metal Deposition (PMD®), an additive manufacturing process with high deposition rates for large part production. Additionally, the alloy is reinforced with ceramic Al2O3 particles that improves the mechanical properties at high temperatures. The weldability is studied. To assess the performance test coupons are investigated and analysed with respect to the mechanical properties.

Innovative Aspect(s) :
This work aims to demonstrate the use of the Plasma Metal Deposition as an additive manufacturing Direct Metal Deposition technology using nickel-chromium super alloys powder feedstock reinforced with ceramic particles and compare the thermal mechanical properties with the standard alloy.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2 23
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764980

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Mrs Carbajales Hernández Rita (University Carlos III of Madrid, Spain)

Co-author(s) : Dr Sobrino Fernández Celia, Dr Alvaredo Olmos Paula (University Carlos III of Madrid, Spain), Dr Lagos Miguel Angel (Tecnalia, Spain)

Title : Influence Of The Fabrication Process On The Corrosion Behavior Of Two High Entropy Alloys In Molten Solar Salt

Keyword(s) :
High-Entropy Alloys; Molten Salts; Corrosion; Arc Melting; Spark Plasma Sintering (SPS); Electrical Resistance Sintering (ERS); Concentration Solar Power (CSP) Plants

Abstract :
Heat storage in molten mineral salts is one promising option in energy conversion technologies, with concentration solar power (CSP) plants being the main exponent. However, the compatibility between molten salts and structural alloys has been of real concern due to corrosion problems. In the present work, the corrosion resistance in molten solar salt (40 wt.% KNO3|60 wt.% NaNO3) of two HEAs, one of original composition, FeCrMoAlTiNi, and one of eutectic composition, AlFeCrCoNi, is studied and compared with the SS316, an alloy used in CSP plants. In order to understand the variation of corrosion resistance with microstructure, the HEAs were processed by advanced fast and ultrafast techniques, Spark Plasma Sintering (SPS) and Electrical Resistance Sintering (ERS) and compared with samples processed by arc melting. The results obtained by Electrochemical Impedance Spectroscopy (EIS) confirm the promising use of HEA in applications in extreme environments.

Innovative Aspect(s) :
Hot corrosion is a problem that can implicate the reduction of the service life of engineering components. Accumulating heat in molten mineral salts is one of the options in energy conversion technologies that is proving to be operative. However, the compatibility between molten salts and the structural materials has been of real concern due to the corrosion problems. Although high entropy alloys are widely studied, there are little works on their behaviour under extreme conditions. In this work, the behaviour of an alloy of an original composition and a eutectic alloy processed by different techniques is studied. As already seen in other works, the manufacturing technique used in these alloys is key to achieve a homogeneous microstructure and for this reason the resistance to hot corrosion in samples processed by arc melting, and two fast and ultra-fast sintering techniques, SPS and ERS, are compared.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764983

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Dr Ing Mohammadzadeh Ahad (IMDEA materials, Spain)

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Title : Additively Manufactured Novel CoNi-based High Entropy Superalloy

Keyword(s) :
High Entropy Superalloys; Laser Powder Bed Fusion; Process Optimization; Thermodynamic Modeling; Microstructure

Abstract :
A novel CoNi-based high entropy superalloy has been developed for fusion-based additive manufacturing processes based on high entropy alloy concepts. A multi-component compound (Co-35Ni-8Al-4Ti-4V-2W-2Ta-9Cr) was prepared via gas atomization. A comprehensive study was conducted to establish a process-structure relationship in laser powder bed fusion processed CoNi superalloy powder. The effect of processing parameters, including laser power and scan speed on part characteristics, was studied using the Design of Experiment approach based on the Response Surface Methodology. Numerical models validated by experimentation were used to develop a process window to attain parts with a relative density of >99.9%. Advanced electron microscopy incorporated with phase analysis and hardness measurement were used to observe grain structure and texture, defects, phase evolution, and mechanical behavior. It was concluded that thermodynamic predictions were in good agreement with microstructure analysis to attain a single-phase fcc solid solution in the powder and as-built coupons.

Innovative Aspect(s) :
Developing eight component CoNi based high entropy superalloy with a single-phase fcc microstructure. Production of the designed HESA powder via gas atomization. Consolidation of the developed powder by means of laser powder bed fusion approach. Validation of the thermodynamic predictions by advanced microscope analyses.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765329

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Dr Sporer Dieter (Oerlikon Surface Solutions AG, Switzerland)

Co-author(s) : Mr Bautmans Ludo (Oerlikon Eldim B.V., Netherlands), Mr Beretta Davide (Georg Fischer Additive, Switzerland)

Title : Optimization Path For LB-PBF Manufactured Structures Of Inconel 738 LC

Keyword(s) :
Additive Manufacturing; Spherical Powder Material; Laser Beam Powder Bed Fusion; LB-PBF; Inconel 738LC Type; Crack Density; High Temperature Tensile and Stress-Rupture; Grain Structure for Use at High Temperature

Abstract :
Inconel 738LC is a superalloy with a high content of gamma prime precipitates to improve high temperature creep strength. This type of material is difficult to process in Additive Manufacturing by Laser Based Powder Based Fusion (LB-PBF) due to its inherent tendency to form microcracks during the laser processing. This paper reviews a systematic approach to mitigate the crack formation in 738 type compositions for LB-PBF by varying the alloy chemistry and the processing conditions. Further the creation of a commercial supply chain for components will be presented by transferring an optimized chemical composition into a commercial production environment including the necessary heat treatments that are required not only to perform a solutioning and precipitation treatment for the alloy but also to coarsen the grain structure which is inherently fine compared to castings

Innovative Aspect(s) :
Optimized chemistry for 738LC for Additive ManufacturingReduction of crack densities during LB-PBF processingOptimized HT procedureHigh temperature properties up to 927 °CTransfer of optimization into a commercial component manufacturing environment.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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EURO PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235765478

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Mr Mejía Reinoso Alexander (Universidad Carlos III de Madrid, Spain)

Co-author(s) : Dr Tan Qing, Dr Saksena Aparna, Dr Gault Baptiste (Max-Planck-Institut für eisenforschung GMBH, Germany), Dr Campos Gomez Mónica (Universidad Carlos III de Madrid, Spain), Dr Torralba José Manuel (IMDEA Materials, Spain)

Title : Powder Metallurgy Processing And Characterization Of Low Density Co-based Superalloys

Keyword(s) :
Co-Based Superalloys; Powder Metallurgy

Abstract :
Ni-based superalloys are widely used for high-temperature applications but their ?'-solvus temperature is close to their melting points. The Co - Al - W superalloys come up as an alternative but drawbacks such as low ?'-solvus temperature, and high density opened the field to low-density Co-based superalloys. This work has achieved a stable ?|?' microstructure in three viable alternatives Co – 5Ti – 15V, Co – 10Al – 5Mo – 2Ta and Co – 10Ni – 5Al – 3Ta – 2Ti – 3V where the ?'-solvus temperature and volume fraction were enhanced. The alloys were processed by Spark Plasma Sintering (SPS) improving their microstructure by solution and aging treatments. Partitioning of alloying elements on ?|?' phases was studied by Atom Probe Tomography (APT) and their mechanical properties at high temperatures were determined by performing heat compression and small punch creep tests.

Innovative Aspect(s) :
Due to the lack of strengthening mechanisms that are as effective as the L12-ordered γ' precipitates in Ni-based superalloys, traditional Co-based alloys has a limited used. In 2006, Sato et al. discovered Co-based superalloys, based on the ternary Co-Al-W system, with γ'-Co3(Al,W) precipitates with a coherent L12-ordered structure. Since Co has a higher melting point than Ni (1495 vs. 1455°C), these new superalloys have great potential to beat the high-temperature performance of existing Ni-based superalloys. This has generated extensive research and development interest in the design of Co-based alloys containing high volume fractions of γ' (~80%) and high solidus and liquidus temperatures (~150°C higher than those of Ni-based alloys). This research focuses on the replacement of part of the W by various γ' -forming elements and study their microstructre evolution by cutting edge techniques.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235765533

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Mr Masari Facundo (Universidad Carlos III de Madrid, Spain)

Co-author(s) : Dr Hernandez Pascual Rebeca (Centre for Energy, Environmental and Technological Research (CIEMAT), Spain), Prof Dr Torralba Castello Jose Manuel (IMDEA Materials Institute, Spain), Prof Dr Campos Gomez Monica (Universidad Carlos III de Madrid, Spain)

Title : Design Of Alumina Forming Martensitic Steels For Power Generation Systems By Powder Metallurgy

Keyword(s) :
FeCrAl Alloys; Oxidation; Alloy Design; Additive Manufacturing; Alumina Forming Steels

Abstract :
Increasing the operating pressure and temperature of power plants is one method to increase their efficiency and hence lower CO2 emissions. The materials employed define the maximum operating parameters of a plant, ergo, it is crucial to develop new materials to raise its working conditions. Currently, alumina-forming austenitic steels), alloys vulnerable to stress corrosion cracking and irradiation swelling, are one of the materials used for temperatures about 750°C. A novel type of material is proposed, alumina-forming ferritic-martensitic steels, which have superior corrosion and swelling resistance. Advanced fabrication techniques like field-assisted sintering and selective laser melting are explored to achieve different microstructures, starting from pre-alloyed atomized powders. These microstructures were studied with SEM and TEM among other techniques, and the mechanical behaviour was observed at temperatures up to 700°C with small punch tests. Finally, corrosion tests were conducted at temperatures of 800°C and 1200°C for 500 and 8 hours, respectively.

Innovative Aspect(s) :
This is a new type of stainless steel, entirely developed by PM and especially targeted toward high-temperature applications. The formation of an alumina layer, different from the chromium oxide layer formed in standard stainless steel, is an alternate method of preventing oxidation. To maximize the ability to create alumina and obtain the desired microstructure, three distinct alloys with various Cr|Ni contents are proposed. Two advanced fabrication techniques are compared, field-assisted sintering and selective laser melting, to achieve the desired microstructure. These novel stainless steels were created to meet the needs of power plants, but they can also be used in a variety of other applications.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765551

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Mr Ribeiro Bernardo (LAETA|INEGI - Institute of Science and Innovation in Mechanical and Industrial Engineering, Portugal)

Co-author(s) : Dr Ing Santos Rúben, Dr Ing Sequeiros Elsa (LAETA|INEGI - Institute of Science and Innovation in Mechanical and Industrial Engineering, Portugal), Dr Ing Barbosa Maria (Faculty of Engineering - University of Porto, Portugal)

Title : Alloying Effect On The Mechanical And Microstructural Properties Of Rheas Based On The System MoNbTaWX (X=Al|Ti|V)

Keyword(s) :
CALPHAD; Direct Energy Deposition; Mechanical and Microstructure Characterization; MoNbTaWX; RCCAs; RHEAs

Abstract :
In recent years, High Entropy Refractory Alloys (RHEAs) have been presented as possible alternatives to the state-of-art Ni-Superalloys, due to an outstanding combination of properties under high-temperature service conditions. The MoNbTaW system has been particularly explored due to its yield strength above 500 MPa at 1200 °C. Yet, these alloys present a brittle behavior at room temperature, narrowing their applications. To improve the MoNbTaW properties, in-situ alloying with additions of X=Al|V|Ti by Direct Energy Deposition (DED) assisted by thermodynamical simulations (CALPHAD) has been explored to accelerate the screening of promising compositions. In this contribution, we will present the room temperature microstructural and mechanical characterization to evaluate the influence of the alloying elements on ductility while guaranteeing a structure that allows a high yield strength at high temperatures.

Innovative Aspect(s) :
Combustion processes in aerospace and aeronautical would be more efficient, consuming less fuel and reducing CO2 emissions, if they could operate at higher temperatures. In this way, the main innovative aspect of this study is to increase the practical knowledge of RHEAs|RCCAs, accelerating the screening process through the combination of thermodynamical simulations and high-throughput processes such as DED. By these means, it is possible to evaluate a higher number of compositions of the system MoNbTaWX, discovering new strong RCCA candidates to surpass the state-of-art Ni-Superalloys, allowing the possible increase of efficiency of the combustion processes mentioned before. This work is part of the LiRAs project (FCT exploratory project) on high-throughput screening and development of RHEA|RCCAs alloys. This project explores new RCCAs.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235753737

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Dr Shulga Andrey (National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Russia)

Co-author(s) :

Title : Analysis Of Boron Behavior In The High-temperature Ni-based PM HIP Superalloys By The Use Of A Firstly Proposed TTT Diagram

Keyword(s) :
Ni-Based Superalloys; PM HIP Technology; Rapidly Quenched PREP Powder; Boron; TTT Diagram; Carbon; Autoradiography; Microstructure; High Temperature Tensile and Compression Tests

Abstract :
Based on the results of a multiscale experimental study of the behavior of boron, carbon, and microstructure of HIP PM compacts of the high temperature Ni-based superalloys, during various heat treatments, as well as tensile and compression tests, performed in particular by the method autoradiography, was constructed the firstly proposed TTT diagram. Study of boron and carbon behavior in relation to microstructure was carried out by direct methods track autoradiography on boron and activation autoradiography on carbon, metallography, SEM, EDX, OIM methods. Formation of solid solution of boron, segregation of boron, and precipitation of borides, in particular, along grain boundaries as a result of heat treatment of compacts, have been revealed and analyzed. Therefore, the temperature-time conditions for the precipitation of the boride phase were determined as the main parameters of the proposed TTT-diagram of the boride phase in comparison with the TTT-diagrams of the carbide and gamma-prime phases

Innovative Aspect(s) :
High-temperature Ni-based superalloys and austenitic stainless steels for traditional, PM HIP, and AT technologies are characterized by the presence of important microalloying interstitial elements: carbon and boron.At present, only TTT-diagrams for carbide and gamma-prime phases have been constructed, which are used to optimize heat treatment parameters.The lowest content of boron and the experimental difficulty of detecting boron are the main reason for the absence of a TTT diagram for borides.High sensitivity direct nuclear method of track autoradiography on boron together with LM, SEM, OIM methods were used for revealing formation of boron solid solution, boron segregation and boride precipitation in the HIP PM compacts of the high temperature Ni-based superalloy. The temperature-time conditions for the precipitation of the boride phase were determined and TTT-diagram of the boride phase was proposedTTT-diagrams are useful for better understanding of phase transformation kinetics and optimization of heat treatment

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235782977

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** High temperature Materials

Author : Mrs Wrona Adriana (Łukasiewicz Research Centre- Institute of Non-Ferrous Metals, Poland)

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Title : Rhenium-Modified Spherical Molybdenum Powders For Additive Technologies

Keyword(s) :
Molybdenum; Rhenium; Spherical Powders; Plasma Spheroidization; Additive Technologies

Abstract :
One of the problems of the AM technology market is low availability of powder materials, particularlythe high-melting ones. On the other hand, due to the characteristics of this materials, it is difficult toobtain printouts with optimal density and a small number of cracks. There are many ways to avoidthese types of problems. One of them is input materials modification. The paper presents a solutionusing the phenomenon called "the rhenium effect", based on molybdenum powders modification withrhenium. Different processes of thermal reduction and plasma spheroidization were used. Physicalproperties, microstructure, homogeneity, chemical and phase composition of produced powders wereinvestigated.

Innovative Aspect(s) :
The use of plasma technologies in production of high-melting spheroidal powders for additive technologies.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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