EURO PM2024 CONGRESS & EXHIBITION

Technical Programme Committee
8th of February 2024

ABSTRACTS BOOK

GROUP 6 - CONSOLIDATION TECHNOLOGIES

EPMA
european powder metallurgy association

EURO PM2024

CONGRESS & EXHIBITION

Technical Programme Committee

8th of February 2024

CONSOLIDATION TECHNOLOGIES

FIELD ASSISTED SINTERING TECHNOLOGIES

EPMA

european powder metallurgy association

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

Paper Number : C61
ID : 6202215

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Ing Karpowicz Damian (GeniCore Sp. z o.o., Poland)

Co-author(s) :

Title : Hybrid Field Assisted Sintering As An Semi-automated Process For Cost-effective Production Of High Quality Big Volume Samples

Keyword(s) :
Fast Hybrid SPS Sintering

Abstract :
Field assisted sintering called also spark plasma sintering allow to produce exceptional quality materials which found a niche in applications where the quality is a most important factor or making the product with different method is impossible. GeniCore would like to present a new type of HYBRID FAST system which combines FAST type DC power supply with induction heating provided by AC power supply where novelty is oriented on assuring the extraordinary heating rates even for very big samples volume. Such a solution guarantees that FAST technology main advantage which is limiting the grain grow will affect the sample quality which has been challenging in previous solution.

Innovative Aspect(s) :
The presentation will refer to the applications where previously FAST method was inefficient or impossible to imply due to expected product volume. This can refer to the military, aerospace and energy applications. The second novelty is related with eddy current impact on the sintering with FAST technology for big volumes where using a different frequencies can generate a various results and when used properly lead to great energy savings or enhancing the material quality.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : C62
ID : 6268565

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Ing Karpowicz Damian (GeniCore Sp. z o.o., Poland)

Co-author(s) :

Title : Upgraded Field Assisted Sintering Technology Latest Devices And Applications

Keyword(s) :
Spark Plasma Sintering, SPS, FAST, Field Assisted Sintering Technology, U-FAST, Upgraded Field Assisted Sintering Technology, Latest SPS Device, Latest SPS Applications

Abstract :
Field assisted sintering technology become a good alternative for most demanding applications. During the presentation most recent examples of materials made with FAST and PPC technology will be presented and solutions which allows to compete with other technologies when it comes for cost-effectiveness which in most cases is the biggest disadvantage for FAST|SPS technology. Presentation includes descriptions of solutions like graphite mold multi-hole design, near-net shaping, functionally graded materials. The current market expectations related with FAST technology will be shown on real examples.During the presentation also the new types of SPS devices will be presented to prove SPS techology can be used in bigger volume production.

Innovative Aspect(s) :
The article focuses on device technologies that affect the ability to not only achieve new types of results when it comes to sintering materials, but also enable the transition from research and development to the industrial world. New materials and increased material quality are key to scientific progress, and this article will show the tools that help create them.

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 : C63
ID : 6276973

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Dr Fregeac Arnaud (NORIMAT, France)

Co-author(s) : Dr Epherre Romain (NORIMAT, France); Dr Mackie Jennifer (NORIMAT, France); Ing Beynet Yannick (NORIMAT, France); Dr Ing Larignon Céline (NORIMAT, France)

Title : FAST|SPS: Industrial Post-process For Full Densification Of 3D Complex Shape From Additive Manufacturing

Keyword(s) :
FAST|SPS, Complexe Shape, Additive Manufacturing, High Mechanical Performance

Abstract :
The FAST|SPS process is recognized as an R&D method capable of producing high-performance parts from a wide range of materials. In recent years, significant progress has been made in overcoming the two main constraints of the technology: production capacity and geometric limitations, thanks to important advances in research and technology.This conference will focus on the progress made in the production of dense 3D complex shapes using FAST|SPS. An innovative and versatile approach, combining additive manufacturing and FAST|SPS, will be presented, along with original use cases involving various ceramic and metallic materials designed for applications in the aerospace, space, or defense sectors. Numerical tools to define the green part, chemical analisys and mechanical properties of the 3D parts will also be presented.

Innovative Aspect(s) :
Norimat made an important industrial breakthrough by developing a unique and easy process which enables the consolidation of 3D complex shapes by SPS. It allows to fully densify (porosity <1%) green parts made from additive manufacturing just after printing in only one step and less than 1h of thermal treatment. The debinding of the green parts made of AM has been optimized and is in situ realize in the FAST|SPS process. That's allowed to limit the thermal treatment time and to enhance the quality of the part in terms of chemistry and deformation. Moreover, the first FAST|SPS software suite dedicated to the FAST|SPS process has been developed to help the users with all aspects of SPS, from R&D (Digital Twin) to production monitoring (Statistical Process Control). Numerical simulation has ensured that thermal gradients during sintering of 3D parts are kept to a minimum.

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 : C64
ID : 6278593

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Mr Weber Gerhard (Dr. Fritsch Group, Germany)

Co-author(s) :

Title : Sintering Of Ceramic Material On FAST|SPS-machines

Keyword(s) :
FAST|SPS-Sintering of ceramics, Graded Ceramics, Mould Set-up

Abstract :
The FAST-SPS-sintering of metallic materials is state of the art since a long time. One huge application there is the diamond tool industry. Recently, there were numerous approaches to sinter ceramic materials also with this technology to benefit of the many advantages of the FAST-SPS. However, the sintering of ceramics is much more challenging. The lack of electrical conductibility, the brittleness of the material and the reaction with the mould material is making fast results difficult.This paper will address several materials like B4C, Al2O3, ZrO2 TiB2 and some more. Furthermore, it will look into different Applications like Defense Industry, Sputter Targets, Jewelry and Electronic Industry.Also, the paper will have a look at graduated materials and heterogenic materials, e.g. bonding of ceramic powders onto metallic surfaces.

Innovative Aspect(s) :
FAST|SPS-sintering of ceramic materials Graded ceramic materials Metallic-ceramic-bonding by FAST|SPS

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 : C66
ID : 6280921

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Ing Sauceda Martínez Sergio (Departamento de Ingeniería de Materiales, Universidad de Concepción, Chile)

Co-author(s) : Dr Ing Arévalo Mora Cristina (Universidad de Sevilla, Spain); Dr Ing Lascano Farak Sheila (Departamento de Ingeniería Mecánica, Universidad Técnica Federico Santa María, Chile); Dr Montealegre Melendez Isabel (Universidad de Sevilla, Spain); Dr Perez Soriano Eva Maria (Universidad de Sevilla, Spain); Ing Pedrosa Fernández Pablo (Universidad de Sevilla, Spain); Ing Machuca Lorca Ayelén (Departamento de Ingeniería Mecánica, Universidad Técnica Federico Santa María, Chile); Ing Chávez Vásconez Ricardo (Departamento de Ingeniería Mecánica, Universidad Técnica Federico Santa María, Chile); Ing Oropesa Márquez Yovany (Departamento de Ingeniería de Materiales, Universidad de Concepción, Chile); Dr Ing Araya Rivera Nicolás Ignacio (Departamento de Ingeniería de Materiales, Universidad de Concepción, Chile)

Title : A Comparison Between Spark Plasma Sintering (SPS) And Rapid Sinter Pressing (RSP) For Sintering Of W-Cu Composites At Low Temperature

Keyword(s) :
Metallic Composites, W-Cu, Field Assisted Sintering Technology|Spark Plasma Sintering, Rapid Sinter Pressing

Abstract :
Applications demanding exceptional electrical and thermal conductivity under extreme conditions, such as high-power contacts or nuclear fusion reactors, frequently rely on W-Cu composites. Powder metallurgy serves to create this type of material with distinct melting points; however, there is a discussion in the literature about the most suitable powder metallurgy techniques. Spark Plasma Sintering (SPS) and Rapid Sintering Process (RSP) propose the creation of materials within minutes and at lower temperatures on an industrial scale. This study undertakes a comparative analysis of two different sintering techniques at 600°C, while varying the pressure and sintering time for W-Cu samples containing 25% and 75%wt of W. The findings showed that the materials' density, hardness, and electrical conductivity are significantly affected by the applied pressure during sintering, particularly in the case of the SPS technique. Furthermore, in SPS and RSP, with even minor increments in sintering time results in improved properties.

Innovative Aspect(s) :
This paper compares two non-traditional sintering methods for manufacturing metallic compounds, intending to select the most suitable for industrial scaling and studying the benefits of the sintering principles of each technique on their microstructure and final properties in W-Cu 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 : C67
ID : 6280685

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Prof Dr Bram Martin (Forschungszentrum Jülich, Germany)

Co-author(s) : Dipl-Ing Keszler Monica (Forschungszentrum Jülich, Germany); Dipl-Ing Großwendt Felix (Ruhr-Universität Bochum, Germany); Dipl-Ing Assmann Anna-Caroline (RWTH Aachen University, Germany); Prof Dr Guillon Olivier (Forschungszentrum Jülich, Germany); Prof Dr Weber Sebastian (Ruhr-Universität Bochum, Germany)

Title : Application Of Field Assisted Sintering For The Recycling Of Steel Swarf

Keyword(s) :
Field Assisted Sintering, FAST|SPS, Steel Swarf, Circular economy

Abstract :
The grinding of steel tools to their desired form generates sludge containing metallic swarf considered undesirable for direct recycling. After cleaning and separation of this steel swarf, its morphology often leaves it unsuitable for standard powder metallurgical uses. However, the possibility exists of utilizing field assisted sintering techniques to densify this swarf directly into new parts, thereby avoiding the need for remelting. This technique also allows for the generation of new metal matrix composites through its quick sintering time. The application of field assisted sintering as a recycling tool is realized through the densification of two different steels, AISI D2 and AISI T15, exploring the influence of varied parameter sets and tool setups on their sintering. For proof of concept, a cutting disc made of AISI D2 swarf has been produced and tested.

Innovative Aspect(s) :
Direct recycling of metallic grinding waste, Demonstration on the example of steel swarfCutting disc for proof of concept, Preservation of critical elements like W or CoCircular economy

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 : C68
ID : 6281891

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Dr Ing Daudt Natalia (UFSM, Brazil)

Co-author(s) : Ing Noal Alves Sergio (UFSM, Brazil); Dr Ing de Lima Dalton Daniel (UFSM, Brazil); Prof Dr Limberger Inacio (UFSM, Brazil)

Title : Ultra-fast High Temperature Sintering (UHS) Of Ni-NiO Composites

Keyword(s) :
UHS Sintering, Ni Alloys, Metal Matrix Composites

Abstract :
Powder metallurgy and sinter-based additive manufacturing are cost effective routes for manufacturing high value metal alloys and metal matrix composites such as Ni based alloys used in the aerospace and energy industries. Despite the development of these manufacturing techniques in recent years, the sintering step remains a challenge due to its high energy consumption and long dwell times. Ultrafast High Temperature Sintering (UHS) has emerged as an alternative capable of sintering metal alloys in just a few seconds. In this study, we evaluate the UHS sintering of Ni-NiO composites. The effects of UHS current and dwell time on the microstructure and mechanical properties of Ni-NiO was investigated. UHS should facilitate the development and manufacture of metal alloys and composites from metal powders.

Innovative Aspect(s) :
UHS sintering is very recent technology. First, UHS sintering reports were published in 2020. To our best knowledge this is the first time the technology was applied to Ni alloys and it is the first time the mechanical properties of alloy processed by this technology was investigated. This is an important step to drive the UHS to applications.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : C69
ID : 6281338

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Dr Rajaei Hossein (University of Trento, Italy)

Co-author(s) : Prof Molinari Alberto (University of Trento, Italy); Dr Ángel Lagos Miguel (Tecnalia, Spain); Dr Agote Iñigo (Tecnalia, Spain); Dr Ferrari Daniele (Dellas, Italy); Dr Dai Pré Marta (Plumake, Italy)

Title : Comparative Study Of FAST And Conventional Sintering Of Cutting Tool Materials

Keyword(s) :
FAST, X-ray Diffraction, Phase Characterization, Cutting Tools, Cobalt, Bronze

Abstract :
This study explores the effectiveness of Field Assisted Sintering Technology (FAST) in producing cutting tools from various materials, using powder mixes in granulated and non-granulated conditions. The goal is to demonstrate FAST efficiency across diverse materials by comparing results obtained on the same systems using a conventional sintering approach. Two powder mixtures were examined: one consisting of Bronze, containing: Co, Fe, and W; and a Co|Bronze 85|15 powder mix. Sample characterization involved Rietveld refinement of X-ray diffraction patterns coupled with microstructural analysis using SEM and EDXS. The study revealed that the sintering process significantly influenced microstructural characteristics. The FAST process maintained a consistent ratio of starting phases, unlike conventional sintering prone to reactions, diffusion, and intermetallic compound formation. Conventional sintering of the Bronze-Co-Fe-W material resulted in a lattice expansion in cobalt polymorphs with respect to the starting powder. FAST samples showed a lower volume change, due to short sintering time.

Innovative Aspect(s) :
The current manufacturing process of these parts takes several hours and is inefficient in terms of energy and material consumption. The new process will manufacture components in few seconds, allowing to obtain final parts with less energy consumption and minimum raw material wastage (it is a near net shape process); thus, contributing to the green manufacturing and environmental footprint reduction.

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 : C71
ID : 6281353

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Dr Sicard Damien (Sintermat, France)

Co-author(s) : Prof Bernard Frederic (University of Burgundy, France); Dr Naimi Foad (Sintermat, France); Dr Ariane Mostapha (Sintermat, France)

Title : Toward A Spark Plasma Sintering Digital Twin Using A Deep Learning-Based Approach

Keyword(s) :
Deep Learning, Digital Twin, Spark Plasma Sintering

Abstract :
Over the last two decades, Spark Plasma Sintering (SPS) has become a major technique for manufacturing advanced materials. Nevertheless, the control of SPS process is complex and requires the use of complex multiphysics and multiscale numerical simulations. Nowadays, the emerging data-driven approaches such as Deep Learning have proven their effectiveness in many fields. Thus, we develop a Deep Learning architecture based on Convolutional Neural Network (CNN) and Generative Adversial Neural Network (GAN). The network is train on high-throughput macroscale FEM simulation maps and associated process parameter tabular data. The power of this approach lies on the ability of the network training process to be incrementally augmented by multivariate data such as real microstructure images and real sintering signals : toward a SPS digital twin.

Innovative Aspect(s) :
The innovative aspect of the paper lies in the usage of artificial intelligences algorithms such as Deep Learning to build a Spark Plasma Sintering Digital Twin. In this purpose, a custom neural network architecture was built to allow a training on multivariate Spark Plasma Sintering Data.

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 : C72
ID : 6274524

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Mr Carlucci Giovanni (Politecnico di Milano, Italy)

Co-author(s) : Mr Ferrario Edoardo (Politecnico di Milano, Italy); Mr Bianchi Andrea (University of Pavia, Italy); Ms Maranini Giulia (University of Pavia, Italy); Dr Coduri Mauro (University of Pavia, Italy); Prof Anselmi-Tamburini Umberto (University of Pavia, Italy); Prof Casati Riccardo (Politecnico di Milano, Italy)

Title : Microstructural And Mechanical Characterization Of A Spark Plasma Sintered Al-Containing Refractory High-Entropy Alloy

Keyword(s) :
Refractory High-Entropy Alloys, Spark Plasma Sintering, Powder Metallurgy, Alloy Design, Microstructure, Mechanical Properties

Abstract :
Over the past decade, refractory high-entropy alloys (RHEAs) have been intensively studied due to their excellent high-temperature performances. Significant effort was dedicated to reducing their density, aiming to make them competitive with Ni-based superalloys. However, RHEAs are typically produced through casting methods, which, given the high melting temperatures of their constitutive elements, may lead to inhomogeneous and coarse microstructures, thereby compromising their mechanical properties. Given this context, powder metallurgy would be a preferable route for manufacturing high-performing RHEA components. In this study, spark plasma sintering was employed to produce the biocompatible MoNbTaTiZr RHEA, later modified with the addition of aluminum to reduce its density. The microstructure and the mechanical properties of both alloys were investigated. Eventually, a component with a gradient of aluminum through its thickness was also manufactured by a diffusion couple, allowing a more in-depth investigation on the effect of aluminum content on the properties of the RHEA.

Innovative Aspect(s) :
In this work, to the best of our knowledge, the microstructure and the mechanical behavior of a spark plasma sintered AlMoNbTaTiZr RHEA were investigated for the first time. Furthermore, a compositionally graded material was employed to study in a novel way the effect of aluminum content on the properties of this alloy system. This identified SPS as a manufacturing process suitable for a high-throughput screening of the unexplored RHEA compositions.

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 : C73
ID : 6281368

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Ing Mathey Baptiste (Burgundy University, France)

Co-author(s) : Dr Naimi Foad (Sintermat, France); Dr Ariane Mostapha (Sintermat, France); Prof Dr Bernard Frederic (Burgundy University, France)

Title : Development Of Complex Shape Parts In Large Size By Spark Plasma Sintering

Keyword(s) :
SPS, Near Net Shape, Large Size Pieces

Abstract :
Spark Plasma Sintering (SPS) technology is well-known for allowing the elaboration of enhanced and high-performance materials by fine control of the microstructure. Nevertheless, Near Net shape parts (complex shape), monitoring control (test reliability) and scale-up (industrialisation) remain a technological challenge.In this study, we present the sintering of sputtered materials (B4C + additive, 316L, Al2O3, SiC+ additive) which are adapted for the production of large-sized and complex shape parts by SPS process. We focus on development of tooling solutions (solid tooling and deforming tooling) to obtain complex shape samples and to control the thermomechanical gradient. The choice of the sacrificial material in order to not affect the property of the targeted material is also investigated. Finally, all parameters are tested to achieve enhanced properties with the finest microstructure. This study aims to in a short time an industrial scale-up and flow production.

Innovative Aspect(s) :
This study aims to the development of access a large size complex shape in Spark Plasma Sintering. It's improving the choice to use different technology of forming Near Net shape piece (additive manufacturing or other technology) and combine classical tooling or adding mobile tooling to produce large sizes Near Net shape piece. This study aims to adapt tooling and Spark Plasma Sintering technology to access fine microstructure, high performance.

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 : P-C74
ID : 6269600

Requested presentation type : Poster Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Prof Grigoryev Evgeny (Merzhanov Institute of Structural Macrokinetics and Materials Science Russian Academy of Sciences, Russia)

Co-author(s) : Prof Goltsev Vladimir (NRNU MEPhI, Russia); Prof Osintsev Andrey (NRNU MEPhI, Russia); Dipl-Ing Kuznechik Oleg (SSI PMI, Belarus); Dr Chumakov Alexander (B.I.Stepanov Institute of Physics, Belarus); Dr Nikonchuk Irina (B.I.Stepanov Institute of Physics, Belarus); Prof Strizhakov Evgeny (DON STATE TECHNICAL UNIVERSITY, Russia); Prof Nescoromniy Stanislav (DON STATE TECHNICAL UNIVERSITY, Russia); Dipl-Ing Ageev Stanislav (DON STATE TECHNICAL UNIVERSITY, Russia)

Title : Features Of High-Voltage Consolidation Of Powder Materals

Keyword(s) :
High-voltage Electric Pulse Consolidation, Refractory Powder Materials, Electrothermal Processes, High-voltage Welding, Thermal Radiation, Pulse Photometry

Abstract :
The main features of the method of high-voltage consolidation of powder materials and the resulting advantages and limitations of this method are considered. The short duration of high-temperature exposure in the process of high-voltage consolidation makes it possible to preserve the structural-phase state of the initial powder material in the consolidated compact material The formation of the structure of a powder material during high-voltage consolidation is determined by processes of different scales occurring at interparticle contacts, in powder particles, in the bulk of the entire sample, and by the mutual influence of these processes. The high energy density in the particle contact zones leads to a local change in the state of aggregation of the powder substance in these zones. Along with the inhomogeneity of powder heating in interparticle contacts, a macroscopically inhomogeneous distribution of the current density in the volume of the consolidated sample is possible.

Innovative Aspect(s) :
The registration of electrothermal processes during high-voltage electric pulse consolidation of refractory powder materials makes it possible to establish the optimal parameters of high voltage consolidation for optimal structure in consolidated samples.

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 : P-C75
ID : 6276957

Requested presentation type : Poster Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Prof Ctibor Pavel (Ústav fyziky plazmatu AVCR, Czech Republic)

Co-author(s) : Dr Straka Libor (Faculty of electrical engineering CTU Prague, Czech Republic); Dr Lukac Frantisek (Ústav fyziky plazmatu AVČR, Czech Republic)

Title : Copper Oxides CuO And Cu2O Produced By Spark Plasma Sintering - Electrical Characterization

Keyword(s) :
CopperOxide, Dielectric Properties, Spark Plasma Sintering, Microstructure, Phase Composition, Photoconductance

Abstract :
Commercial powders made of two copper oxides were compacted by spark plasma sintering (SPS). Their dielectric properties were studied in a broad range of frequencies and temperatures. The relaxation phenomena were demonstrated. Microstructure and phase composition were studied, and phase purity was shown for CuO, whereas Cu2O was more sensitive to carbon contamination during SPS processing and also to the oxygen reduction. Influence of the SPS temperature on microstructure and electrical properties was described for both materials. The difference between them from the electrical standpoint was finally found to be not so dramatic as the stoichiometry indicates. Both materials exhibited photoinduced electrical conductance under visible light. This photoconductance had a persistent character and was studied during a long-term exposure.

Innovative Aspect(s) :
The dielectric properties of bulk CuO and Cu2O, as well as their photoconductance were studied more deeply than (worldwide) in the past. Photoconductance was demonstrated at first time.

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 : P-C76
ID : 6283678

Requested presentation type : Poster Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Ing Chávez-Vásconez Ricardo (Universidad Técnica Federico Santa María, Chile)

Co-author(s) : Mr Acevedo Nicolás (Universidad Técnica Federico Santa María, Chile); Dr Arévalo Cristina (Universidad de Sevilla, Spain); Ing Sauceda Martínez Sergio (Universidad de Concepción, Chile); Dr Ing Pérez Soriano Eva (Universidad de Sevilla, Spain); Prof Dr Torres Yadir (Universidad de Sevilla, Spain); Dr Ing Lascano Farak Sheila (Universidad Técnica Federico Santa María, Chile)

Title : Graded Porosity Structures In High Entropy Alloys: An Innovative Synthesis Approach Utilizing Space-Holder Technique And Pressureless Spark Plasma Sintering

Keyword(s) :
Field Assisted Sintering Technology, Functional Graded Porosity, High Entropy Alloys

Abstract :
A high entropy alloy (HEA) is an innovative alloying strategy, introduced recently in materials science research, that vastly increases the number of alloy systems that can achieve properties such as high strength, high ductility, and enhanced fracture toughness. Potential applications of HEAs include the aerospace field, where the requirements for high-temperature resistance alloys are pushing the HEAs, high-speed cutting tools, nuclear industry, hydrogen storage materials, and biomaterials. In these areas some of the applications require functionalisation of the structure by porous gradual distribution to reduce weight or add functional characteristics. In this work, a consolidation route to obtain graded porosity distribution (radial and longitudinal) in samples of HEAs based on TiNbTaHfMo is presented. This approach combines the use of pre-compaction process, temporary space holder and the sintering by Field Assisted Sintering Technology|Spark Plasma Sintering in a pressureless die to consolidate radial and longitudinal samples of HEAs based on TiNbTaHfMo

Innovative Aspect(s) :
A high entropy alloy (HEA) is an innovative concept introduced by Yeh in 2004, as an innovative alloying strategy that vastly increases the number of alloy systems that can achieve properties such as high strength, high ductility, and enhanced fracture toughness. Although high entropy alloys expand opportunities for discovering alloys, they present an important challenge related to long processing time. In this sense, non-conventional and novel sintering routes, such as spark plasma sintering (SPS), presents notable advantages that allow processing HEAs with tailored microstructure and properties. Exploring this method to obtain porous structures is non- conventional way to use spark plasma sintering process. To the best of our knowledge, there are no reports of Ti-Nb-Ta-Hf-Mo with functional graded porosity.

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 : P-C159
ID : 6281603

Requested presentation type : Poster Presentation

Topic : Consolidation Technologies **Subtopic :** Field Assisted Sintering Technologies

Author : Mr Chaaban Khalil (ICB, UMR 6303 CNRS|Université de Bourgogne, France)

Co-author(s) : Dr Ariane Mostapha (SINTERMAT SAS, France); Dr Szczepan Victor (Safran Tech, France); Dr Chateau-Cornu Jean-Philippe (ICB, UMR 633 CNRS|Université de Bourgogne, France)

Title : Material Approach And Modelling Of The Thermo-electro-mechanical Sintering Process For The Dimension Control Of Complex Shape Parts

Keyword(s) :
Modelling, Densification, Complex Shape, Spark Plasma Sintering

Abstract :
Spark plasma sintering (SPS) technology is used to sinter, in a very short time, a large range of materials. One of the challenges of using this process is to control the final dimension of complex shape parts. In order to predict the compaction of the powder during a SPS cycle, we develop numerical models which take into account several physical laws involved during the sintering such as granular rearrangement and creep behavior at high temperatures (viscoplasticity). In this study, the code is fitted on an experimental densification curve of a nickel-based superalloy and implemented via the Abaqus® software in a thermal-electrical-mechanical model of the SPS process. A comparison of the numerical outputs with the experimental data shows a good agreement. The results demonstrate the capability to simulate accurately the sintering of powder with a limited number of experimental adjusted parameters compared to literature and to decrease significantly simulation run-time.

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

Technical Programme Committee

8th of February 2024

CONSOLIDATION TECHNOLOGIES

HOT ISOSTATIC PRESSING

EPMA

european powder metallurgy association

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

Paper Number : C78
ID : 6219721

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Hot Isostatic Pressing

Author : Mr Magnusson Anders (Quintus Technologies AB, Sweden)

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

Title : Combining AM And HIP For Speed And Performance

Keyword(s) :
HIP|HPHT, AM Speed Printing, Possibilities, Pitfalls

Abstract :
AM (Additive Manufacturing) technology naturally benefits from HIP (Hot Isostatic Pressing) post processing to enhance reliability and mechanical properties for components in high risk, mission critical applications. In addition to this, the past few years have seen several investigations exploring the potential of combining AM and HIP, both for reducing time and cost of manufacturing, and for improving mechanical properties of AM builds. This in using innovative concepts such as speed, shell and LoF (Lack of Fusion) printing in combination with a final densification using HIP. This presentation aims to compile and highlight potential benefits, and pitfalls, using these innovative strategies for high volume AM manufacturing of high-performance components from different metal alloys.

Innovative Aspect(s) :
We offer a summary of current state for the possibilities and pitfalls of AM speed printing as seen from the HIP equipment manufacturers point of view including examples from the research community, cost savings calculations and do|do nots' for the strategy to work.

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 : C79
ID : 6275416

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Hot Isostatic Pressing

Author : Mr Ehrlin Niklas (Air Liquide, Sweden)

Co-author(s) :

Title : The Effect Of Hydrogen In The HIP Treatment Of Additive Manufactured IN718

Keyword(s) :
IN718, Hot Isostatic Pressing, Hydrogen Degradation, Surface OxideReduction

Abstract :
Hydrogen has a long history of being used as a reducing agent in many different types of heat treatments. So far, the wide application of hydrogen is limited to heat treatment processes that are in the range of atmospheric pressure. In this study, the use of hydrogen in hot isostatic pressing (HIP) was investigated and its influence on component properties was studied. By using a gas mixture with a low concentration of hydrogen in argon as the atmosphere gas in a HIP treatment of additively manufactured Inconel 718 test parts, there is a clearly visible reduction of surface oxides, compared to similar test parts HIP treated in the traditional atmosphere of 100% argon. A reduction of surface oxides could have a substantial impact on both the mechanical properties of the treated parts and on the further manufacturing steps in the production chain, where surface oxides might be problematic.

Innovative Aspect(s) :
By using a pre mixed gas containing 2.65% hydrogen in argon in HIP application, unwanted surface oxides can be reduced and even removed completly. This leads to HIP treated parts with a much more homogenous surface that can have substantial effect on the need of post processing such as polishing as well as yielding a more aestethic looking part after HIP'ing.

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 : C80
ID : 6281533

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Hot Isostatic Pressing

Author : Mr Jabir Hussain Ahmed Fardan (Chalmers University of Technology, Sweden)

Co-author(s) : Mr Gårdstam Johannes (Quintus, Sweden); Dr Brodin Håkan (Siemens Energy, Sweden); Prof Hryha Eduard (Chalmers University of Technology, Sweden)

Title : Taming The Cracks: Overcoming Strain Age Cracking In An Additively Manufactured Non-weldable Ni-base Superalloy Through HIP

Keyword(s) :
Strain Age Cracking, Non-Weldable Ni-Base Superalloy, Powder Bed Fusion - Laser Beam, Additive Manufacturing

Abstract :
Non-weldable Ni-base superalloys processed via powder bed fusion – laser beam (PBF-LB) exhibit high cracking susceptibility, particularly during heat treatment, owing to the formation of gamma prime (?') precipitates during the first solutioning heat treatment, leading to a cracking phenomenon called strain age cracking (SAC). CM247LC is a high ?' Ni-base superalloy that is particularly prone to SAC. SAC is detrimental and hinders the usage of components manufactured by PBF-LB. This study explores the utilization of hot isostatic pressing (HIP) to mitigate SAC and enhance recrystallization in CM247LC processed by PBF-LB. Two distinct HIP strategies, both conducted above the ?' solvus temperature, were employed. Findings indicate that tailored HIP processing is promising in effectively reducing SAC and enabling the successful heat treatment of this conventionally "non-weldable" Ni-base superalloy.

Innovative Aspect(s) :
The innovative aspect of the work is to study the impact of HIP strategies to control stain age cracking and to increase recrystallization. One of the HIP strategies were found to be better indicating that strain age cracking risk can be reduced in non-weldable Ni-base superalloys manufactured by powder bed fusion-laser beam.

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 : C81
ID : 6281909

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Hot Isostatic Pressing

Author : Prof Prikhodko Sergey (University of California Los Angeles, USA)

Co-author(s) : Dr Markovsky Pavlo (G.V. Kurdyumov Institute for Metal Physics of N.A.S. of Ukraine, Ukraine); Prof Dr Ivasishin Orest (G.V. Kurdyumov Institute for Metal Physics of N.A.S. of Ukraine, Ukraine); Dr Savvakin Dmytro (G.V. Kurdyumov Institute for Metal Physics of N.A.S. of Ukraine, Ukraine); Dr Stasyuk Olexandr (G.V. Kurdyumov Institute for Metal Physics of N.A.S. of Ukraine, Ukraine); Dr Oryshych Denis (G.V. Kurdyumov Institute for Metal Physics of N.A.S. of Ukraine, Ukraine)

Title : Titanium Based Laminates Made Using Blended Elemental Powder Metallurgy: Microstructure And Mechanical Behavior

Keyword(s) :
Titanium Alloy, Metal Matrix Composites, Layered Structure, Phase Composition, Microstructure, Mechanical Characteristics

Abstract :
Titanium-based laminates combining hard metal matrix composites (MMC) and ductile alloy layers are promising materials due to an improved set of mechanical and service characteristics. In present study the two and three-layered structures that combine MMC on the base of titanium alloy Ti-6Al-4V (Ti-64) reinforced with 5 to 40 % (vol.) of TiC or TiB particles and the layer made of the alloy Ti-64 were manufactured using press-and-sinter blended elemental powder metallurgy. The effect of processing parameters and amount of reinforcing phase on microstructure and mechanical behavior of these materials was analyzed. In addition, hot plastic deformation and hot isostatic pressing of laminates have been used to investigate the potential to improve their microstructure mechanical characteristics. It has been demonstrated that the structures made according to optimized processing parameters exhibit excellent protective performance in ballistic tests. Prospects for improving the structure and methods of making titanium-based laminates are discussed.

Innovative Aspect(s) :
Greater introduction of titanium to the industry can be achieved by reducing the cost of parts and significant improvement of their performance. A significant increase in the hardness of Ti composite made via powder metallurgy can considerably boost the use of Ti. High residual porosity may be unavoidable in composites made using blended elemental powder metallurgy when the reinforcement phase content exceeds 10%, but it can be significantly rectified by subsequent processing of composites using hot isostatic pressing, which considerably improves their hardness. The present study shows that it is possible to double the hardness of a titanium-based material without compromising its low specific weight.

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 : C109
ID : 6281171

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Hot Isostatic Pressing

Author : Prof Dr Araya Nicolás (Universidad de Concepción, Chile)

Co-author(s) : Ing Sauceda Sergio (Universidad de Concepción, Chile); Ing Oropesa Yovany (Universidad de Concepción, Chile); Dr Maril Marisol (Universidad de Concepción, Chile); Miss Contreras Javiera (Universidad de Concepción, Chile)

Title : Comparative Study Of Densification Of Fe-SiC Cermet Through Press And Sinter And Hot-pressing

Keyword(s) :
CERMETS, Sintering Techniques, Abrasive Wear

Abstract :
In CERMET material development, Co and W, due to their high cost and limited access, result in high cost and enviromental issues. Seeking a cost-effective alternative, the Fe-SiC system was explored, showing potential for developing wear resistant CERMETS. This study compared Fe-SiC CERMET produced via conventional sintering (CS) and Hot Pressing (HP). Samples with 50, 70 and 90 wt.% SiC were produced, but due to densification problems, the 90 WT.% SiC condition was quickly discarded. CS utilizing 5% PVA a binder faces densification challenges. To address this, 0.2% graphite was added, enhancing densification up to 80% but compromising mechanical properties at 1100°C. SEM analysis confirmed proper Fe dispersion around SiC particles and the formation of sintering necks, however CS lacked time for complete consolidation. On the other hand, hot-pressed samples were able to reach more than 90% densification. Microstructural and mechanical analysis show promising results for applications involving abrasive-wear resistance.

Innovative Aspect(s) :
CERMET production using Fe-SiC has been almost not explored. Somo authors have used this system to produce self-lubricating steel with up to 5 wt.% SiC and other author have sintered Fe with milimetric SiC particles for cutting tool applications but have not reached more than 75% densification. This study used 50, 100 and 150 microns SiC particles in order to develop a material with higher density an suited for abrasive wear applications.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : C141
ID : 6281542

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Hot Isostatic Pressing

Author : Dr Cox Erik (Gencoa Ltd, United Kingdom)

Co-author(s) : Dr Cox Erik (Gencoa Ltd77, United Kingdom)

Title : Optimisation Of Degassing Metal Powders With Optical Emission Spectroscopy

Keyword(s) :
Degas, Process Monitoring, Powder Analysis, Vacuum

Abstract :
Although time consuming, degassing of HIP canisters is a critical step in the manufacture of powder hot isostatic pressed components. Carried out effectively, this stage of the process enables high quality components to be produced by preventing the retention of atmospheric contaminants such as oxygen, nitrogen, hydrogen and argon which are responsible for defects leading to poor material performance.Gencoa Optix is a gas sensing instrument that can be utilised to monitor the level of contaminant gases such as water vapour, nitrogen, oxygen etc. Optix requires no additional pumping or sampling equipment, And can operate throughout the entire degassing process.

Innovative Aspect(s) :
Use of a pioneering technique developed by Gencoa - Remote plasma optical emission spectroscopy, provides useful data allowing degas end point to be determined.

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 : C382
ID : 6299296

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Hot Isostatic Pressing

Author : Dr Wu Zhanfang (CISRI HIPEX, China)

Co-author(s) : Dr Che Lida (CISRI HIPEX, China); Dr Wang Kai CISRI HIPEX, China); Dr Lv Zhoujin (CISRI HIPEX, China); Prof Li Xiangyang (CISRI HIPEX, China)

Title : Research On Numerical Simulation Technology Of Hot Isostatic Pressing Near Net Forming For Dual Phase Stainless Steel

Keyword(s) :
Hot Isostatic Pressing, Near Net Forming, Powder Metallurgy, Duplex Stainless Steel, Numerical Simulation

Abstract :
As one of the important technologies in powder metallurgy, hot-isostati-pressing near-net-shape(HIP-NNS) technology has been widely used in the aerospace field in recent years due to its ability to prepare high-performance products with complex structures. Duplex stainless steel (DSS) products have garnered attention from various industries such as marine engineering, shipbuilding, nuclear power, and petrochemical, owing to their exceptional mechanical properties and corrosion resistance. However, the complex preparation process and the high cost of raw materials have hindered the widespread application and development of DSS products. In this article, the author employs HIP-NNS technology and numerical simulation to fabricate DSS products. This approach significantly enhances powder utilization and production efficiency while reducing processing costs. Consequently, it offers a novel solution to address the challenges associated with the high cost and difficult forming of DSS products.

Innovative Aspect(s) :
1. Complex structure modeling ; 2. Considering the DEM relationship between powder particles ; 3. Create FEM-DEM coupling model ; 4.Simulation results guide on-site production of products

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

Technical Programme Committee

8th of February 2024

CONSOLIDATION TECHNOLOGIES

METAL INJECTION MOULDING

EPMA

european powder metallurgy association

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

Paper Number : C82
ID : 6278267

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Metal Injection Moulding

Author : Dr Meza Alberto (IMDEA Materials Institute, Spain)

Co-author(s) : Ing Alonso Andrea (IMDEA Materials Institute, Spain); Dr García de la Cruz Lucía (University Carlos III of Madrid, Spain); Prof Torralba José Manuel (IMDEA Materials Institute, Spain)

Title : High Entropy Alloy Components Prepared From Commodity Alloys And Metal Injection Moulding

Keyword(s) :
High Entropy Alloys, Metal Injection Moulding, Sustainable Feedstock, Additive Manufacturing

Abstract :
High entropy alloys (HEAs) are researched due to their distinct microstructures and impressive mechanical performance, which are achieved by combining multiple principal elements in nearly equal ratios. However, the inclusion of multiple elements poses challenges in HEAs fabrication by PM routes due to the high cost of pure elemental powders and the absence of readily available prealloyed HEAs compositions. Employing commodity powders such as Ni625, CoCrF75, or 316L has emerged as a viable approach, reducing manufacturing expenses and facilitating HEAs development. Furthermore, these powders ease the production of HEAs components by metal injection moulding. In this study, various binders were studied to optimise powder loadings in the feedstocks, subsequently utilised in injection or 3D printing via pellet extrusion. Debinding and sintering stages were optimised while microstructural and mechanical assessments were conducted on the final samples. The goal was to achieve a single FCC HEA phase exhibiting exceptional mechanical properties.

Innovative Aspect(s) :
This study pioneers the fabrication of High Entropy Alloys (HEAs) via Metal Injection Moulding (MIM) using readily available commercial commodity powders. Typically, these powders are mass-produced using methods like press and sinter, spark plasma sintering, or powder-related additive manufacturing, yielding components with commercial alloy compositions. However, their diverse alloying elements at specific proportions make them suitable for sourcing elements to create HEAs, deviating from their original intent. This unconventional use allows tailoring the composition and reducing costs in HEA development, contrasting with more expensive prealloyed powders processed in smaller batches. Additionally, exploring HEA processing via MIM remains an underexplored area as there are few studies in the literature about this. This study introduces innovative sustainability by employing eco-friendly binders in conjunction with these commodity powders.

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 : C83
ID : 6278323

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Metal Injection Moulding

Author : Mr Luoto Mikael (Fraunhofer IFAM, Germany)

Co-author(s) : Dr Ing Daenicke Enrico (Rolls-Royce Deutschland Ltd & Co KG, Germany); Mr Müller Ralf (Rolls-Royce Deutschland Ltd & Co KG, Germany); Dr Hartwig Thomas (Fraunhofer IFAM, Germany)

Title : A Study On A Method Of Sinter Joining In Metal Injection Moulding Process

Keyword(s) :
Metal Injection Moulding (MIM), Sinter Joining, Sintering

Abstract :
Although Metal Injection Molding (MIM) is a process for complex designs, not all geometries are feasible. The goal of the project was to find a way to join two or more individually moulded parts between moulding and sintering steps, at first for one feedstock (material: Inconel 713L). The joining of the parts was achieved by using pastes. The achieved mechanical properties were measured on tensile, fatigue and creep tests. The tensile strength values were comparable to normal material, but a drop in elongation was observed. However, in the fatigue and creep tests the joined specimens reached the elongation properties of the normal samples. One possible application with a geometry that is not feasible on normal MIM-process was tested and it seemed plausible that the sinter joining could be used to solve this kind of challenges.

Innovative Aspect(s) :
More freedom in design for MIM-process. Higher degree of freedom in MIM production.

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 : C84
ID : 6282995

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Metal Injection Moulding

Author : Prof Dr Herranz Gemma (Universidad Castilla La Mancha, Spain)

Co-author(s) : Ing Jimenez Juan (Universidad Castilla La Mancha, Spain); Dr Ing Hidalgo Javier (Universidad Castilla La Mancha, Spain); Dr Berges Cristina (Universidad Castilla La Mancha, Spain); Dr Ing Campana Roberto (Centro Nacional del Hidrógeno, Spain)

Title : A Synergy Approach Integrating Master Alloy Design And Powder Injection Moulding For High-performance Interconnectors Leveraging SOFCs Industry

Keyword(s) :
Powder Injection Moulding, Solid Oxide Fuel Cell (SOFC), Interconnector, Hydrogen

Abstract :
This study explores innovative approaches to boost the Solid Oxide Fuel Cell (SOFC) interconnector industry, integrating intelligent master alloy design and powder injection molding (PIM). Current challenges in interconnector fabrication via powder metallurgy include economic high-scale production of complex designs for improved SOFC performance and the restricted availability of commercial powders. To address these limitations, we propose the use of commercial high-Cr master alloys combined with ferrous powders, aiming for compositions equivalent to or surpassing standard Crofer 22. This strategy overcomes powder scarcity challenges and enables precise control over shrinkage and thermal expansion coefficient, crucial for producing ambitious large thin-walled interconnector geometries through PIM. A comprehensive comparative study, covering all PIM stages and properties characterization, is conducted, comparing Crofer 22 pre-alloyed powders with a modified Fe-Cr alloy incorporating additional elements for enhanced performance.

Innovative Aspect(s) :
This study explores innovative approaches to boost the Solid Oxide Fuel Cell (SOFC) interconnector industry, integrating intelligent master alloy design and powder injection molding (PIM).

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 : C157
ID : 6278273

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Metal Injection Moulding

Author : Ing Valsecchi Giorgio (TAV VACUUM FURNACES, Italy)

Co-author(s) : Ing Valsecchi Giorgio (TAV VACUUM FURNACES, Italy)

Title : Sintering Atmospheres For The Vacuum Sintering Of 316L Stainless Steel

Keyword(s) :
Sintering, Sintering Furnaces, Metal Injection Molding, Metal Binder Jetting, Sinter-Based Additive Manufacturing

Abstract :
Sintered stainless-steel components are widely adopted in the automotive, biomedical, electronics and fashion industries. For complex shaped sintered stainless-steel parts, metal injection molding (MIM) has been the primary production technology for decades but, in past few years, sinter-based additive manufacturing (SBAM) has grown significantly in popularity.Both metal injection molded and additively manufactured stainless-steel parts are often sintered on vacuum furnaces to prevent oxidation, contamination and obtain high densities with bright surfaces. In that case, a partial pressure of inert or reactive gas is commonly adopted to suppress evaporation of volatile alloying elements (i.e. chromium and nickel) and to help remove binder residuals. During sintering, the gaseous atmosphere interacts with the steel influencing its final mechanical and corrosion properties.In this experiment, the effects of sintering on vacuum furnaces with different atmospheres (argon or hydrogen) on 316L parts manufactured through MIM and metal binder jetting SBAM were investigated.

Innovative Aspect(s) :
The use of different sintering atmosphere is affecting the density and other relevant properties of sintered stainless-steel. In particular, hydrogen is often regarded as the best solution to sinter low carbon stainless steels. There are, however, several factor that should be kept into consideration while comparing hydrogen to argon and nitrogen, such as the higher cost, the requirement for additional safety measures and, consequently, the increased complexity of furnaces designed for hydrogen operation. The aim of this experimentation is to investigate how the choice of different atmospheres impacts on the properties of sintered stainless steel parts produced using Metal Injection Molding and Metal Binder Jetting and, finally, provide an overall comparison between the different options.

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

Technical Programme Committee

8th of February 2024

CONSOLIDATION TECHNOLOGIES

OTHER CONSOLIDATION TECHNOLOGIES

EPMA

european powder metallurgy association

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

Paper Number : C85
ID : 6281343

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Other Consolidation Technologies

Author : Ing Colaneri Alessandro (RINA, Italy)

Co-author(s) : Ing Lionetti Stefano (RINA, Italy); Dr Tassa Oriana (RINA, Italy); Ing Mohamed El Sayed Yasin (RINA, Italy)

Title : Heat Treatment Development On SLM 3d M300 Alloy Printed Samples To Improve Mechanical Properties

Keyword(s) :
Additive Manufacturing, Heat Treatment, Mechanical Properties

Abstract :
The purpose of this work was to develop a heat treatment to be performed on Additive Manufacturing (AM) 3D printed samples made of M300 steel in order to improve their mechanical properties, tailoring the as-built microstructure with the minimization of material defects like voids, porosity, micro-cracks, and variations in material structure. Different solution and ageing heat treatments were performed on samples printed via Selective Laser Melting (SLM) technique, testing different duration, temperatures and trends in the heating and cooling phases. The samples were microscopically analyzed and mechanically tested with tensile tests and hardness (HV10). The results were compared with as is samples showing improved mechanical properties meaning of an effective heat treatment applied

Innovative Aspect(s) :
The innovative aspect of this work is to develop a heat treatment that allows to increase the mechanical properties of commercial steel M300 SLM printed samples.

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 : C86
ID : 6281505

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Other Consolidation Technologies

Author : Dr Kukla Christian (Montanuniversitaet Leoben, Austria)

Co-author(s) : Mr Momeni Vahid (Montanuniversitaet Leoben, Austria); Dipl-Ing Schuschnigg Stephan (Montanuniversitaet Leoben, Austria); Prof Dr Holzer Clemens (Montanuniversitaet Leoben, Austria)

Title : Polylactic Acid (PLA) As Backbone For The Fused Filament Fabrication (FFF) Of Aluminium

Keyword(s) :
Fused Filament Fabrication, Feedstock Backbone, Aluminium

Abstract :
The backbone plays a significant role in the binder system for FFF of metals. Since the backbone is degraded thermally, the temperature for this debinding step should be below the sintering temperature of the involved metal. Thus, the low degradation temperature makes PLA a proper candidate for the backbone in feedstocks for aluminium with a relatively low sintering temperature. However, processing of PLA is challenging due to high shear and temperature sensitivity. Therefore, the printability at different nozzle temperatures (230, 250, 270 °C) was investigated for various formulations with PLA content ranging from 25 to 40 vol.% in the binder system. Solvent debinding for printed samples was conducted at room temperature and different immersion times. The results indicated the substantial impact of printing temperature on enhancing shape retention and preventing interlayer cracking during the solvent debinding process. The main binder was removed successfully without any defects during solvent debinding.

Innovative Aspect(s) :
Material extrusion of aluminium with filaments; New backbone material; New results regarding printing and solvent debinding

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 : C87
ID : 6283629

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Other Consolidation Technologies

Author : Dr Raghavendra Sunil (University of Trento, Italy)

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Title : Enhancing Worm Gear Efficiency: Directed Energy Deposition Of CuSn10 Alloy Onto Worm Gear Tooth Profiles

Keyword(s) :
CuSn10, Directed Energy Deposition, Process Parameters, Worm Gear

Abstract :
With the current development in additive manufacturing (AM) processes, such as directed energy deposition (DED), efficient usage of raw materials is possible. With the aid of this DED process, we aim to develop an efficient way to reduce the use of bronze in worm gears. Building upon insights from prior research into process parameter development, our objective is to fabricate worm gears by applying CuSn10 alloy onto a stainless steel tooth created through the LPBF process. We assess the impact of laser power, feed rate, scanning speed, and scanning strategy on the deposition process. The deposited cross-sections undergo analysis for porosity, hardness, dilution, and microstructure at various locations along the tooth profile. The optimal deposition parameters and strategy identified are then employed to coat an entire gear, subsequently subjected to testing on a worm gear test bench.

Innovative Aspect(s) :
Process optimization for DED of highly reflective copper alloys. Develop a scanning strategy for high-quality deposition on a worm gear tooth profile. Replace a complete bronze gear tooth with a tooth consisting of a steel substrate and deposited bronze alloy.

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 : C125
ID : 6283203

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Other Consolidation Technologies

Author : Ing Maffia Simone (Ponticon GmbH, Germany)

Co-author(s) : Dr Stittgen Tobias (Ponticon GmbH, Germany)

Title : Investigating The Application Of 3D-EHLA For Microstructure Control In Large-Scale Additive Manufacturing

Keyword(s) :
Laser Metal Deposition, Directed Energy Deposition, Extreme High-Speed Laser Metal Deposition, LMD, DED, EHLA, Microstructure Tailoring

Abstract :
Conventional powder Laser Metal Deposition (LMD) has revolutionized Additive Manufacturing (AM) by enabling the fabrication of large, support-free geometries and minimizing material waste through targeted deposition. Despite these advantages, conventional LMD faces challenges in microstructure control, primarily due to high heat inputs, limiting fine adjustments and compromising material integrity. In this work, the transformative potential of Ponticon's 3D Extreme High-Speed Laser Metal Deposition (EHLA) for large-scale applications is investigated, highlighting its capabilities in both deposition performance and microstructural control. 3D EHLA's high feed rates, reaching up to 200 m|min, not only significantly enhance deposition performance but also enable precise control over microstructures, thanks to a two-order-of-magnitude increase in cooling rates. As a result, tailored microstructures enables local modification of mechanical properties through process parameter adoption. This innovation addresses the limitations of conventional LMD, providing a viable solution for high-end large-scale AM components.

Innovative Aspect(s) :
This study explores Ponticon's 3D-EHLA for large-scale AM. 3D EHLA's high feed rates revolutionize microstructure control. This innovation enables precise adjustments in mechanical properties via localized modifications, addressing challenges encountered in conventional Laser Metal Deposition, in which the microstructure is hindered the high heat inputs and relatively slow cooling rates. The research introduces a groundbreaking solution for optimizing material integrity in high-end large-scale AM components by exploiting the full potential of 3D-EHLA technology.

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 : C129
ID : 6282622

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Other Consolidation Technologies

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Title : Key Factors Influencing The Gas And Nozzle Outlet Temperature In Cold Spray

Keyword(s) :
Cold Spray, Additive Manufacturing

Abstract :
Cold spray is an innovative process with high potential for the additive manufacturing of metallic materials. It has several unique characteristics—most notably, the process does not require any melting or fusion of the processed materials and the substrate. The powder is accelerated by a gas flow and forms dense layers on impact due to the high kinetic energy. The chamber temperature is the most known parameter in cold spray alongside the pressure of the process gas. The set chamber temperature has a crucial effect on the gas flow and thus the build quality. However, in addition to the chamber temperature, other parameters, such as the nozzle material and the powder gas flow rate, also influence the gas flow. The cause-effect relationships are not yet fully understood. This paper describes and examines the key factors associated with the temperature during cold spray in more detail.

Innovative Aspect(s) :
This paper deals with fundamental topics of cold spray, which have not yet been sufficiently addressed, for example, the relationship between the nozzle-material and the temperature of the exiting gas stream. However, this relationship is essential for the cold spraying process: the higher the gas stream temperature, the higher the achievable gas and particle velocity. This means that high-strength materials in particular, such as Inconel alloys, where modern cold spray plant technology is already at its limit, may only become processable with this knowledge. Furthermore, the influences of other parameters that have received almost no attention in the literature, such as the gas flow rate of the powder feeders, are examined in more detail on the basis of experiments. Therefore, this paper provides a deeper understanding of the interrelationships between the lesser known parameters of cold spray, and thus contributes to the further improvement of this process.

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 : C142
ID : 6282795

Requested presentation type : Oral Presentation

Topic : Consolidation Technologies **Subtopic :** Other Consolidation Technologies

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Title : Characterization Of Recycled Powder And Effect On The Microstructure And Mechanical Properties Of Re-additively Manufactured 316L Stainless Steel Bulk By Directed Energy Deposition

Keyword(s) :
Additive Manufacturing, DED, 316L stainless steel, Recycling, Oxidation

Abstract :
The part manufacturing industry using additive manufacturing processes is increasing its focus on reusing post-process powders to improve cost competitiveness. However, the powder characteristics of AM-processed powders and their influences need to be addressed. Hence, in this study, we evaluate the powder characterization of the recycled 316L stainless steel powder using the Direct Energy Deposition (DED) process and further investigate its impact on 316L DED as-built samples. We studied the oxidation characteristics of the 316L stainless steel powders and compared the impact of powder recycling on the microstructural and mechanical properties of the as-built samples to those made from fresh powder. Our findings indicate that the use of recycled powders affects the microstructural and mechanical properties of the as-built samples. This was attributed to the presence of oxide-rich inclusions in the microstructure produced from recycled powders. The findings of the study indicate that the as-built sample produced using recycled powder.

Innovative Aspect(s) :
The characteristics of recycled powders in the DED process are based on their falling distance, an aspect not explored in previous research. This study revealed the presence of oxides in the microstructure of recycled DED 316L, which were absent in DED 316L produced using conventional origin powder. Additionally, we explored the oxide formation mechanism and its influence on the mechanical properties when using recycled powder in the DED process.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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