EURO PM2023
CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

ABSTRACTS BOOK – GROUP 3

MATERIALS

EPMA
european powder metallurgy association

EURO PM2023

CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

MATERIALS

LIGHT MATERIALS

EPMA
european powder metallurgy association

EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235725900

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Light Materials

Author : Dr Ing Martucci Alessandra (Politecnico di Torino, Italy)

Co-author(s) : Ing Marchese Giulio, Ing Aversa Alberta, Prof Manfredi Diego, Prof Biamino Sara, Prof Ugues Daniele, Prof Bondioli Federica, Prof Messori Massimo, Prof Lombardi Mariangela, Prof Fino Paolo (Politecnico di Torino, Italy)

Title : A Time-saving Empirical Strategy For The Geometric Optimisation Of Support Structures Validated On AlSi10Mg And IN625 Alloys

Keyword(s) :
PBF-LB|M; Support Structures; Residual Stress; Empirical Strategy; Decision Support Matrix; Geometrical Indexes; AlSi10Mg; IN625

Abstract :
PBF-LB\M is a promising additive-manufacturing process that allows the production of complex-shaped functional components for a wide variety of applications. However, the layer-by-layer scanning and high cooling rates result in a high thermal gradient (?T) and, thus, in thermally induced stresses that could lead to undesirable cracking and delamination phenomena. A strategy to reduce the ?T and facilitate a correct heat flow is using support structures. However, the support geometry needs to be properly optimised, considering that the thermal resistance increases as the support-height increases and the contact cross-section decreases. For the design phase, it is also essential to consider the anchoring function of the support structures. Based on these considerations, two indices and a decision support matrix were developed in the present work for a quick and efficient setting of geometric parameters. The robustness of the developed strategy was verified on two very different alloys: AlSi10Mg and IN625.

Innovative Aspect(s) :
Support structures are broadly used in the literature to prevent problems related to the extremely high PBF-LB\M cooling rate and ensure proper sample-platform adhesion. However, the simulated methods for the geometric optimisation of support structures currently available are affected by errors in the powder bed and PBF-LB|M solidification phenomena modelling. Furthermore, available software for designing support structures tends to focus on the sample-platform adhesion function and not on ensuring a correct heat flow. The novelty of this work is the development of an easy-to-implement empirical method that allows the most appropriate geometric parameters for residual stress reduction and a correct sample-platform adhesion to be quickly defined. This strategy is based on the use of two geometrical indices and a decision-support matrix. Moreover, the method robustness was established by testing this innovative approach on two materials with very different thermophysical properties but likewise residual stress-sensitive, AlSI10Mg and IN625.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235734146

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Light Materials

Author : Ms Nkosi Nompumelelo (Stellenbosch University, South Africa)

Co-author(s) : Prof Sacks Natasha (Stellenbosch University, South Africa)

Title : Effect Of Build Direction On The Tensile Properties Of A Ti6Al4V Alloy Manufactured Using Selective Laser Melting

Keyword(s) :
Ti6Al4V; Tensile Test; Microstructure; Scanning Pattern; Selective Laser Melting

Abstract :
In this study the effect of build direction on the tensile properties of a Ti6Al4V alloy produced by selective laser melting was investigated. Initial cubes were printed using three different scanning patterns, namely island, meander and bi-directional alternating and rotated at 67°, to determine the optimum pattern producing the highest density and hardness. From the initial results all three patterns produced similar densities of > 99%, while the island pattern had the highest average hardness. Tensile test samples were printed in the vertical and horizontal directions in terms of the gauge length respectively, using the island pattern. The ultimate tensile strength, % elongation and Young's modulus were determined. The microstructure of the samples was studied using scanning electron microscopy, energy dispersive spectroscopy, x-ray diffraction and computerized tomography. The tensile samples printed in the vertical direction had better strength properties.

Innovative Aspect(s) :
Understanding of how the build direction influences the tensile properties of a Ti6Al4V alloy manufactured using selective laser melting. Investigating the role of the resultant microsctructure, deposition parameters and feedstock powder on the tested properties.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763571

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Light Materials

Author : Dipl-Ing Yamashita Taiki (Kansai University, Japan)

Co-author(s) : Dr Sato Tomohiro, Prof Dr Saitoh Ken-ichi, Prof Dr Takuma Masanori, Prof Dr Takahashi Yoshimasa (Kansai University, Japan)

Title : Development Of Composite Materials For Additive Manufacturing Using Environmentally Friendly Materials

Keyword(s) :
PLA; Composite Materials; FDM; Sliding Members

Abstract :
In the machine parts as sliding members, complex shapes and small-lot production are required. Therefore, manufacturing with Fused Deposition Modeling (FDM) technology using resin materials has attracted attention. However, in this method mechanical properties are inferior to those of metallic materials. In addition, many of the resin materials are petroleum-based resins, and environmental problems are a concern. In this study, we tried to improve it by mixing polylactic acid (PLA) with MoS2 as solid lubricants. PLA is a material with carbon-neutral properties. In the experiment, we used specimens made by a 3D printer after mixing raw materials and passing through intermediate materials. The stability of the composite is worse than that of PLA alone in friction tests. However, the coefficient of friction was partially low. This is thought to be the result of the function of the properties of MoS2 as a solid lubricant.

Innovative Aspect(s) :
Innovative aspects of our study is that it contributes to the improvement of environmental pollution from two directions, materials and manufacturing processes. The main material, PLA, is derived from plants and has biodegradability, which means that it can be decomposed in the natural environment.FDM used for modeling does not require a mold and can use materials without waste. Intermediate materials like pellets and wire-like filaments are required for modeling with FDM. In recent years, there have been an increasing number of prior publications using 3D printers as additive manufacturing technique, but there are few examples of experimenting by making specimens from intermediate materials. In addition, the range of research will be expanded by changing materials to be combined with PLA according to the assumed machine parts without limiting it to MoS2. Therefore, the results of this research have many points that can be used for general purposes.

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 PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764195

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Light Materials

Author : Ing Recalcati Sébastien (EPoS Technologies SA, Switzerland)

Co-author(s) : Dr Ing Fais Alessandro (EPoS Technologies SA, Switzerland)

Title : Diffusion Of Carbon In Titanium During Electro-Sinter-Forging

Keyword(s) :
Titanium Alloys; Titanium Composites; Reinforced Titanium; Interstitial Diffusion; Electro-Sinter-Forging; Field Assisted Sintering; FAST

Abstract :
This work investigates the diffusion mechanism of carbon in titanium during Electro-Sinter-Forging (ESF) at different levels of Standard Energy Input [J|g]. Carbon diffusion along interstitial sites occurs extremely rapidly (full dissolution and reprecipitation happen in less than one second) and seems to be favored by the high electrical current densities (up to 1 kA·mm2) that pass through the material during ESF. When sintering a mixture of CP-Ti and 0.5% wt. graphite, carbon atoms diffuse and react with titanium to precipitate acicular TiC whiskers in a near-fully to fully dense material. The shape of these precipitates evolves with increasing levels of energy from being finely dispersed sharp whiskers to a dendritic-like network. Understanding this behavior opens new possibilities to design novel reinforced Electro-Sinter-Forged titanium alloys or composites by precisely tweaking the precipitate's shape and arrangement to optimize structural or functional properties of the material.

Innovative Aspect(s) :
In high speed single pulse methods, densification occurs in completely out-of-equilibrium conditions. This allows the fabrication of novel metastable alloys and composites as can be seen in the microstructures produced in this work. Here, an observation of the diffusion behavior of carbon in titanium enhances the understanding of the underlying mechanisms that go on during Electro-Sinter-Forging. Specifically, details of a new Ti-C alloy are given, with improved mechanical properties with respect to standard Electro-Sinter-Forged CP-Ti. Comparison with an Ti-50Al Electro-Sinter-Forged metal-metal composite, with no diffusion from Al (a substitutional atom in Ti) helps create the framework to a novel design path for titanium alloys and composites by combining substitutional and interstitial alloying elements.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235764676

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Light Materials

Author : Dr Yilmazer Hakan (Yildiz Technical Univertsity, Turkey)

Co-author(s) : Mr Sadikoglu Yusuf Atilla (Turkish Aerospace Industries, Turkey), Ms Kuçuk Şeyma (Ford Otosan, Turkey), Dr Gokcekaya Ozkan, Dr Nakano Takayoshi (Osaka University, Japan), Dr Turu İrem Cemre, Dr Bulutsuz Aslı Günay (Yildiz Technical University, Turkey)

Title : Effect Of Dual Heat Treatment On Additively Manufactured Ti-6Al-4V Alloys Through Selective Laser Melting And Electron Beam Melting

Keyword(s) :
Ti-6Al-4V; Additive Manufacturing; Heat Treatment; Corrosion Behavior; Mechnical Properties

Abstract :
Coorrosion resistance and mechanical properties has influences on large scale usage of the addively manufactured Ti-6Al-4V alloys. Therefore, a double annealing heat treatment has been studied to optimize the corrosion resistance and the mechanical properties of the Ti-6Al-4V alloy produced by EBM and SLM in this work. With first heat treatment at 1050°C for different holding times for 30 min, 1 h and 2 h. Afterwards, the second heat treatment was applied for half an hour annealed samples in the first heat treatment. With second heat treatment, it was aimed to increase the reduced mechanical properties by preventing formation of martensite phase. While the holding constant time of 1 hour, different holding temperatures were tried which were 650°C, 750°C and 850°C. All heat treatments were carried out under the argon atmosphere. The microstructure, mechanical properties and corrosion behaviour of the alloy

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764719

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Light Materials

Author : Dipl-Ing Simola Jukka (EOS Finland Oy, Finland)

Co-author(s) : Dipl-Ing Virtanen Eero, Dipl-Ing Välikangas Jarno (EOS Finland Oy, Finland)

Title : Development Of Novel Aluminium Alloy For Additive Manufacturing For Applications Requiring High Conductivity

Keyword(s) :
Aluminium; Novel; Material Development; Alloy Development; Conductivity; Electrical Mobility; Satellite Communications; Telecommunications; Thermal Management; Additive Manufacturing; L-PBF; EOS

Abstract :
A novel low alloyed aluminium grade was developed for additive manufacturing to meet targets of high electrical and thermal conductivity combined with moderate strength. Typical application fields for it would be telecommunications, waveguides for satellites, electric mobility applications and thermal management. For example, coupling of radiofrequency transmissions by the material is dependent on its surface conditions, including surface roughness and surface electrical conductivity. To tackle this, particular attention in the development was steered towards thin wall and fine feature buildability. Due to high conductivity of the material, the resulting melt pool size was limiting its suitability for filigree designs. This work is completed with parameter study using smaller spot size and|or pulse modulation for laser beams within EOS machines. Being a novel material, characterization of mechanical properties and corrosion properties was done as well. Material passed stress corrosion cracking test ECSS-Q-ST-70-37C classifying as Class 1- high resistance to stress corrosion.

Innovative Aspect(s) :
Novel aluminium material for additive manufacturing, high conductivity combined with moderate strength. Filigrene part processability improvements using novel laser scanning features and process monitoring using EOS DMLS systems.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765372

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Light Materials

Author : Miss Lagalante Ilaria (Politecnico di Torino, Italy)

Co-author(s) : Miss Martucci Alessandra, Dr Aversa Alberta, Prof Lombardi Mariangela, Prof Manfredi Diego Giovanni (Politecnico di Torino, Italy)

Title : Characterization At Room And High Temperature Of Scalmalloy® Lattice Structures By LPBF

Keyword(s) :
Lattice Structure; Scalmalloy®; LPBF; Cell Topology; Compressive Test; High Temperature

Abstract :
Great interest has been expressed towards lattice structures in the past decade thanks to their excellent specific strength, surface area, and ensured light-weighting. Mechanical behaviour is affected not only by chosen material, but also by cell topology and relative density, allowing performance customization. In this field, additive manufacturing (AM) has enhanced the lattice design space, thus expanding their range of applications. Also, new materials developed to the benefit of AM generated new opportunities. Scalmalloy® is one of them. Used in aerospace, automotive and others, it owes its success to its excellent corrosion resistance, ductility, and strength-to-weight ratio.The present work aims to characterize Scalmalloy® lattice structures produced by Laser Powder Bed Fusion process. It focuses on the optimization of the main process parameters to obtain full dense struts. The role of the lattice topology on mechanical performance was investigated. Furthermore, compressive tests were conducted at room and at high temperature.

Innovative Aspect(s) :
Lattice structures have sparked interest in many fields in the past years. At the same time, Scalmalloy® has become one of the most required Al alloy, thanks to its excellent mechanical properties and low density, becoming increasingly popular in elite areas such as automotive racing, like Formula 1. Combining both advanced design and high-performance material makes possible to obtain previously unachievable results. Nonetheless, only few studies have explored this application, doing so with partial results.This study provides a complete analysis of the optimization and characterization process, including different cell topology and relative density in order to define the limitations and the opportunities of this high-performance alloy in a lattice design by LPBF. Moreover, mechanical behaviour is examined not only at 20 °C, as usually performed, but also at 200 °C, taking into account possible applications at high temperature, such as for new compact heat exchangers.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765700

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Light Materials

Author : Dr Neubauer Erich (RHP Technology GmbH, Austria)

Co-author(s) : Dipl-Ing Ariza-Galván Enrique, Dr Horky Jelena (RHP Technology GmbH, Austria)

Title : Assessment Of Plasma Metal Deposition (PMD) For The Manufacturing Of Titanium Based Metal Matrix Composites

Keyword(s) :
Metal Matrix Composites; Plasma Metal Deposition; Additive Manufacturing; Specific Stiffness

Abstract :
Plasma Metal Deposition is an additive manufacturing technology which is suitable for the fabrication of large structures. Especially for space relevant components with sizes of > 0.5 meter this method offers a potential to fabricate parts made from light weight metals with enhanced stiffness. The PMD process uses a plasma welding torch where powder or wire is used as a feedstock. The layer by layer processing allows to realize near net shape structures. Especially by using powder as a feedstock there is a large flexibility in creating various alloys as well as metal matrix composites with modified properties. Within this study, the goal was to improve the specific modulus (ratio of Young´s modulus|density) by introducing ceramic particles into a titanium alloy matrix. Beside addressing the main challenges in the manufacturing of composites by blown powder methods, an overview will be provided on various ceramic particles which have been investigated.

Innovative Aspect(s) :
The innovative aspect is the manufacturing of a titanium composite using additive manufacturing methods. Blown powder methods are used for the fabrication of ceramic particle reinforced composites with the main aim to increase the specific modulus.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

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EURO PM2023

CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

MATERIALS

FUNCTIONAL MATERIALS

EPMA
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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235753675

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Dr Vollert Florian (MIMplus Technologies GmbH & Co. KG, Germany)

Co-author(s) : Dr Maurath Johannes (MIMplus Technologies GmbH & Co. KG, Germany)

Title : Production Of NdFeB Magnets By Metal Injection Molding (MIM) - Challenges And Chances

Keyword(s) :
NdFeB; Permanent Magnets; Metal Injection Molding; MIM; Production Technologies; Functional Materials; Magnets

Abstract :
NdFeB magnets show the highest energy products of all known magnetic materials. It is predicted that the demand for this kind of magnets will increase in the following years. However, the required rare earth elements are almost exclusively produced in China. To reduce the dependency on China the recycling of NdFeB magnets is becoming more and more interesting. In the last few years, MIMplus has developed a process to produce NdFeB magnets from either virgin or recycling material by means of MIM. In contrast to the conventional production route via press sintering, MIM allows a high level of design freedom (complex shapes) with comparable magnetic properties.The focus on this work is a review of the different challenges that exist for this new production method in order to achieve the state of the art magnetic properties from press sintering.

Innovative Aspect(s) :
The possibility of producing NdFeB permanent magnets from recycling and virgin material with Metal Injection Molding (MIM) revolutionizes the magnets using applications. MIM allows for production of permanent magnets in a design freedom that hasn't been available so far. However, this production process together with highly reactive NdFeB powder, brings several challenges with it. The paper focusses onto the different challenges of the production of NdFeB permanent magnets via Metal Injection Molding to achieve state of the art properties of sintered permanent magnets.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235754756

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Ing Checa Fernández Blanca Luna (CEIT-Basque Research and Technology Alliance (BRTA) | University of Navarra, Spain)

Co-author(s) : Dr Martín García Jose Manuel, Dr Burgos García Nerea, Dr Sarriegui Estupiñán Gabriela (CEIT-Basque Research and Technology Alliance (BRTA) | University of Navarra, Spain)

Title : Study Of The Grain Growth Of Nd-Fe-B Atomized Powders With Different Nd Contents And The Addition Of Nb And Ga As Doping Metals

Keyword(s) :
Permanent Magnet; Gas Atomization; Nd-Fe-B- Alloy; EBSD; Grain Growth; Doping Metals

Abstract :
This work presents a detailed study of grain growth annealing of gas atomized Nd-Fe-B powders with different Nd content, ranging from 27.5 to 31.5 wt.%, and additions of Nb or Nb-Ga have been investigated. First of all, the microstructure and magnetic properties of the initial as-atomized powders for all the compositions were measured. Grain growth has been carried out at 1150°C for 5 hours. Nb addition resulted in the decrease of the final grain size due to the pinning effect of Nb-Fe rich compounds and the reduced amount of free Nd to form a liquid phase. Moreover, it has been determined by Thermo-Calc simulations that Nb content in the liquid increases when the Nd content decreases, enhancing the pinning effect. In contrast, Ga addition increased the liquid formed and enhanced the grain growth kinetics, particularly in the samples with the lower Nd content.

Innovative Aspect(s) :
The innovation of this research consists in the study of the effect of Nb and Ga on the grain growth process of atomized powders with different Nd contents. Currently, there is practically no information on the effect of these elements on the properties of atomized powders with different Nd content and the influence of these elements when a high temperature treatment is applied. As the demand for HRE element is on the rise worldwide due to its use in many fields of technology, the development of a Nd-Fe-B powder manufacturing process with enhanced magnetic properties in which the use of these elements is minimized is necessary.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235762510

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Prof Dr Carreno-Morelli Efrain (University of Applied Sciences and Arts Western Switzerland, Switzerland)

Co-author(s) : Ing Meylan Ludovic, Ing Rodriguez-Arbaizar Mikel, Ing Carthoblaz-Delèze Xavier, Prof Dr Chevailler Samuel, Ing Sahli Benoît, Dr Rajasundar Chandran, Dr Balestra Gioele (University of Applied Sciences and Arts Western Switzerland, Switzerland)

Title : Solvent-on-granules 3D-Printing And Material Extrusion Of Soft Magnetic Fe-6.5Si Alloy

Keyword(s) :
Soft Magnetic Alloys; Solvent on Granule 3D Printing; Material Extrusion; Sinter-Based Additive Manufacturing; Electrical Motors

Abstract :
Soft ferromagnetic parts have been produced by two sinter-based additive manufacturing techniques: Solvent on Granules 3D Printing (SG-3DP) and Material Extrusion (MEX). Fe2.7Si and Fe6.5Si powders were mixed with multicomponent binders, then shaped to granules. Different formulations suitable for SG-3DP and MEX respectively were processed. Square section toroids for magnetic measurements, test cubes and a rotor|stator prototype were printed.The green parts were debound under nitrogen and sintered under hydrogen atmosphere, in a single thermal cycle, using a retort furnace. The sintered parts were characterized by measurements of B-H hysteresis cycles, optical metallography and SEM observations.The impurity contents of carbon and oxygen were measured by melt extraction. The performance of parts processed by both SG-3DP and MEX methods, was compared with literature values obtained from conventional powder metallurgy processes.

Innovative Aspect(s) :
Processing of high silicon content soft magnetic Fe-Si by Solvent on Granule 3D Printing, and comparison with material extrusion 3D Printing.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235762561

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

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

Co-author(s) : Dr Maccari Fernando (Technical University Darmstadt, Germany), Dipl-Ing Keszler Monica, Dr Prasad Mishra Tarini (Forschungszentrum Juelich, Germany)

Title : Flash Spark Plasma Sintering Of Nd-Fe-B Magnets With Tailored Anisotropic Magnetic Properties

Keyword(s) :
Nd-Fe-B Magnets; Anisotropic Magnetic Properties; Flash Spark Plasma Sintering (Flash SPS); FAST|SPS

Abstract :
Flash spark plasma sintering (Flash SPS) is an attractive alternative method for the processing of Nd-Fe-B magnets with anisotropic magnetic properties. Therefore, a load is applied on a pre-compacted sample. Then, a well-defined power pulse is applied followed by deformation and densification of the sample in seconds. Compared to established processing of anisotropic magnets via hot pressing with subsequent die-upsetting, Flash SPS introduces the possibility of electroplasticity as an additional deformation mechanism. This mechanism has the potential to improve the magnetic properties through the fine-tuning of the microstructure. Our results reveal that suitable pre-heating of the sample before applying the power pulse plays a crucial role for tailoring grain size and grain aspect ratio, both being the key for well-pronounced anisotropic magnetic properties. For better understanding of the relationship between Flash SPS parameters, microstructure and resulting magnetic properties, in the present work a systematic parameter study has been done.

Innovative Aspect(s) :
Processing of Nd-Fe-B magnets via Flash SPS
Demonstration of well-pronounced anisotropic magnetic properties
Relationship between Flash SPS parameters, microstructure and magnetic properties Benchmark with other shaping technologies

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763601

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

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

Co-author(s) : Dr Mix Torsten, Dipl-Ing Thamm Merlin, Dr Ing Reuter Kay, Dr Ing Kirchner Alexander (Fraunhofer IFAM, Germany), Prof Dr Weißgärber Thomas (Fraunhofer IFAM & Technische Universität Dresden, Germany)

Title : New Prospects For Fabrication Of Fe-6.5Si Soft Magnetic Components Using Powder Metallurgy

Keyword(s) :
Soft Magnets; Magnetic Measurement; Structural Characterization

Abstract :
Excellent soft magnetic properties of the Fe-6.5Si alloy are well known since a very long time. But its usage was hindered by the difficulty of processing by conventional methods. Until now, most innovative fabrication methods are limited to the lab scale. In this study, different powder metallurgical methods are demonstrated for the fabrication of soft magnetic Fe-6.5Si parts with industrialization potential. The magnetic properties as well as geometric limitations of the specific manufacturing processes will be compared for a sinter-based method (screen printing) with a powder bed based (E-PBF) and a more conventional pressing process (FAST|SPS) for manufacturing soft magnetic components from Fe-6.5Si. The magnetic properties of the components will be correlated with their structural properties. Most important aspects like different powder properties as well as fabrication constraints and conditions will be discussed.

Innovative Aspect(s) :
Study on the powder metallurgical fabrication of low loss Fe-6.5Si soft magnetic components.
Comparison of different manufacturing techniques (additive and conventional).
Correlation of magnetic properties with structural properties- Effect of powder characteristics size and process conditions on the magnetic properties.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763857

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Dr Pejchal Vaclav (CSEM SA, Switzerland)

Co-author(s) : Mr Manzoor Ayman, Dr Sohrabi Navid, Dr Sereda Olha (CSEM SA, Switzerland), Mr Puyol Yoël (Almatech, Switzerland)

Title : Two-way Shape Memory Actuators By Laser Powder Bed Fusion

Keyword(s) :
Shape Memory Alloys; 4d Printing; Lpbf; Niti; Actuators

Abstract :
Compliant mechanisms can achieve macroscopic linear and rotary motion without friction, wear, and backlash. In recent years, the advent of Additive Manufacturing enabled new topologies for compliant mechanisms that were too complex to manufacture using traditional subtractive manufacturing methods. Today, at CSEM we tackle the challenge of the development of AM process for the next generation of compliant mechanisms with shape memory behavior. The advantages of using shape memory alloys such as NiTi are numerous: (i) actuation without micro-vibration, (ii) simplified assembly, (iii) simplified control of electronics. In this paper, we show the development of full-chain laser powder-bed fusion (LPBF) process covering feedstock specifications and selection, definition of the process window and post-process optimization for NiTi actuators aiming the actuation strain up to 4% with austenite start temperature above 50°C. Combined with shape memory training techniques two-way shape memory effect triggered by on-demand localized heating was achieved.

Innovative Aspect(s) :
The paper shows development of full-chain LPBF process for NiTi-based shape memory alloy including post-processing to achieve fully reversible two-way shape memory effect. The process enables to explore the untapped potential in design freedom for smart shape memory actuators. Potential applications will be discussed and presented.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235764224

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Dr Ing Fais Alessandro (EPoS Technologies SA, Switzerland)

Co-author(s) : Ing Recalcati Sébastien (EPoS Technologies SA, Switzerland)

Title : Novel Metal Based Hard Magnetic Composites

Keyword(s) :
Magnets; Nd-Fe-B; MMC; Composites; Gold; Silver; Bronze; 18kt Magnetic Gold

Abstract :
We present here for the first time a series of novel hard magnetic metal based composites with increased mechanical and corrosion properties with an extended range of use, from sensors to jewelry. The novel Nd-Fe-B based materials, produced through a single step pulse discharge sintering, combine an increased toughness and mechanical stability with various degrees of polarization and coercivity that change with the volume fraction of the hard magnetic phase and the chemical composition of the metal base and of the Nd-Fe-B based powder. Unique combinations, such as Nd-Fe-B with gold to form 18kt magnetic gold, extend the use of magnets in domains where there are currently marginal, such as jewelry and watchmaking.

Innovative Aspect(s) :
We have combined a wide range of metals with Nd-Fe-B to create novel composites that have never been produced. Unique combinations such as the ones with gold, silver, bronze and even high melting point metals such as molybdenum are possible. Data and materials that have never been produced before are here presented.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764739

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Ms Köhler Marie Luise (Institute for Materials Applications in Mechanical Engineering, RWTH Aachen University, Germany)

Co-author(s) : Mr Norda Michael, Prof Dr Petzoldt Frank (Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, Germany), Dr Ing Herzog Simone, Dr Ing Kaletsch Anke, Prof Dr Broeckmann Christoph (Institute for Materials Applications in Mechanical Engineering, RWTH Aachen University, Germany)

Title : Particle-reinforced Tool Steels Through Powder Additivation In Laser-based Powder Bed Fusion

Keyword(s) :
Laser-Based Powder Bed Fusion; Powder Blend; Carbides; Tool Steel; Isotropic Microstructure

Abstract :
Laser-based powder bed fusion (LPBF) is still rarely applied due to the limited range of available alloys. Powders of carbide containing tool steels have a low weldability and a high cracking tendency during processing. Additivation of an easily processable steel with high-melting carbides in the powder feedstock enables a higher carbide content in the alloys without affecting the processability. In this study, AISI H13 base steel was additivated with 5 wt.-% edged TiC. TiC remain as partially unmolten particles within the steel matrix and enhance macro hardness and wear resistance of the alloy while enabling a stable processing of crack-free alloys. Supplementary in-depth microstructure analysis by EBSD and texture analysis were performed and a shift toward isotropic microstructures was observed. The TiC act as nucleation sites for equiaxed grain growth during solidification, which eliminates the typical epitaxial grains in building direction and potentially reduces the anisotropy of mechanical properties.

Innovative Aspect(s) :
Powder blends have gained significant interest in research over the last few years. However, the focus has always been laid upon complete homogenization of the melt and less on particle reinforcement possibilities. Carbides in AM materials are usually very fine, limiting the application for abrasive wear environments. The novel approach offers the potential of good processability combined with enhanced carbide contents and resistance against abrasive wear.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235765269

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Prof Dr Weißgärber Thomas (Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM & Technische Universität Dresden, Germany)

Co-author(s) : Dr Ing Studnitzky Thomas, Dipl-Ing Scheibler Jakob (Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, Germany)

Title : Lithography Based Manufacturing Of Near Net Shape Dispersion Strengthened Copper Parts By Cuprous Oxide Reduction

Keyword(s) :
Metal AM; Dispersion Strengthening; Copper; Non Ferrous Materials; Highly Conductive Materials; Functional Materials

Abstract :
Dispersion strengthening of copper enables the combination of high strength and high conductivity. However, production of dispersion strengthened materials is complex and only yields semi-finished products. The following work presents a new approach based on cuprous oxide as matrix with dispersed Alumina. Powder mixtures are printed into a near net shape part via Lithography-based Metal Manufacturing. After debinding, cuprous oxide is reduced to copper in a hydrogen sintering atmosphere. Furthermore, the influence of milling the powder mixtures is investigated with samples produced by film drawing. Characterization includes scanning electron microscopy, Vickers hardness, and electrical conductivity measurements.Electrical conductivity reaches values of up to 78 % IACS. Vickers hardness surpasses pure copper, however, falls short of comparative values from the literature for dispersion strengthened materials. Reasons for that are insufficient densification and suboptimal dispersoid distribution. Optimization of densification and dispersoid distribution should be investigated in further studies.

Innovative Aspect(s) :
Additive Manufacturing of dispersion strengthened copper Complex near net shape dispersion strengthened parts Manufacturing of metal parts by reducing a metal oxide green part.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765316

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Mr Sota Angel (CEIT-BRTA, Spain)

Co-author(s) : Dr Burgos Nerea, Dr Martin Jose Manuel (CEIT-BRTA, Spain), Dr Zhukova Valentina, Dr Ipatov Mihail, Dr Gonzalez Julian (UPV|EHU, Spain), Mr Osinalde Mikel (ELESA, Spain)

Title : Improvement Of The Magnetic Properties Of Powder Cores By Optimizing The Volume Fraction Of Amorphous Material

Keyword(s) :
Amorphous; Soft Magnetic Material; Electrical Insulator Coating; Core Loss; Density

Abstract :
Nowadays, new electromagnetic devices are developed in a wide frequency range application to cover technologies needs in high value sectors as automation, medical, electrical machines, aeronautic and more. Between these devices stand out those which work at high frequency operations, where high resistivity soft magnetic materials are employed to reduce Eddy current losses induced in AC electrical process.In this work, gas atomization is employed to obtain spherical amorphous powders with different compositions. As amorphous materials are very hard and brittle, conventional cold press consolidation of the magnetic powder after mixing with a polymeric binder resulted in a low density compact, thus limiting the maximum values of some magnetic properties, such as the saturation magnetization. To minimize this problem, powders with two different particle sizes were selected and mixed in a specific volume percent that maximizes spherical particles packing and the compact density.

Innovative Aspect(s) :
Nowadays, the use of electrical devices such as inductors, rotors and transformers is rising. Iron-silicon electrical sheet is the most common material for these applications due to its high magnetic saturation, high permeability, and good mechanical properties. However, its low electrical resistivity produces high power loss due to eddy currents at medium-high frequencies. Amorphous composites are a promising candidate to substitute the electrical steel at high frequency range.Amorphous composites have some drawbacks such as low permeability and low density. In this work, new amorphous composite with polymer bonding has been developed. Different particles sizes were mixed in a specific volume percent to increase compact density and then magnetic saturation. Also, stress relieved of amorphous powder has been carried out by heat treatment, reducing coercivity and power loss.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765357

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Dr Sarriegui Gabriela (CEIT-BRTA, Spain)

Co-author(s) : Dr Sarriegui Gabriela, Dr Martin José Manuel, Dr Burgos Nerea, Dr Urionabarrenetxea Ernesto (CEIT-BRTA, Spain), Dr Ugalde Gaizka, Dr Eguren Imanol (Mondragon Unibertsitatea, Spain)

Title : Short-loop Recycling Of NdFeB Scrap By Gas Atomization

Keyword(s) :
NdFeB Alloys; Gas Atomization; Recycling; Bonded Magnets; Magnetic Properties; Hard Magnetic Materials

Abstract :
In this work, it is presented a direct metallurgical route for the recycling of end-of-life (EoL) sintered NdFeB magnets to produce competitive bonded magnets. Three different grades of scrap, classified according to the total content of heavy rare earth elements, were converted into fresh recycled NdFeB powder by gas atomization. Several atomizations with He and Ar were conducted to produce isotropic spherical powders. The use of He as atomizing gas resulted in higher cooling rates and, thus, finer and almost fully amorphous particles. After proper annealing, the powder exhibited a greater improvement in magnetic properties. Laboratory specimens were produced by compression molding using an epoxy resin as bonding phase. The magnetic, mechanical and physical characterization of the bonded NdFeB recycled magnets confirm that gas atomization is a suitable process for recycling NdFeB scrap.

Innovative Aspect(s) :
Nowadays, there is a need for a stable supply of raw materials and lower cost magnets to meet the increasing demand. The main need of manufacturer end users is a European alternative source of bonded NdFeB magnets with competitive prices and fulfilling their performance specifications. Gas atomization is a highly productive industrial process that could be used as the starting process for the production of recycled powder. The manufacturing process of the recycled powder does not include any milling step, which typically produces material losses. Consequently, the use of gas atomization will contribute to the production of cheaper recycled powder and make it feasible to develop in a short term.

Reviewer's name : .....

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Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765549

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Dr Ing Poskovic Emir (Politecnico di Torino, Italy)

Co-author(s) : Ing Ceroni Marta, Ing Franchini Fausto, Prof Ferraris Luca, Prof Dr Actis Grande Marco (Politecnico di Torino, Italy), Dr Sangregorio Claudio (Institute for the Chemistry of OrganoMetallic Compounds, Italy), Prof Caneschi Andrea (Università di Firenze, Italy)

Title : The Implementation Of A Novel Approach To The Rare Earth Magnets Recycling

Keyword(s) :
Rare Earth Magnets Recycling; NdFeB Magnets; Bonded Magnets; Innovative Process

Abstract :
Rare Earth magnets have been used in different industrial sectors: household utilities, automotive applications, informatics sensors, etc. Rare Earth magnets show the best magnetic performance, predominantly in the case of Neodymium magnets. However, the economic aspect concerning the raw magnetic materials affects many of the magnet devices, mainly considering the instability of the raw material market. For these reasons, recycling NdFeB magnets is considered a promising solution. Different techniques are available, but they are generally expensive or very dangerous. This work proposes a new approach to recycling the NdFeB sintered magnets using a particular mechanical technique without using Hydrogen, resulting in a safer, less complicated and cheaper process than chemical methods. Based on an impact mill, the process has been performed to grind the magnets recovered from the hard disks. The operation was conducted in vacuum. Finally, some bonded magnets with recycled powder have been prepared and characterized.

Innovative Aspect(s) :
Many methods to recover the NdFeB powder from different devices have already been proposed, usually based on Hydrogen, such as Hydrogen decrepitation (HD) or hydrometallurgical methods, and alternatively chemical processes. All these processes show drawbacks, and their industrial scale-up is challenging and expensive. This work proposes a new approach to recycle the NdFeB sintered magnets using a particular mechanical technique without using Hydrogen, resulting in a safer, less complicated and cheaper process than chemical methods. Based on an impact mill, the mechanical process has been performed to grind the magnets recovered from the hard disks. The operation was conducted in a vacuum. Finally, some bonded magnets with recycled powder have been prepared and characterized.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764617

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Dr Heo Sung Gue (Korea Institute of Industrial Technology, Korea, Republic of)

Co-author(s) : Mr Lee YongKwan, Mr Sim Jae-Jin, Prof Oh Soong Ju, Dr Park Kyoung-Tae, Dr Seo Seok-Jun (Korea Institute of Industrial Technology, Republic of Korea)

Title : Effect Of Vacuum Annealing On Mesoporous Copper Cobalt Oxide(CuCo2O4) For Supercapacitors

Keyword(s) :
Mesoporous; Copper Cobalt Oxide; Inverse Micelle; Supercapacitor; Vacuum Heat-Treatment

Abstract :
Mesoporous CuCo2O4 is interesting material for electrodes of high-performance supercapacitors because of their high surface area, controlled porosity and excellent electrochemical properties. In this work, mesoporous CuCo2O4 powders were synthesized using inverse micelle method and analyzed by X-ray diffraction(XRD), Brunauer-Emmett- Teller analysis(BET), transmission electron microscopy(TEM), and X-ray photoelectron spectroscopy(XPS). The mesoporous CuCo2O4 powders after additional heat-treatment at 250°C in vacuum atmosphere exhibited high specific surface area of 114cm2|g with pore size of 8nm. The mesoporous CuCo2O4 electrodes achieved maximum specific capacitance of 140 Fg-1 in 6M of KOH electrolyte. The capacitance retention was 91.4% after 3000 cycles at 1Ag-1. This superior electrochemical supercapacitor property is mainly due to increased surface area.

Innovative Aspect(s) :

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 PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235766656

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Functional Materials

Author : Dr Ing Tomiczek Blazej (Silesian University of Technology, Poland)

Co-author(s) :

Title : Development Of Maraging Steel-copper Composite Produced By Selective Laser Melting And Pressure Infiltration

Keyword(s) :
Selective Lase Melting; Gas-Pressure Infiltration; Maraging Steel; Copper; Composite

Abstract :
The main aim of the research was to develop a steel-copper composite with increased thermal conductivity for tools for plastics processing. In the first stage, samples of maraging 18Ni300 steel with microchannels of a specific geometry were produced by the selective laser melting method. The SLM process parameters were selected mainly regarding the maximum degree of densification. The research work carried out proved that with such selected parameters, it is possible to produce channels with a diameter exceeding 300 µm. A pre-vacuum gas-pressure infiltration was chosen among the known types of infiltration methods. Regardless of the infiltration pressure, all porous shapes were filled with liquid copper in the entire volume, and the composite materials produced in this way achieved full densification. The wettability and reactivity of the connection were determined based on microstructural tests carried out by optical and scanning electron microscopy.

Innovative Aspect(s) :
An innovative aspect of the research is developing a hybrid technology for producing steel and copper composite materials using selective laser powder sintering and pressure infiltration. Using the SLM technique, skeletons of maraging steel were made with appropriately designed channels filled with liquid copper thanks to pressure infiltration. The developed materials are characterized by a favourable system of mechanical properties and increased thermal conductivity, allowing them to be used as a tool material for injection moulds used in plastics processing.

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 PM2023
CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

MATERIALS

OTHER PM MATERIALS

EPMA
european powder metallurgy association

EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235746379

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Other PM materials

Author : Dr Jahangiri Hadi (Koç University, Turkey)

Co-author(s) : Mr Asghari Alamdari Armin, Prof Unal Ugur, Dr Motallebzadeh Amir (Koç University, Turkey),

Title : Development And Characterization Of CoCuFeNiMnMox (x=0.5, 1.0, And 1.5) High Entropy Alloys Prepared By Mechanical Alloying And Spark Plasma Sintering Method

Keyword(s) :
High-Entropy Alloy; Spark Plasma Sintering; Mechanical Alloying; Nanoindentation

Abstract :
In this investigation, CoCuFeNiMnMox (x=0.5, 1.0, and 1.5) high entropy alloys (HEA) were prepared by mechanical alloying followed by spark plasma sintering (SPS) at 850 °C temperature. The powders were produced by high energy ball milling (HEBM) after 20 h with a speed of 400 rpm. SPS was performed at 850 C with a uniaxial pressure of 55 MPa. The heating rate was 100 C|min up to 850 C. The maximum temperature and pressure were held for 3 min, before allowing the furnace to cool down. The phase and microstructure of the as-sintered samples were studied by SEM and XRD and the effect of Mo amount alteration was studied. More addition, TOPAS 4.2 was employed for the phase fraction calculation by Rietveld refinement analysis of XRD spectra. Following the microstructural analysis of the as-sintered mechanical properties including hardness, modulus of elasticity, and stress-strain response were measured using the nanoindentation method.

Innovative Aspect(s) :
CoCuFeNiMnMox (x=0.5, 1.0, and 1.5) high entropy alloys (HEA) were prepared by mechanical alloying followed by spark plasma sintering for the 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 PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235756908

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Other PM materials

Author : Dr Wimbert Lars (GKN Powder Metallurgy Engineering GmbH, Germany)

Co-author(s) : Dr Lindsley Bruce, Mr McQuaig Kylan (Hoeganaes Corporation, USA)

Title : Introduction Of Advanced Lubricants Into Serial Production Processes

Keyword(s) :
PM Lubricants; Compaction; Powder Blending

Abstract :
Modern compaction lubricants must address a wide range of key properties through the entire powder metallurgical process flow. These include not only compaction density requirement but also the ability to mix uniformly at scale, good powder flow and fill in powder premixes, ejection, compaction as well as clean burn-off during sintering. Modern lubricant developments, such as AncorLube LV, provide excellent processability in all process steps and are far more clean-burning and environmentally friendly as previous materials. This lubricant has now been used in several production settings and new applications for an extended period with positive results. The benefits and opportunities of using advanced lubricants will be discussed in this paper for various parts geometries and powder compositions with respect to the whole PM process chain.

Innovative Aspect(s) :
After sucessfull lab-scale development of a new compaction lubricant this paper documents the impact of the improved material on several serial production processes. The manuscript aims to give a comprehensive overview about all relevant processes from powder blending to sintering and the impacts of the new lubricant on process robustness and parts quality.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235762930

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Other PM materials

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

Co-author(s) : Mrs Mortalò Cecilia, Mrs Deambrosis SIlvia Maria, Mr Montagner Francesco, Mrs Zin Valentina, Mr Miorin Enrico (National Research Council of Italy - CNR Institute of Condensed Matter Chemistry and Technologies for Energy – ICMATE, Italy), Mrs Fabrizio Monica (CNR Engineering ICT and Technologies for Energy and Transportation Department, National Research Council of Italy, Italy), Mrs Colombini Elena, Mrs Lassinantti Gualtieri Magdalena, Mr Veronesi Paolo (Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia, Italy)

Title : Conventional Powder Metallurgy Process To Synthetize Multi Principal Element Alloys

Keyword(s) :
Multi Principal Element Alloys; MPEA; High Entropy Alloys; HEA; Sintering; Vacuum Furnace; Vacuum Sintering

Abstract :
Multi-principal element alloys (MPEAs) have drawn the attention of many research and industrial fields, thanks to their extraordinary properties including high strength, toughness, wear resistance, fatigue resistance and corrosion resistance. However, the fabrication of MPEA parts with desired microstructures and properties using conventional powder manufacturing techniques is still challenging. This work focuses on the development of a simple powder metallurgy route, including cold uniaxial pressing of powder mixtures followed by pressureless vacuum sintering, for the preparation of cylindrical samples and sputtering targets made of FeNiCrMn, FeNiCrCo and FeNiCrCo +10%wt. Al. Green pellets were heated up to 400°C in high vacuum and then under Ar atmosphere up to selected sintering temperatures, i.e. 1200°C and 1300 °C.Relative densities (RD) of the green and sintered samples were determined and discussed. Finally, the microstructure of the sintered targets was evaluated using a scanning electron microscope (SEM) equipped with an energy-dispersive X-ray spectroscope (EDS).

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764645

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Other PM materials

Author : Dr Ing Kovacova Zuzana (RHP-Technology GmbH, Austria)

Co-author(s) : Dr Stelzer Nils, Dr Baca Lubos, Dr Merstallinger Andreas (Aerospace & Advanced Composites GmbH, Austria), Dr Toufine Alain (OPTÁLM Additive Manufacturing Options, France), Dr Makaya Advenit (ESTEC, Netherlands), Dipl-Ing Kitzmantel Michael, Dr Neubauer Erich (RHP-Technology GmbH, Austria)

Title : Assessment Of Bulk Metallic Glasses (BMGs) Manufactured By Powder Based Methods

Keyword(s) :
BMG; Amorphous Metals; Additive Manufacturing

Abstract :
BMGs represent an interesting class of materials for structural and functional applications. Due to their extraordinary properties such as ultra-high strength, high hardness, soft magnetic properties along with a high corrosion and wear resistance they can be used in a wide range of applications.Within this study, the manufacturing of Zr-based amorphous alloys (AMZ4 and VIT105) using atomised powders but also mechanically alloyed powders have been investigated. The processability of starting powders by hot-pressing as well as by additive manufacturing methods (laser melting deposition and plasma metal deposition) was studied. Materials were characterised with respect to XRD analysis, microstructure and corrosion resistance. Although the individual processing routes were quite challenging, it was possible to prepare fully amorphous samples. While additional future work is required to remove the residual porosity, the present results contribute to the development of Zr-based bulk metallic glasses parts with complex geometry via powder based methods.

Innovative Aspect(s) :
Typically liquid phase processing (melting+quenching) show certain limiations in the size of components which can be manufactured. Therefore, within this study various powder based processing techniques have been assessed in order to allow to form metallic glasses with larger geometrical dimensions. In addition, possible applications have been identified.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765118

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Other PM materials

Author : Dr Quilter Connor (University of Liverpool, United Kingdom)

Co-author(s) : Dr Head Michael, Prof Black Kate (University of Liverpool, United Kingdom), Dr Neveu Aurélien, Mr Francqui Filip (Granutools, Belgium)

Title : Iron Ore As A Suitable Candidate For AM: Relation Between Rheology And Spreadability

Keyword(s) :
Iron Ore; Spreadability; Rotating Drum; Rheology

Abstract :
Powder bed-based methods are common in additive manufacturing (AM), where successive thin layers are created using a ruler or rotating cylinder. The homogeneity of the layers determines the mechanical quality of the built parts. However, the layer quality is directly related to the spreading properties of the feedstock, which relies mainly on the cohesiveness and rheology of the powder. Despite wide availability, iron ore has never been considered a suitable feedstock material for AM. If a viable iron ore feedstock could be produced for AM, it would enable the manufacture of bespoke agglomerates which could be used in blast furnaces to produce steel. This could reduce the thermal budget and considerably lower CO2 emissions in the steel sector.In this study, the spreadability of iron ore powders has been evaluated in a binder jet printer and correlated with its flowability and rheological properties evaluated in a rotating drum (GranuDrum, Granutools).

Innovative Aspect(s) :
In this study, iron ore is evaluated for additive manufacturing applications. This could lead to opening futur processing applications for this material, reducing cost in the steel sector.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

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EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765342

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Other PM materials

Author : Prof Veronesi Paolo (University of Modena and Reggio Emilia, Italy)

Co-author(s) : Prof Colombini Elena, Dr Lassinantti Gualtieri Magdalena (University of Modena and Reggio Emilia, Italy)

Title : Recycling Of Spent Powders From Additive Manufacturing Processing Of Inconel 625 For The Synthesis Of CoCrFeNiMoxNb0.4x (x=0-0.1) Multi-Principal Element Alloys (MPEAs) By Spark Plasma Sintering (SPS) Of Mechanically Alloyed Powders

Keyword(s) :
Recycling; Spark Plasma Syntering; MPEAs

Abstract :
Sieve residues from the powder recycling stream in Laser powder bed fusion (L-PBF) processing of Inconel 625 are currently disposed of as hazardous waste which is in conflict with circular economy thinking. Here, the synthesis of equimolar CoCrFeNi Multi-Principal Element alloys (MPEAs) doped with the 4d transition metals (i.e. Nb and Mo) is proposed as a valid recycling option of these powders. In particular, mixtures of virgin powders and a spent Inconel 625 powder were mechanical alloyed and subsequently consolidated by Spark Plasma Sintering (SPS). By carefully controlling the powder mixture compositions, MPEAs with various contents of Nb and Mo were obtained. The bulk samples were thoroughly characterized by metallographic analyses, X-ray powder diffraction and preliminary mechanical analyses using instrumented indentations. The results will show that spent powders of Inconel 625 is a valuable source of 4d transition metals for the synthesis of CoCrFeNiMoxNb0.4x (x=0-0.1) with enhances solid solution.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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