EURO PM2024 CONGRESS & EXHIBITION

Technical Programme Committee
8th of February 2024

ABSTRACTS BOOK

GROUP 4 - CONSOLIDATION TECHNOLOGIES

AM BEAM BASED TECHNOLOGIES

EPMA
european powder metallurgy association

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

Paper Number : C02
ID : 6275270

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Mr Johannsen Jan (Fraunhofer Research Institution for Additive Manufacturing Technologies IAPT, Germany)

Co-author(s) : Mr Abraham Sachin (Fraunhofer Research Institution for Additive Manufacturing Technologies IAPT, Germany); Mr Matthes Sebastian (Günter-Köhler-Institut für Fügetechnik und Werkstoffprüfung GmbH, Germany); Mr Maximilian Streinz (Günter-Köhler-Institut für Fügetechnik und Werkstoffprüfung GmbH, Germany)

Title : Influence Of Powder Moisture On The Quality In Laser Beam Powder Bed Fusion (PBF-LB|M)

Keyword(s) :
AlSi10Mg, Powder Moisture, PBF-LB|M, Quality, Humidity

Abstract :
The impact of powder moisture on the quality of additively manufactured parts through laser beam powder bed fusion (PBF-LB|M) is investigated in this study. Pre-alloyed AlSi10Mg powder was artificial moistened by aging it in a climate chamber under regulated conditions of relative humidity and temperature. Various powder batches, ranging from 85 ppm to 1767 ppm water content, were prepared and processed by PBF-LB|M using diverse sets of process parameters. The printed specimens were examined for relative density, mechanical properties, hydrogen and oxygen content.The findings demonstrate a correlation between the moisture content in the powder and both mechanical properties and H- and O-content. Notably, a decline in the quality of printed AlSi10Mg specimens is observed when the moisture content exceeds 189 ppm water content in the powder. This study sheds light on the criticality of moisture in powder, providing valuable insights for ensuring the production of high-quality additively manufactured components.

Innovative Aspect(s) :
The industrial and scientific community has noticed a negativ behaivour of moistured metal powder onto the mechanical properties of parts additivley manufactured with laaser beam powder bed fusion. However, a comprehensive study of the impact of moistured powder onto the quality of printed parts and the effect on the PBF-LB|M process was missing. This study for the first time used controlled moistened powder to analyze the effect and mechanisms on the part properties. With the measurements of the resulting H- and O-content in the printed parts the mechanism of the reduction of mechanical properties can be reconized. The results highlight the importance of the quality control of the moisture in AM-metal powders and will help the AM community to ensure high-quality AM parts.

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 : C03
ID : 6276978

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Mr Memu Firat (TOBB University of Economics and Technology, Turkey)

Co-author(s) : Prof Dr Durlu Nuri (TOBB University of Economics and Technology, Turkey)

Title : Size-Dependent Microstructure Of Electron Beam Melted Ti-6Al-4V Alloy

Keyword(s) :
Electron Beam Melting, Ti-6Al-4V, X-ray Diffraction, Microstructure, Size Effect, Mechanical Properties

Abstract :
The Powder Bed Fusion (PBF) techniques allow for the production of complex-shaped components, yet geometric variations lead to varying mechanical properties within the fabricated structures. Despite employing the same manufacturing process, specimens of different sizes exhibit distinct microstructures. This study compares the microstructures of Electron Beam Melted (EBM) Ti-6Al-4V samples with build diameters of 6, 7.5, and 15 mm by examining alpha (a) phase thickness, dislocation densities, and hardness. Lattice parameters of phases and dislocation densities in the specimens are compared through X-ray diffraction (XRD) analysis. Notably, the study finds that a phase thickness increases with an increase in build diameter. The results demonstrate that size-induced differences in microstructure led to variations in mechanical properties. This highlights the crucial need to consider size effects in the design and assessment of complex PBF-fabricated structures.

Innovative Aspect(s) :
Witness samples are frequently used in various studies and manufacturing procedures to assess the final mechanical characteristics of a part produced through Powder Bed Fusion techniques. However, this practice increases the unnecessary use of alloy powder, resulting in adverse effects on the environment, cost, and time. Alternatively, without the requirement for destructive mechanical tests, the regional mechanical properties can be predicted by analyzing the traces of geometric differences in the final microstructure. The study examines the thickness of alpha phase, dislocation densities, and hardness to reveal the complexities of size-related impacts of Electron Beam Melted Ti-6Al-4V samples. The detailed examination of X-ray diffraction (XRD) helps in understanding the variations in lattice parameters and dislocation densities that are dependent on size. The study's novelty is found in its investigation of how these features directly impact the mechanical properties, highlighting the essential need to take into account the effects of size.

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 : C04
ID : 6278214

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Dr Salam Shahzad (Sumitomo Heavy Industreis ltd., Japan)

Co-author(s) : Dr Mitama Ichiro (Sumitomo Heavy Industreis ltd., Japan); Mr Sakata Takuma (Sumitomo Heavy Industreis ltd., Japan)

Title : Influence Of Powder Characteristics On Mechanical Behavior Of Additively Manufactured Alloys

Keyword(s) :
Additive Manufacturing, Mechanical Properties, Powder Characterisitics

Abstract :
Powder quality is a critical processing parameter in powder-based metal additive manufacturing that can affect both the processability and mechanical properties of the manufactured parts. While commercially available powders come in various shapes, sizes, and distributions, it is essential to understand the impact of these powder characteristics on the finished product. This study investigates the correlation between powder characteristics and stress-rupture behavior of IN718 alloy. Test samples were fabricated using laser powder bed fusion (L-PBF) with powders of varying characteristics. The results indicate that the samples fabricated with powder of optimal characteristics contained fewer microstructural defects resulting in a significant 13-fold improvement in rupture-life. The aim of this article is to discuss these powder effects and provide a basis for producing final components with consistent mechanical properties.

Innovative Aspect(s) :
Powder effects on high-temperature mechanical properties of additive manufactured alloys are reported.

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 : C05
ID : 6278649

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Miss Lupi Giorgia (Politecnico di Milano, Italy)

Co-author(s) : Miss Ceroni Marta (Politecnico di Torino, Italy); Prof Actis Grande Marco (Politecnico di Torino, Italy); Prof Casati Riccardo (Politecnico di Milano, Italy)

Title : Powder Functionalization Of Pure Cu With Ag For Improved PBF-LB|M Processability

Keyword(s) :
Coated Metal Powders, Powder Functionalization, PBF-LB|M, Copper, Silver

Abstract :
The PBF-LB processability of pure Cu pose significant challenges due to the high laser-reflectivity and thermal-conductivity of this metal. Near-IR lasers are widely considered not suitable for processing Cu, unless high power is employed, limiting the accessibility to Cu. In this work, we investigate a disruptive approach to improve Cu processability by using a low-power (200W) near-IR PBF-LB|M system, which is based on the Ag-coating of Cu particles that were heat-treated at 500°C|600°C to promote diffusion at the coating interface. Pure Cu and coated powder were processed by PBF-LB|M to produce bulk samples. Microstructure analysis was performed by SEM, EDX, and XRD. It was observed that the Ag layer has a positive effect on the laser processability of Cu. Almost fully dense materials (>98%) were achieved due to the formation of a Cu-Ag eutectic network able to heal pores and defects during solidification.

Innovative Aspect(s) :
The near-IR PBF-LB at low power is difficult due to the high reflectivity and thermal conductivity of Cu. Manufacturing of fully dense Cu parts with conventional PBF-LB systems is challenging.Cu powder particles were coated with a thin layer of Ag to improve their PBF-LB processability. The functionalization of Cu powder with Ag is a novel approach, highly scalable, that has never been studied so far.This work sheds light on the ability of Ag layer to heal pores and defects during solidification of Cu.

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 : C06
ID : 6281101

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Dr Thangamani Geethapriyan (Politecnico di torino, Italy)

Co-author(s) : Mr Vanzetti Matteo (Politecnico di torino, Italy); Mr Felicioni Stefano (Politecnico di torino, Italy); Dr Padovano Elisa (Politecnico di torino, Italy); Prof Bondioli Federica (Politecnico di torino, Italy)

Title : Microhardness And Microstructural Evolution Of Additive Manufactured GRCop-42 By Electron Beam Powder Bed Fusion

Keyword(s) :
Additive Manufacturing, Electron beam Powder Bed Fusion (EB-PBF), GRCop-42, Microhardness, Microstructure

Abstract :
GRCop-42 samples were additively manufactured by varying the electron beam powder bed fusion (EB-PBF) process parameters in a volumetric energy density (VED) range from 112.9 – 213.3 J|mm3: laser scan speed was varied from 450–850 mm|s, while voltage, power, line-offst and layer thickness were fixed parameters, to study their influence on the density, melt pool structure, and microstructure. Under the optimal conditions, the microhardness of the GRCop-42 samples achieved the highest value of 112.4 ± 5.8 HV. In addition, the microstructural evolution as a function of VED variation on additive manufactured GRCop-42 samples was examined using scaining electron microscopy (SEM) and X-ray Diffraction. From the microstructure observation, Cr2Nb precipitates, formed in the alloy during the printing process, reinforce the Cu matrix by preventing dislocation motion and impeding grain development.

Innovative Aspect(s) :
This study demonstrates the use of innovation in GRCop-42 sample additive manufacturing by carefully examining the parameters of the electron beam powder bed fusion (EB-PBF) method. Interestingly, the study maintains other parameters constant and systematically modifies the laser scan speed within a given range, providing a detailed analysis of its effects on density, melt pool structure, and microstructure. This comprehensive approach adds greatly to developing additive manufacturing methods and understanding material behavior, marking a remarkable step forward in the area. These GRCop alloys with exceptional oxidation resistance were created specifically for regeneratively-cooled combustion chambers and nozzles in severe situations. Consequently, the creation of GRCop-42 for use with combustion devices for liquid rocket engines.

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 : C08
ID : 6281597

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Ms Larsson Anna (Höganäs AB, Sweden)

Co-author(s) : Mr Oshchepkov Denis (Höganäs AB, Sweden); Mr Gårdstam Johannes (Quintus Technologies AB, Sweden); Mr Shipley James (Quintus Technologies AB, Sweden)

Title : Experience In AM & HIP Of Ni-based Superalloys

Keyword(s) :
Additive Manufacturing, PBF-LB, Nickel Base Superalloys, Hot Isostatic Pressing

Abstract :
Industrial sectors such as aerospace, industrial gas turbines are transforming by using powder bed fusion – laser beam (PBF-LB) process for making critical parts in nickel base super alloys. The performance requirements on these parts are very strict and process defects must be minimized and under control. All process steps must be optimized in order to reach the required quality goals. In this study the properties of additively manufactured nickel base super alloys are examined. The influence of print process, as well as post processes like heat treatment and hot isostatic pressing and the combination of the last two on the mechanical properties and on the microstructure was examined. Tensile tests, Impact test and Hardness were evaluated, and the microstructures were examined in light optical microscope and in SEM.

Innovative Aspect(s) :
Increase robustness and reliability of additive manufactured components by postprocessing.Combination of postprocessing operations (HIP + Heat treatmet) for increased productivity.Optimise the microstructure for desired mechanical properties.

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 : C10
ID : 6281718

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Ing Svanberg Arvid (Rise research institutes of Sweden, Sweden)

Co-author(s) : Ing Larson Anna (Höganäs, Sweden); Dr Ing Hosseini Seyed Behnam (RISE research institutes of Sweden, Swaziland); Ing Habelmann Fenja (University of Rostock, Germany, Germany); Dr Ing Khademzadeh Saeed (RISE research institutes of Sweden, Sweden)

Title : Exploring Enhanced Productivity In Laser Powder Bed Fusion Of Inconel 718: Analyzing Microstructure, Support-Free Printing, Surface Integrity, And Spatter Formation

Keyword(s) :
Powder Bed Fusion Laser Beam, Inconel 718, Productivity, Process Development

Abstract :
While laser powder bed fusion (PBF-LB) technology holds significant promise for integration into industrial manufacturing workflows, it still faces challenges related to low production rates. The adjustment of process parameters, such as the utilization of heightened values for layer thicknesses and scanning speeds, proves effective and cost-efficient in enhancing productivity in the LPBF process. However, ensuring the retention of appropriate properties poses challenges that necessitate further studies. Another obstacle arises from the elevated level of spatters due to the intensified energy density required for increased layer thicknesses. This study delves into the feasibility of this approach in enhancing productivity in PBF-LB for Inconel 718 components, encompassing inclined features. The investigation includes various aspects such as relative density, surface roughness, microstructure, spatter formation, and mechanical properties. Optimal process parameters have been determined for different layer thicknesses, extending up to 120 µm, with corresponding adjustments tailored for downfacing surfaces.

Innovative Aspect(s) :
Including challenging features, such as down-facing surfaces, in the test geometries to replicate real-world situations in productivity analysis; Analyzing spatter formation, a crucial factor in scaling up production from test geometries to actual components.

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 : C11
ID : 6281394

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Dr Montero-Sistiaga Maria L. (NLR- Royal Netherlands Aerospace Centre, Netherlands)

Co-author(s) : Mr Osinga Timo (NLR- Royal Netherlands Aerospace Centre, Netherlands); Mr Haagsma Ralph (NLR- Royal Netherlands Aerospace Centre, Netherlands); Dr Bottazzi Olmo (Mokveld Valves B.V., Netherlands); Ing Esveldt Vincent (Mokveld Valves B.V., Netherlands); Ing Bautmans Ludo (Oerlikon Metco AM powders, Belgium); Ing Hamer Wouter (Shell Global Solutions International B.V., Netherlands); Ing de Smit Marc (NLR- Royal Netherlands Aerospace Centre, Netherlands)

Title : Hybrid And Multimaterial Production Of A Check Valve Combining Laser Powder Bed Fusion And Directed Energy Deposition Technologies

Keyword(s) :
Directed Energy Deposition, Laser Powder Bed Fusion, Muti-material, Hybrid Manufacturing

Abstract :
Extensive research is currently done on microstructure and mechanical property characterisation of metal additive manufacturing technologies. However, there remains a limited focus on the combination of these technologies. This study addresses this gap by combining laser powder bed fusion (LPBF) and directed energy deposition (DED) technologies to produce a check valve. The interior of a valve requires high corrosion resistance which can be obtained using In718, while the exterior benefits from intermediate mechanical properties, specifically using 316L. From the consolidation side, LPBF allows the production of small complex features and DED offers a higher production rate and the possibility of tailoring compositions and mechanical properties.The interface quality and microstructure of different multi-material combinations were studied in this work. Tensile properties were investigated of hybrid multi-material parts to select the best combination. In addition, the production route for producing a multi-material check valve combining LPBF and DED was developed.

Innovative Aspect(s) :
Different multi-material interfaces are produced between 316L and In718. Besides muti-material interfaces, LPBF and DED technologies are combined to increase the production flexibility of AM. The production route for producing hybrid and multi-material check valve is described.

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 : C12
ID : 6281572

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Mrs Guillon Maxence (école des Mines de Saint Etienne, France)

Co-author(s) : Mr Desrayaud Christophe (école des Mines de Saint Etienne, France); Mr Boulnat Xavier (Mateis, France); Mr Elguedj Thomas (Lamcos, France); Mrs Lambert Pauline (école des Mines de Saint Etienne, France)

Title : Characterization Of Keyhole Regime For Laser Powder Bed Fusion: From Single Track Formation To Multi Layers Volume, The Change In Laser And Matter Interaction

Keyword(s) :
Additive Manufacturing, Laser, Focal Shift, Process Windows, 316l

Abstract :
Laser Powder bed Fusion is a strong process enabling the on-demand production of components with complex geometry and high added value. Despite its strengths, there are still significant challenges to fully understanding the interaction between laser and powder.The interaction between laser and material differs significantly between single tracks and multiple tracks. In a single track, the laser only interacts with the powder. In contrast, for multiple tracks, the laser interacts also with the previously laid tracks. This underscores the inadequacy of characterizing only a single track for a comprehensive understanding of the interactions between laser and powder. Moreover, previous analyses show a focal shift that cannot be neglected on the machine used. Hence, this works aims at characterizing the melt pool during the formation of a single and multiple tracks with 316L powder material. The consequence of the focal shift is observed and measured.

Innovative Aspect(s) :
In this paper, the innovative aspect is the characterization of laser spot due to focus beam profiler and the effect of laser focal shift on final characteristic of the final bulk material. A thorough study of the laser used for this study revealed a significant focal shift. Because of the heating of the elements in the optical path, the laser focal point tends to shift and reduce the focal distance during sintering of the powder layer. Indeed, the beam size and its energy distribution evolve quickly as a function of time. For a fixed working distance, the state of the laser beam is very different. This results in an important during the process and therefore influences the formation and integrity of the single tracks.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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Notes to author : .....

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

Paper Number : C13
ID : 6281977

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Dr Kaserer Lukas (University of Innsbruck, Austria)

Co-author(s) : Dr Braun Jakob (University of Innsbruck, Austria); Dr Mayr-Schmoelzer Bernhard (Plansee SE, Austria); Dr Distl Benedikt (Plansee SE, Austria); Dr Schafbauer Wolfgang (Plansee SE, Austria); Prof Dr Leichtfried Gerhard (University of Innsbruck, Austria)

Title : Alloying Concepts For Grain Refinement And Grain Boundary Engineering In Powder Bed Fusion-Laser Beam Of Tungsten

Keyword(s) :
Tungsten, Powder Bed Fusion-Laser Beam, Alloying Strategy

Abstract :
The Powder Bed Fusion - Laser Beam (PBF-LB) technology enables the production of complex-shaped components that surpass the limitations of other manufacturing methods. PBF-LB is, therefore, ideally suited for producing functionally optimized components in novel high-tech applications, especially for high-performance materials such as tungsten (W).The disadvantage of PBF-LB-manufactured W components is that they show a coarse-grained, columnar microstructure which is prone to cracking, preventing them from competing with conventional powder metallurgical components. To suppress the formation of such an unfavorable microstructure, it is necessary to adapt the material to the unique solidification conditions of the PBF-LB process.In the present work, different alloying concepts are investigated, firstly to induce grain refinement and thus suppress the formation of a coarse-grained microstructure and secondly to purify the grain boundaries from impurities and thus prevent the formation of cracks. Both the theoretical foundation and experimental results are shown.

Innovative Aspect(s) :
Presentation of different alloying strategies to counteract the main defect-initiating mechanisms in PBF-LB of W Discussion on the mechanism of grain refinement Discussion on the mechanism for the purification of grain boundaries

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

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

Paper Number : C14
ID : 6282019

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Dr Karimi Paria (OptiFab Technologies, Canada)

Co-author(s) : Mrs Karimi Paria (Opti-Fab Technologies, Canada); Dr Sadeghi Esmaeil (OptiFab Technologies, Canada)

Title : Application-Driven Intelligent Scan Patterns In Additive Manufacturing

Keyword(s) :
Additive Manufacturing, Powder Bed Fusion, Toolpath, Scan Patterns, Magnets

Abstract :
This study concentrates on leveraging a distinctive feature of the 3D printing technology known as toolpaths to produce magnets essential for applications in electrical machines, notably motors and generators. Delving into the powder bed fusion branch of 3D printing processes, the focus extends to two primary magnet categories: NdFeB (integral for rotor applications in energy conversion and electronic devices) and FeSi (deployed in both rotor and stator cores). Employing artificial intelligence-based scan patterns for each layer, the study aims to optimize thermal and stress distribution through laser powder bed fusion (LPBF) technologies. The investigation meticulously elucidates the microstructure evolution and phase selection, highlighting the significance of solidification parameters influenced by scan patterns. Despite yielding identical relative densities, different scan patterns engender varying structural features, thereby impacting magnetic properties. Applying a targeted scan pattern mitigates losses, yielding superior magnetic properties compared to conventional methods and laser powder bed fusion (LPBF).

Innovative Aspect(s) :
OptiFab is showcasing an AI-powered platform that generates scan patterns and optimizes each individual layer in order to minimize the part deformation and decrease dependence on design-oriented aspects throughout the process.

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 : C16
ID : 6282485

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Dr Ing Deirmina Faraz (sandvik, Sweden)

Co-author(s) : Dr Ing Bettini Eleonora (sandvik, Sweden); Dr Ing amir sasan (Prom, Italy); Dr Hann Jonathan (Bergische Universität Wuppertal, Germany); Dr Ing Zhao Zhao (Trento university, Italy); Dr Ing dossin Sylvain (Hydro Norsk, Belgium); Prof Dr Röttger Arne (Bergische Universität Wuppertal, Germany); Prof Dr Pellizzari Massimo (Trento University, Italy)

Title : Laser Powder Bed Fusion And Directed Energy Deposition Of A Novel Hot Work Tool Steel : A Comparative Study

Keyword(s) :
Hot Work Tool Steel, Additive Manufacturing, L-PBF, L-DED

Abstract :
To address the challenges in processing of medium-carbon hot work tool steels by laser based additive manufacturing (AM), a recently developed hot work tool steel with improved processability was processed by both laser powder bed fusion (L-PBF) and laser directed energy deposition (L-DED). Microstructure and phases in as built (AB) and quenched (Q) states were compared for both processing routes. Hardness, impact toughness, tempering- and thermomechanical softening resistance, and nitriding response, after direct double tempering from AB condition (ABT) and quenching and tempering (QT) were measured and assessed. Properties were then compared with those of AM-, as well as wrought- AISI H13 hot work tool steel. The results suggest the new steel exhibits comparable mechanical and thermomechanical properties to H13. Finally, practical case studies of repair of tools in H13, using the new tool steel (L-DED), and production of relatively large molds with complex geometries (L-PBF) was demonstrated.

Innovative Aspect(s) :
The research aims at developing leaner tool steels with improved processabilty by Laser based additive manufacturing methods.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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Notes to author : .....

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

Paper Number : C17
ID : 6281362

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Mrs Scheck Marie Luise (Institute for Applied Powder Metallurgy and Ceramics at RWTH Aachen e.V., Germany)

Co-author(s) : Mr Santos Batista Rui Joao (Fraunhofer Institute for Laser Technology ILT, Germany); Dr Ing Herzog Simone (Institute for Materials Applications in Mechanical Engineering at RWTH Aachen University, Germany); Dr Ing Kaletsch Anke (Institute for Applied Powder Metallurgy and Ceramics at RWTH Aachen e.V., Germany); Prof Häfner Constantin (Fraunhofer Institute for Laser Technology ILT, Germany); Prof Dr Broeckmann Christoph (Institute for Materials Applications in Mechanical Engineering at RWTH Aachen University, Germany)

Title : Effect Of Substrate Plate Heating On Retained Austenite Content And Cracking Susceptibility Of A Carbide-rich Tool Steel

Keyword(s) :
Laser-based Powder Bed Fusion, Retained Austenite, Carbides, Tool Steel, Substrate Plate Heating, Cracks

Abstract :
Processing carbide-rich tool steels with laser-based powder bed fusion is challenging as cracks occur frequently. Substrate plate preheating is commonly applied to improve the processability as the temperature gradients are lowered and stresses reduced. The modified temperature gradients alter the microstructure formation of the alloy. In this study, a carbide-rich tool steel was processed at RT, 500°C and 800°C substrate plate preheating which lead to different precipitated carbide and retained austenite contents. The high substrate plate heating of 800°C significantly reduced cracking of the alloy and a fully martensitic microstructure was obtained. In the samples built at RT or 500°C, the lower diffusion hinders carbide precipitation and thus leads to austenite stabilization. These specimens show cracks despite their higher retained austenite contents. Here, the retained austenite has a high hardness, and therefore it is assumed that it is distorted, brittle and thus cannot prevent crack growth within the specimens.

Innovative Aspect(s) :
Retained austenite is often referred to as beneficial for processing alloys that are prone to cracking. This study shows that in this case the retained austenite is not able to compensate the stresses within the alloy and that it is more advantageous to achieve a martensitic microstructure during cooling after the process than by trying to improve processability via a high retained austenite content.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

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

Paper Number : C18
ID : 6277112

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Ing Felicioni Stefano (Politecnico di Torino, Italy)

Co-author(s) : Dr Vanzetti Matteo (Politecnico di Torino, Italy); Prof Padovano Elisa (Politecnico di Torino, Italy); Prof Bondioli Federica (Politecnico di Torino, Italy)

Title : Advanced Analysis Of Cu-Cr-Zr Alloy Obtained By Electron-Beam Powder Bed Fusion: Microstructural Insights And Precipitation Behaviour

Keyword(s) :
Additive Manufacturing, Electron beam Powder Bed Fusion (EB-PBF), CuCrZr,C18150, Precipitation Behaviour, Microstructure, TEM, SEM

Abstract :
A comprehensive characterization of microstructure and mechanical properties of CuCrZr alloy processed by electron beam powder bed fusion (EB-PBF) was conducted to explore the impact the thermal history of the material has on printed part properties. In fact, this technology requires a careful control of the thermal evolution underwent by the material during the manufacturing process because it significantly affects the crystallographic texture and the grain morphology. Nearly fully dense samples with a relative density up to 99.77±0.04% was successfully obtained. The as-built samples exhibit an anisotropic trend for the horizontal and vertical planes, which is independent of energetic input and specimen defects. Huge microstructural transformation coincides with the precipitation and segregation of specific chromium-rich species, driven by the elevated thermal conditions during the deposition. To identify and quantify the precipitations within the microstructure, scanning and transmission electron microscopy, along with X-ray diffraction were used.

Innovative Aspect(s) :
The present investigation offers novel insights into the feasibility of processing the system without relying on the essential post-processing heat treatment typically associated with this material. This alloy, specifically engineered for utilisation in high-temperature environments, confronts the inherent challenge of precipitation clustering. The complexities of high-temperature processing simulate the operational conditions of the component. Therefore, an in-depth understanding of the precipitation mechanism not only serves as a valuable guide for anticipating potential issues, but also provides essential information for predicting the material's behaviour under operational conditions.

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 : C19
ID : 6281376

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Miss Sajjadivand Shahrzad (University College Dublin, Ireland)

Co-author(s) : Dr Celikin Mert (University College Dublin, Ireland); Mr Hartnett Mark (Irish Manufacturing Research, Ireland)

Title : Understanding The Differences In Microstructural Evolution Between Additively Manufactured And Conventional 18Ni(300) Maraging Steel Upon Post-Processing Heat Treatment

Keyword(s) :
18Ni (300) Maraging Steel, Laser powder Bed Fusion (L-PBF), Heat Treatment, Microstructure, Mechanical Property

Abstract :
This study aims to optimise post-processing heat treatment methodology of 18Ni(300) Maraging steel manufactured via Laser Powder Bed Fusion (L-PBF). This is achieved by understanding the effect of post-processing heat treatment on the microstructural evolution and mechanical behaviour of LPBF 18Ni(300) Maraging steel in comparison to conventionally manufactured 18Ni(300) Maraging steel. In-depth materials characterisation was carried out using X-ray diffraction (XRD), optical and scanning electron microscopy (OM| SEM), and transmission electron microscopy (TEM). Resultant changes in mechanical properties determined via compression and hardness testing were linked with precipitation kinetics (formation, size, and distribution of secondary phases), process-induced porosity and micro-strain levels. Based on conventionally produced 18Ni(300) steel as a control and baseline, a novel heat treatment methodology has been developed for AM maraging steels.

Innovative Aspect(s) :
18Ni(300) maraging steels belong to an exclusive class of ultra-high-strength low-carbon steels. Because of their high strength, toughness, and weldability, they are widely used in tool|die industry. Using L-PBF instead of conventional processes for producing maraging steel components has become more important due to its ability to produce complex and precise geometries in one step and reduce production costs, waste material, and time. Currently, there are several studies on L-PBF 18Ni(300) maraging steel focused on improving mechanical properties to be in similar levels to conventional ones by optimizing the post-processing heat treatment. There is a optimised post-processing heat treatment for conventionally produced maraging steels however according to recent studies there is considerable scattering in published data concerning the post-processing heat treatment recommended for L-PBF 18Ni maraging steel due to the variation in processing conditions. Therefore, developing a novel heat treatment methodology for L-PBF 18Ni(300) maraging steel is crucial.

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 : C20
ID : 6281349

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Ing Hajeck Tobias (Institute for Materials Applications in Mechanical Engineering (IWM), Germany)

Co-author(s) : Ing Weiß Christian (Fraunhofer Institute for Laser Technology ILT, Germany); Prof Dr Broeckmann Christoph (Institute for Materials Applications in Mechanical Engineering (IWM), Germany); Prof Häfner Constantin (Fraunhofer Institute for Laser Technology ILT, Germany)

Title : Influences Of Process Parameters On Failure Mechanisms Of Additively Manufactured 16MnCr5 Under Cyclical Loading

Keyword(s) :
Fatigue Strength, Laser Powder Bed Fusion, Internal Defects, Process Parameters

Abstract :
The mechanical properties, especially the strength of a component under cyclic loading, depend on factors such as the chosen material, component geometry and manufacturing history. In Laser Powder Bed Fusion (LPBF), metal powder is deposited and selectively melted using focused laser radiation. The properties of additively manufactured components exhibit a strong dependence on process-related conditions, such as component position and orientation within the build space, or the chosen process parameters. In particular, the density, type and distribution of defects show a significant variability depending on parameter selection, which in turn has a notable impact on the mechanical properties of the components. Present work focuses on fatigue strength, as many mechanical components undergo cyclic stress, which is particularly sensitive to internal defects. Especially the position on the build platform shows a significant impact on the mechanical properties.

Innovative Aspect(s) :
Additively manufactured components, unlike conventionally produced ones, offer several advantages such as increased geometric freedom and reduced material consumption. However, to fully harness these benefits, it is important to understand the failure mechanisms inherent in this relatively novel manufacturing technology. This knowledge is essential for designing and calculating components for use under cyclic loading. This study elucidates the failure mechanisms of components produced using this additive manufacturing technology, aiming to ensure their future designs are robust and secure.

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 : C22
ID : 6282865

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Dr Tobar Maria Jose (Universidade Da Coruña, Spain)

Co-author(s) : Dr Amado Jose Manuel (Universidade Da Coruña, Spain); Dr Luaces Alan (Universidade Da Coruña, Spain); Dr Yañez Armando (Universidade Da Coruña, Spain)

Title : Characterization Of Compositionaly Graded A316L|Inconel 625 Profiles Manufactured By Laser Direct Energy Deposition Using Different Powder Morphologies

Keyword(s) :
AM, Laser DED, Inconel 625, 316L, Functionally Graded Material, Multimaterial

Abstract :
Multimaterial additive manufacturing allows to obtain near-net-shape components with local customized properties. Combining different alloys, significant increased life service, functionality and cost savings are to be expected if mechanical, thermal, electric|magnetic properties can be tailored to specific demands. The laser DED technology provides with a natural environment for multi-material manufacturing with steels and high performance alloys. They can be mixed along the process with custom mixing ratios, although this is usually performed by developing compositionally graded interfaces between different materials. As when processing single alloys, laser DED deposits often suffer from known detrimental features as porosity, micro-segregation, cracks and|or directional grain growth. In this work this features will be examined in compositional graded A316L|Inconel 625 laser DED samples manufactured with powders from different providers. It will be analysed whether the morphology or minor elemental composition of the powders might influence the microstructure and mechanical characteristics of the deposited material.

Innovative Aspect(s) :
Features as the porosity, micro-segregation and directional grain growth of the metallic deposits obtained will be compared.But AM offers a unique feature: which is the capability of producing multi-material parts. This means that the final AM product would not only be a near-net-shape component but also had local customized properties, adapted to specific needs. The ability to readily combine metallic| metal-ceramic|ceramic materials in a single piece will deploy all its benefits when applied to high demanding industries. Significant increased life service and functionality is to be expected in components if mechanical, thermal, electric|magnetic properties can easily be tailored to specific demands. Obvious examples could be the combination of hard ceramics for thermal and wear resistance with structural metals easily machined. Or high performance and expensive alloys combined with cheaper support materials.The laser DED technology provides with a natural enviroment for multi-material manufacturing with high performance alloys.

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 : C24
ID : 6283184

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Dr Tobar Maria Jose (Universidade Da Coruña, Spain)

Co-author(s) : Dr Amado Jose Manuel (Universidade Da Coruña, Spain); Ing Luaces Alan (Universidade Da Coruña, Spain); Dipl-Ing García Garazi (Universidade Da Coruña, Spain); Dipl-Ing Aourdou Ali (Universidade Da Coruña, Spain); Dr Yañez Armando (Universidade Da Coruña, Spain)

Title : Laser-DED Of WC-Ni Composites: Functionally Graded Deposition And Tribological Performance

Keyword(s) :
AM, Laser DED, Tungsten Carbide, Metal Matrix Composite, Functionally Graded Material, Multimaterial

Abstract :
This study examines the laser deposition process for functionally graded WC-Ni metal matrix composites, employing in-flight powder mixing to concurrently incorporate tungsten carbide (WC) and a nickel-based alloy. The research systematically assesses how variations in WC percentage and deposition strategy impact the resulting microstructure and mechanical properties of the fabricated composites.

Innovative Aspect(s) :
The present study focuses on the laser deposition of functionally graded WC-Ni metal matrix composites, employing advanced Additive Manufacturing (AM) Laser-DED technology. Noteworthy innovations include the exploration of multimaterial capabilities, allowing the simultaneous integration of tungsten carbide (WC) and a nickel-based alloy. The introduction of in-flight powder mixing enhances homogeneity, contributing to improved integrity and performance. Graded deposition strategies, featuring variations in WC percentage, offer controlled transitions in material properties, presenting opportunities for tailored mechanical and tribological characteristics. Beyond the fabrication process, the study emphasizes practical applications, particularly in wear and tribocorrosion resistance. Overall, these innovations advance material design possibilities and hold promise for diverse applications requiring specialized metal matrix composites

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 : C26
ID : 6282627

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Ms Mkhaliphi Thuli (Stellenbosch University, South Africa)

Co-author(s) :

Title : Suitable Laser Scanning Strategy For Producing Ti-4.7Mo-4.5Fe Alloy Using Laser Powder Bed Fusion

Keyword(s) :
Laser Powder Bed Fusion, Selective Laser Melting, Scanning Strategy, Ti-4.7Mo-4.5Fe, Mechanical Properties, In-Situ Alloying, Low-Cost Titanium Alloys

Abstract :
In laser powder bed fusion, the quality and material properties of the built part depend on process parameters such as the employed laser scanning strategy. For this study, the investigation focused on determining the optimal laser scanning strategy for producing Ti-4.7Mo-4.5Fe alloy using laser powder bed fusion. Cylindrical and tensile testing samples were printed with three scan patterns: a line scanning strategy with a 67° rotation, a chessboard pattern, and a cross-striped scanning strategy with a 45° rotation. The initial results indicated that the different scanning strategies produced samples with a relative density >99% and hardness ranging between 380 and 420 HV. The samples produced using the chessboard pattern demonstrated the highest porosity and lowest hardness. The microstructure of the samples was investigated using a scanning electron microscope, an X-ray diffractometer and a micro-diffraction instrument. The ultimate strength, % elongation and Young's modulus were also determined for the samples

Innovative Aspect(s) :
The paper will provide insight into the optimum parameters to produce the novel Ti-4.7Mo-4.5Fe alloy using laser powder bed fusion, as research regarding additive manufacturing of this alloy is still in its infancy. Most published research regarding this alloy is related to conventional processing methods.

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 : C27
ID : 6283756

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Mr Nagaram Anok Babu (Chalmers University of Technology, Sweden)

Co-author(s) : Mr Mahoney Phillip (GE Additive (ARCAM EBM), Sweden); Mr Algardh Joakim (GE Additive (ARCAM EBM), Sweden); Prof Nyborg Lars (Chalmers University of Technology, Sweden); Prof Hryha Eduard (Chalmers University of Technology, Sweden)

Title : Effect Of Microstructure On Thermal And Electrical Conductivity Of Pure Copper Produced Via Powder Bed Fusion-electron Beam (PBF-EB)

Keyword(s) :
Additive Manufacturing (AM), Powder Bed Fusion-Electron Beam (PBF-EB), Pure Copper, Point Melt, Thermal And Electrical Conductivity

Abstract :
The outstanding thermal and electrical conductivity characteristics of pure copper renders it a highly desirable material for diverse applications such as electronics, heat exchangers and electric motor components. The capability of fabricating intricate geometries using additive manufacturing (AM) technology, makes it a well-suited for heat exchangers. Powder bed fusion-electron beam (PBF-EB) exhibits relatively low reflectivity for pure copper compared to powder bed fusion-laser beam (PBF-LB). In this work the influence of microstructure, and component density on thermal and electrical conductivity of pure copper are investigated. Copper samples were fabricated using virgin and recycled powders with different processing parameters and printing strategies, namely hatch and point melt. Results indicates that employing point melt yields a relative density of about 99.9%, while achieving twice the productivity compared to hatch melt. Deviations in the conductivity properties observed using specific geometry samples highlights the influence of measurement directions, emphasizing the crucial role of microstructure.

Innovative Aspect(s) :
This paper focusses mainly on the specific printing strategy, namely point melt. It involves selectively melting specifiic spots within a powder bed using an electron beam, allowing for the fabrication of intricate and complex geometries with foremost details. The precision of point melt contributes to efficiency and productivity in the manufacturing process. Furthermore, point melt results in improved microstructure and better mechanical properties, thus enhancing the thermal and electrical conductivity of pure copper.

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 : C28
ID : 6282705

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Dr Ing Heikkilä Irma (Swerim AB, Sweden)

Co-author(s) : Mr Gustavsson Oliwer (Swerim AB, Sweden); Dr Ing Blackwell Cameron (MTC Ltd., United Kingdom); Dr Ing Chroztek-Mroz Aneta (MTC Ltd., United Kingdom); Dr Ing Meisnar Martina (ESA, United Kingdom); Dr Ing Pambaguian Laurent (ESA, United Kingdom); Dipl-Ing Karlsson Oskar (Swerim AB, Sweden); Dr Ing Heikkilä Irma (Swerim AB, Sweden)

Title : Evaluation Of The Mechanical Strength Of AlSi10Mg Manufactured By Laser Powder Bed Fusion -- The Impact Of The Laser Contour Strategy

Keyword(s) :
Contour, AlSi10Mg, L-PBF, Mechanical Strength, Design Of Parts

Abstract :
The mechanical strength of laser power bed fusion (L-PBF) of AlSi10Mg is correlated to a fine hierarchical microstructure formed during the repeated layer-by-layer melting guided by a digital model. The microstructure of the surface area of the L-PBF parts is often different to that of the bulk material as specific laser contouring strategies are applied at the surface areas. However, the evaluation of the mechanical strength is frequently made on machined tensile specimens where the microstructure of the surface area is removed. In this investigation two different AlSi10Mg powders are processed by two bureaus, each having different contouring strategies. Mechanical testing is conducted with machined and contoured specimens. The microstructure and fracture surfaces of four materials is studied. The results show that the mechanical strength of the contoured specimens is slightly lower than the one of the machined specimens and has a correlation to the microstructure at the contour areas.

Innovative Aspect(s) :
The necessity of designing L-PBF parts taking into consideration the most realistic material data i.e. including the potential adverse impact of a contour.

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 : C30
ID : 6282740

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Mr Großwendt Felix (Ruhr-Universität Bochum, Germany)

Co-author(s) : Mr Hantke Nick (Ruhr-Universität Bochum, Germany); Prof Dr Sehrt Jan (Ruhr-Universität Bochum, Germany); Prof Dr Weber Sebastian (Ruhr-Universität Bochum, Germany); Dr Ing Lentz Jonathan (Ruhr-Universität Bochum, Germany)

Title : Increasing Chemical Homogeneity In In-situ Alloying In Laser Powder Bed Fusion Of Metals By Targeted Raw Material Selection

Keyword(s) :
Laser Powder Bed Fusion, Powder Mixing, In-Situ Alloying, Chemical Homogeneity

Abstract :
Many commercial alloys suffer from defect formation like cracking during laser powder bed fusion owing to high cooling rates. To provide a variety of starting materials adapted to laser powder bed fusion and specific applications, mixing powders, known as in-situ alloying, using a modular powder design set is a promising approach. Unfortunately, in-situ alloying promotes chemically inhomogeneous components. In this work, different powder mixtures were analyzed and processed to obtain a carbon steel of a specified composition. The samples were characterized microstructurally applying several methods and compared to a pre-alloyed reference. The chemical homogeneity is statistically assessed employing fast first-order variograms. The composition of the individual raw materials was found to be critical for homogenization within the melt pool. Large scale homogenization is also affected by the amount of raw material added. Almost complete in-situ homogenization has been achieved in laser powder bed fusion by careful selection of raw materials.

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 : C31
ID : 6282914

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Mr Koob Jonas (Institute for Materials Applications in Mechanical Engineering, RWTH Aachen University, Germany)

Co-author(s) : Mr Mirz Markus (Institute for Materials Applications in Mechanical Engineering, RWTH Aachen University, Germany); Ms Scheck Marie Luise (Institute for Applied Powder Metallurgy and Ceramics at RWTH Aachen e. V., Germany); Dr Ing Kaletsch Anke (Institute for Materials Applications in Mechanical Engineering, RWTH Aachen University, Germany); Prof Dr Broeckmann Christoph (Institute for Materials Applications in Mechanical Engineering, RWTH Aachen University, Germany)

Title : Influence Of The Process Atmosphere On The Microstructure And Impact Toughness Of PBF-LB|-EB AISI 318LN Duplex Stainless Steel

Keyword(s) :
Laser-Based Powder Bed Fusion, Electron-Beam Powder Bed Fusion, Duplex Stainless Steel, Toughness, Mechanical Properties

Abstract :
Duplex stainless steels (DSSs) exhibit excellent mechanical properties due to their austenitic-ferritic microstructure, which, for example, leads to higher impact toughness compared to fully ferritic steels. The phase equilibrium is dependent on solidification conditions and chemical composition, with elemental nitrogen stabilizing the austenitic phase. To better understand the influence of process gases during processing by laser-based powder bed fusion (PBF-LB) on microstructure and mechanical properties, in this study, DSS AISI 318LN was processed with PBF-LB with different shielding atmospheres (argon and nitrogen) and subsequently, some of the samples were hot-isostatically post-densified before final heat treatment. The impact toughness of the different conditions was tested and complemented by microstructural- and fractographic analyses. To completely exclude the influence of process gases, samples were also built up by electron-beam powder bed fusion (PBF-EB) under vacuum as a reference and subjected to the same post-processing strategies for comparison with the samples produced by PBF-LB.

Innovative Aspect(s) :
PBF-LB is a well-established manufacturing process for stainless steels with the most commonly employed types being austenitic or martensitic grades. However, the influence of PBF-LB-process characteristics on the microstructure and mechanical properties of duplex stainless steels has rarely been investigated. This study expands the knowledge by investigating process-gas-induced differences in DSS manufactured under argon and nitrogen protective atmosphere.

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 : C121
ID : 6276182

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Mr Bemani Lirgeshas Milad (Eurecat, Technological center of Catalunya, Spain)

Co-author(s) : Mr Sjöström William (Mid Sweden University, Sweden); Dr Casellas Daniel (Eurecat, Technological center of Catalunya, Spain); Dr Botero Carlos (Mid Sweden University, Sweden); Prof Dr Das Raj (RMIT university, Australia); Dr Molotnikov Andrey (RMIT university, Australia); Prof Dr Mateo Antonio (UPC university, Spain); Dr Parareda Sergi (Eurecat, Technological center of Catalunya, Spain)

Title : Applicability Of The Stiffness Method To Discern The Effect Of Surface Roughness On The Fatigue Behavior Of Additive Manufacturing Specimens

Keyword(s) :
Additive Manufacturing, Fatigue Strength, Stainless Steel, Surface Roughness, Stiffness Method

Abstract :
Surface roughness of the additively manufactured (AM) parts can reduce the service life, especially under dynamic loadings due to promoting fatigue by providing initiation sites for fatigue cracks. Therefore, improving the surface condition of AM specimens is a solution to increase the fatigue strength. The stiffness method as a rapid fatigue test could obtain fatigue limit values close to those of the conventional test methods more cheaply and easily. Therefore, this work aims to investigate the effect of surface roughness on the fatigue behavior of stainless steel AISI 316L specimens, printed with the laser powder bed fusion (PBF-LB|M) and electron beam powder bed fusion (PBF-EB|M) techniques, with different contour parameters to obtain different surface roughness values using the stiffness method. The competitional effect of the internal defects, which become surface defects after machining, and the surface roughness of the as-built specimen are also addressed based on the stiffness method results.

Innovative Aspect(s) :
This work aims to investigate the effect of surface roughness on the fatigue behavior of AM specimens, measured using the stiffness method which is a novel rapid fatigue testing method. Stainless steel AISI 316L specimens, printed with the laser powder bed fusion (PBF-LB|M) and electron beam powder bed fusion (PBF-EB|M) techniques and with different contour parameters are used to investigate the competitional effect of the internal defects, which become surface defects after machining and polishing, and the surface roughness of the as-built specimen more cheaply and easily and with reduced number of specimens using the novel stiffness method. this innovative fatigue testing method enables the researchers to obtain valuable information about the fatigue behavior of AM parts, effective parameters and their effect on fatigue strength, and ways to improve it in a much faster, easier, and cheaper way and only with 2-3 specimens.

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 : C332
ID : 6300683

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** AM Beam Based Technologies

Author : Mr Canillas Francisco (CIEMAT, Spain)

Co-author(s) : Dr Ordás Nerea (CEIT, Spain); Dr Urionabarrenetxea Ernesto CEIT, Spain); Dr Roldán Marcelo (CIEMAT, Spain); Dr Cardozo Evelin (CEIT, Spain); Dr Bloem Carlos (AIDIMME, Spain); Dr León-Gutiérrez Edgar (CIEMAT, Spain)

Title : Advances In Powder Bed Fusion Electron Beam (PBF-EB) Of CuCrZr: Achieving Optimal Microstructure And Mechanical And Thermal Performance

Keyword(s) :
Additive Manufacturing, Powder Bed Fusion Electron Beam (PBF-EB), CuCrZr Alloy, Transmission Electron Microscopy (TEM), Mechanical Properties

Abstract :
CuCrZr is a precipitation-hardened copper alloy that combines high thermal conductivity and mechanical strength, along with thermal stability up to 350 °C.In this work we demonstrate the feasibility to obtain dense Cu-(0.6-0.9)Cr-(0.07-0.15)Zr (in wt.%) with densities of 99.5%, high thermal conductivity (>80-85% IACS) and enhanced mechanical strength compared to pure Cu, already in the as-built condition, using Powder Bed Fusion Electron Beam (PBF-EB). Further densification was achieved after HIP. Mechanical characterization showed outstanding results, similar or even superior to those reported in the literature for conventional wrought CuCrZr. Microstructural analysis by SEM, EBSD and TEM revealed a multi-scale hierarchical microstructure of ultra-fine Cr-rich precipitates as well as grain and subgrain boundaries, contributing to the excellent mechanical properties achieved. The microstructural stability of the CuCrZr alloy was evaluated by heat treatments in the range of 350 – 500 °C for up to 1080 hours.

Innovative Aspect(s) :
Additive Manufacturing (AM) can offer invaluable benefits in the production of CuCrZr components by avoiding certain welding operations and developing net-shape components, a crucial feature in the manufacturing of the complex structrures of heat exchangers or heat sinks. In addition, PBF-EB overcomes many of the difficulties faced when processing alloys with high reflectivity and thermal conductivity, by Powder Bed Fusion Laser Beam (PBF-LB). This work do not only summarises the parametric study to achieve dense CuCrZr free from deffects (pores or cracks), but it also highlights the role of suitable post-build heat treatment conditions to achieve a good compromise between thermal conductivity and mechanical strenght. In addition, the evaluation of properties as a function of Cr and Zr concentration demonstrates that tayloring the composion of the gas atomized powders can be a powerful tool to further improve the mechanical strength.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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