WORLD PM2022
CONGRESS & EXHIBITION

ABSTRACTS – GROUP 4

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ABSTRACTS – GROUP 4

FUNCTIONAL MATERIALS

WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225363056

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Dr Ing Rynio Christopher (Bleistahl Services GmbH & Co. KG, Germany)

Co-author(s): Mrs Seyfarth Anna ; Mr Emde Dirk (Bleistahl Services GmbH & Co. KG, Germany)

Title: Mechanical And Tribological Properties Of Copper Infiltrated High Speed Steel Based Valve Seat Insert Materials With Different Hard Phase Particles

Keyword(s):
Vvalve seat insert, High temperature wear, Tribolgy, Composite materials

Abstract:
The pursuit for higher combustion pressures and temperatures in internal combustion engines demands the development of new materials that meet these requirements. High speed steel based composites reinforced with different hard phases were fabricated by uniaxial pressing and sintering. The corresponding microstructures were analyzed in the scanning electron microscope (SEM) and the mechanical properties (hardness, microhardness) were compared. High temperature wear tests were performed with a pin-on-plate SRV tribometer and with a RIG-test using real valve seat insert and valve geometries. The wear scars were analyzed using SEM with energy dispersive X-ray spectroscopy (EDX) and laser scanning profilometry. It was found that Co- rich hard phases within the matrix lead to significant lower wear rates than Fe-rich hard phases. This could be correlated to the formation of Co-rich compacted oxide layers on the worn surfaces.

Innovative Aspect(s):
Influence of different hard phase particles on the high temperature tribological properties in a pin-on-plate tester AND a rig test with real seat insert and valve geometries has not been presented in this way before.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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Notes to author: .....

WORLD PM2022
CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225367605

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Dipl-Ing Baudry Maxime (CEA Liten, France)

Co-author(s): Dr Savelli Guillaume ; Dr Roux Guilhem (CEA Liten, France)

Title: Development Of Bulk Thermoelectric N-type SiGe Alloy By Laser Powder Bed Fusion

Keyword(s):
Laser powder bed fusion (L-PBF), Silicon Germanium (SiGe), Thermoelectricity, Additive Manufacturing, Powder metallurgy, Rapid solidification

Abstract:
Like printing in its day, additive manufacturing has revolutionized current production methods in many areas like aeronautics, military or medicine. Among these methods, Laser Powder Bed Fusion (L-PBF) is prevalent to printing complex metal parts in small and medium series. Techniques developed recently in L-PBF pave the way for producing new types of materials via this method, including thermoelectric (TE) materials. This document presents the research work carried out at CEA to study the manufacturing of silicon-germanium alloy by L-PBF, a TE material intended for high temperature applications. In this study, we achieved successfully the printing of several dense samples, and then discuss their microstructures, chemical composition and thermoelectric properties.

Innovative Aspect(s):
Additive manufacturing of TE materials is a recent topic, as it was first approached in 2015 by Ahmed El-Desouky et. al, by experimenting laser shots on a Bi2Te3 powder compact. Since then, several TE materials have been studied (MnSi, SnTe, SbTe, ZnNiSn ...) but there's no work published to this day mentioning L-PBF of SiGe. Consequently, our work is likely to be the first instance of SiGe manufacturing via this method. Beyond that, L-PBF is a technique conceived initially for metal powder densification, and SiGe as a semiconductor poses unusual challenges for its development, such as heat dissipation mechanisms substantially different from those observed in metals, or the brittle aspect of the material.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225367983

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Mrs Grau Laura (Pforzheim University, Germany)

Co-author(s): Prof Dr Burkhardt Carlo (Hochschule Pforzheim | STI, Germany)

Title: Factors Influencing The Recyclability Permanent Magnets Used In V-shaped Permanent Magnet Synchronous Motors Via Hydrogen Processing And Powder Metallurgy

Keyword(s):
Design for Recycling, NdFeB scrap sourcing

Abstract:
The rare earths are some of the most critical raw materials, yet electromobility and green energy strongly rely on Rare Earth Permanent Magnets (REPM). To secure the supply and improve the ecological footprint of REPM, a hydrogen-aided powder-metallurgical reprocessing route was successfully established and continues to be improved. A remaining obstacle is the sourcing and demounting of REPM-containing scrap. Demounting must especially be optimized towards achieving a maximum yield of high-quality material in conjunction with economic efficiency. Electric traction motors, which will be an abundant but dissipated scrap REPM source in the future, are often very hard to demount. To exploit this important raw material source, their design must accommodate efficient recycling. This paper deals with how design choices of the most common rotor permutation, the V-shaped internal Permanent Magnet Synchronous Motor rotor (VPMSM), impact the recyclability of the integrated magnets and provides a design for recycling framework.

Innovative Aspect(s):
Proper design for recycling has been mostly tackled internally and confidentially by companies and in the form of manual disassembly trials. This work provides a systematic overview about which design decisions will impact the recyclability and therefore allow a machine designer to consider the respective parameters. Based on this groundwork, purposeful innovation activities towards providing qualitative and quantitative base material for hydrogen processing and further powder preparation can be initiated.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225370577

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Prof Elsayed Ayman (Central Metallurgical Research and Development Institute, Egypt)

Co-author(s): Prof Kondoh Katsuyoshi ; Prof Umeda Junko (JWRI, Osaka University, Japan)

Title: Ti-Ni-Cu Shape Memory Alloy Preparation By Powder Metallurgy And Hot Forging

Keyword(s):
Shape memory alloy, Spark plasma sintering, Hot forging, Cryogenic quenching

Abstract:
As an important group of the Ti-Ni base shape memory alloy family, Ti-Ni-Cu shape memory alloy was prepared by powder metallurgy. Elemental mixing of fine micron-sized powders has been employed and then they were sintered by spark plasma sintering. Further hot forging was then used and the alloy has been heat treated by homogenization, solution treatment, aging and cryogenic quenching. The alloy microstructure evolution during various preparation steps has been observed, and the heat treated alloy transformation characteristics were tested by using differential thermal calorimetry. Tensile test was also employed to assess the alloy super-elasticity and shape recovery. Results have shown that the alloy possess comparatively high transformation temperatures, in the range of 60 to 75° and less transformation hysteresis. Hot forging has also been shown as a tool for enhancing the alloy properties by refining the microstructure.

Innovative Aspect(s):
The Ti-Ni base alloys are a very important group of shape memory alloys used in various applications. The preparation of the alloy could be obtained by various technologies, the most important of which is the powder technology. In contrast with the Ti-Ni alloy which easily show the shape memory effect, Ti-Ni-Cu alloy needs a proper selection of the preparation route. One of the most important technological processes applied to the shape memory alloys to enhance their properties is the thermo-mechanical deformation. The current work employs both hot forging and cryogenic quenching as the main preparation steps. This topic has not been previously (extensively) studied so far.

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Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225370650

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Mr Bacchetta Gatien (Univ. Grenoble Alpes, CEA, LITEN, France)

Co-author(s): Mr Genevrier Stéphane ; Dr Rado Cyril ; Dr Luca Sorana (Univ. Grenoble Alpes, CEA, LITEN, France)

Title: Experimental Study Of Recycled Hydrogen Decrepitated NdFeB Magnetic Powders

Keyword(s):
Rare-Earth, Permanent Magnets, Recycling, Hydrogen Decreptation

Abstract:
NdFeB permanent magnets are essential components for the rising green transition technologies including electric vehicles or wind turbines. Magnets contain critical Rare-Earth Elements (REE) involving strong supply risk and high environmental impacts. Their recycling is thus a key factor for a sustainable production. This study focuses on the short recycling route based on the pulverization of end-of-life NdFeB magnets under H2. The properties of the powders produced by Hydrogen Decrepitation (HD) and Hydrogenation Disproportionation Desorption Recombination (HDDR) are investigated. The role of the composition of initial magnets on the optimal recycling process are clarified. The influence of some process parameters on the particle size distribution and their respective magnetic properties are emphasized. It has been found that magnetic performances of the powders can be enhanced by an appropriate thermal treatment. Systematic microstructural analysis is used for understanding the magnetic properties. A simple model is provided to explain the observed features.

Innovative Aspect(s):
Short-loop recycling of NdFeB permanent magnets via hydrogen-based processes is already well documented. Currently, the HD process is implemented to supply powders from sintered magnets liable to be incorporated in the conventional milling and liquid-phase sintering manufacturing route. Alternately, anisotropic bonded magnets can be produced with recycled powders after an expensive HDDR treatment. This study investigated a cost effective HD treatment prone to supply recycled powders well suited for producing anisotropic bonded magnets. This implied to clarify the influence of the process parameters on the particle size distribution as well as on the magnetic performances of the decrepitated powders. Thermal treatments have been designed on hydrogenated powders to recover initial magnetic properties. This innovative approach paves the way for improving the competitiveness of the magnet recycling activity and thus enables a growing use of end of life NdFeB sintered permanent magnets as a secondary source of raw materials.

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371399

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Prof Dr Luo Xia (Southwest Petroleum University, China)

Co-author(s): Mr Li Mingyu ; Dr Tang Zhaomin (Southwest Petroleum University, China) ; Prof Dr Cai Huawei (Laboratory of Clinical Nuclear Medicine, West China Hospital, Sichuan University, China) ; Prof Dr Hao Lijing (National Engineering Research Center for Tissue Restoration and Reconstruction, South China University of Technology, China)

Title: Degradation Regulation And Bioadaptability Of Medical Mg-6Zn Alloy Prepared By Semi-solid Powder Moulding

Keyword(s):
Semi-solid powder moulding, Medical Mg alloys, Degradation performance, Bioadaptability

Abstract:
In order to improve the corrosion resistance of medical magnesium alloys, a novel powder metallurgy technique named semi-solid powder moulding was used to prepare Mg-6Zn alloy, then micro-arc oxidation (MAO) and addition of Mn (x=0.5, 1 wt.%) were applied. Finally, the vivo and vitro degradation performance and bioadaptability were studied. The results show the degradation rate generally decreased by 2-3 orders of magnitude after MAO with different parameters. Under the different temperature parameters (540℃, 560℃, 580℃, 600℃), Mg-6Zn-1Mn alloy has the lowest degradation rate, which decreases to 0.17mm|year, and the optimum forming temperature is 600℃. PET results show Mg-6Zn alloy has a bioadaptable degradation rate in New Zealand rabbit. The cell adhesion, cytotoxicity and hemolysis rate experiments of rabbit BMSCs show a good biocompatibility.

Innovative Aspect(s):
Semi-solid powder forming combines semi-solid forming and powder forming with one step, which have the fantastic advantages in the preparation of alloys that has wide solidification range with low melting point. Semi-solid powder moulding has been used to prepare medical Mg-Zn alloys with excellent performance. In order to adapt the degradation process in vivo, this study explored the possibilities of corrosion resistance improvement methods via surface modification and alloy elements addition based on semi-solid powder moulded Mg-6Zn alloys. Additionally, nuclear medical imaging diagnosis PET-CT was firstly used to evaluate the degradation rate in vivo from molecular scale. The results show the degradation rate decreases 2-3 orders of magnitude, and the prepared samples have a good biocompatibility. Therefore, the prepared samples have good bioadaptability.

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Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371410

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Prof Dr Guo Hong (GRIMAT Engineering Institute Co. ltd;State Key Laboratory of Nonferrous Metals and Processes, China)

Co-author(s): Dipl-Ing Zhang Yuxiang ; Dr Xie Zhongnan (GRIMAT Engineering Institute Co. Ltd ; State Key Laboratory of Nonferrous Metals and Processes, China)

Title: Research On Properties Of Annealed Pyrolytic Graphite | 6061Al Composites

Keyword(s):

Abstract:
With the increasing heat flux of electronic devices, the thermal problems caused by heat accumulation seriously affect the development of high-power devices. In this paper, annealed pyrolytic graphite | aluminum composites were prepared by spark plasma sintering with annealed pyrolytic graphite as thermal conductive component. The effects of titanium modification on the microstructure and interfacial bonding of annealed pyrolytic graphite | 6061Al composites were discussed. The effects of titanium modified layer with different thickness and annealed pyrolytic graphite geometry on the thermal and mechanical properties of annealed pyrolytic graphite | 6061Al were revealed. The results show that when 400 nm thick interface layer is formed between annealed pyrolytic graphite and aluminum alloy, titanium modified graphite is closely combined with aluminum alloy, and Al4C3 harmful phase is not formed; the in-plane thermal diffusivity of annealed pyrolytic graphite | aluminum composites reaches 901 mm2|s, the maximum bending strength reaches 141 MPa.

Innovative Aspect(s):
Use annealed pyrolytic graphite with complete structure and high degree of graphitization as the thermal conductive component to improve the thermal conductivity of the composite. Titanium modification treatment at the interface of annealed pyrolytic graphite-aluminum alloy composite material forms a carbide transition layer, inhibits the interface Al4C3 phase, and obtains excellent thermal conductivity and good mechanical properties (thermal diffusivity 901 mm2|s, flexural strength 141 MPa) of annealed pyrolytic graphite-aluminum alloy composites. Exploring the effects of different thicknesses of titanium modified layers and surface configuration of annealed pyrolytic graphite on thermal and mechanical of annealed pyrolytic graphite-aluminum alloy composites.

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Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371740

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Ms Navarrete Cuadrado Jazmina (CEIT-BRTA, Spain)

Co-author(s): Dr Soria Biurrun Tomas ; Dr Lozada Cabezas Lorena ; Prof Dr Sanchez-Moreno Jose M. (CEIT-BRTA, Spain) ; Dr Moseley Steven ; Dr Gonzalez Polvorosa Nerea ; Dr Tarragó Jose M. (Hilti Corporation, Liechtenstein)

Title: Densification And Microstructural Characterization Of WB4 Based Ultrahard Materials

Keyword(s):
Tungsten tetraboride (WB4), Densification, Hot isostatic pressure, High hardness

Abstract:
Tungsten borides are potential candidates for the fabrication of tool materials. Among them, tungsten tetraboride is attracting increasing attention due to its very high hardness (» 47 GPa), good electrical conductivity and abrasion and corrosion resistance. Nevertheless, the technologies needed to obtain WB4 based usable tools are still to be developed. In this work, full densification of WB4 based hard materials has been achieved by applying glass encapsulated HIP cycles to powders mixtures with different W|B ratios and Ta additions. Contrary to that reported by other authors, it has been confirmed that Ta addition enhance the transformation of tungsten tetraboride (WB4) into tungsten diboride (WB2). Processing parameters have been tailored for retaining the hard WB4 hexagonal phase after sintering reaching hardness values over 26 GPa (HV5). Interaction between WB4 and different metals has been investigated in order to find suitable binder phases for producing tougher WB4-metal cermets.

Innovative Aspect(s):
Choice of tungsten tetraboride as a basis for producing new tool materials. Full densification of ultrahard dense materials based on WB4 powders by means of glass encapsulated hot isostatic pressing. Tailoring HIP parameters in order to retain the hard WB4 structure after densification. Effect of Ta additions and W|B ratios in the final microstructure of WB4 sintered samples. Study of metallic alloys suitable for producing WB4 based cemented borides.

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Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371873

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Mr Lindroos Tomi (VTT, Finland)

Co-author(s): Mr Antikainen Atte ; Mr Kinos Timo ; Dr Kaunisto Kimmo ; Dr Metsä-Kortelainen Sini ; Mr Riipinen Tuomas ; Dr Pippuri-Mäkeläinen Jenni ; Mrs Manninen Aino (VTT, Finland)

Title: Effect Of Alloying Elements On Fe-Si-X Soft Magnetic Material Produced By AM And PM

Keyword(s):
Soft Magnetic, Additive Manufacturing, Electrification, Laser Powder Bed Fusion

Abstract:
Electrification of the world has significantly increased the demand for novel high performance electromechanical components. Powder Metallurgy (PM) and especially Additive Manufacturing (AM) are seen as enablers to produce components based on novel soft magnetic materials with performance and designs unattainable with conventional manufacturing. Fe-Si-X soft magnetic materials were studied by focusing to tailor material to Laser Powder Bed Fusion (L-PBF) processing. Effect of different alloying elements on magnetic, electrical and mechanical properties were studied based on simulations and experiments. The focus was paid on to increase understanding how segregation occurring in high cooling rates can be utilized in controlling of electrical resistivity and that way in mitigation of eddy current losses. Gas atomized powder corresponding the most promising alloy composition was produced and further, test components were manufactured by L-PBF with appropriate heat treatments. The results of resistivity and magnetic measurements are promising when compared against conventional Fe-6.5Si.

Innovative Aspect(s):
Additive manufacturing (AM) technologies have opened up new possibilities for realising magnetic circuit designs, ultimately leading to electrical machines with enhanced performance, lower material consumption and costs Together with 3D design optimisation, additive manufacturing (AM) provides unparalleled possibilities for creation of complex parts|components with improved characteristics. High cooling rates on L-PBF processing are leading non-conventional microstructures and that way also properties deviating conventionally processed components Segregation happening in high cooling rate L-PBF processing can be utilized as beneficial effect.

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Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371894

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

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

Co-author(s): Prof Carosio Federico ; Dr Ing Franchini Fausto ; Prof Ferraris Luca ; Prof Actis Grande Marco (Politecnico di Torino, Italy)

Title: A Novel Approach To The Development Of Multifunctional Insulating Layers For Soft Magnetic Composites

Keyword(s):
Soft Magnetic Materials, Soft Magnetic Composites

Abstract:
Soft Magnetic Composites (SMC) comprise magnetic grains held together by an insulating layer. The widespread diffusion in in the market for such materials, conventionally employed in electrical machines, is currently held back by limitations associated to material properties and processing constraints. These drawbacks are mostly related to the insulating layer employed. This contribution aims at overcoming such limitations by means of a novel surface approach. The proposed surface modification allows to coat of each particle with a nanostructured layer providing electrical insulation while also conferring additional features such as improved mechanical properties and withstanding higher treatment temperatures. In addition, the use of the proposed technology makes the layer feasible with a wide range of materials. The layer materials can be organic, inorganic or a combination of both. SMC encompassing the developed innovative multi-functional layers have been prepared and characterized by means of surface morphology, magnetic and mechanical properties.

Innovative Aspect(s):
Thinner, uniform, customizable, multifunctional layers. Better electrical insulation with the same layer mass (magnetic benefits).

TPC Reviewer name: .....

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371898

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Dr Martin Jose Manuel (CEIT-BRTA, Spain)

Co-author(s): Dr Burgos Nerea ; Mr Sota-Muños Angel (CEIT-BRTA, Spain) ; Dr Zhukova Valentina ; Dr Ipatov Mihail ; Prof Gonzales Julian (UPV|EHU, Spain)

Title: Characterization Of Soft Magnetic Composites With Ceramic Coating Produced By Hot Press

Keyword(s):
Hot press, Soft magnetic material, Electrical insulator coating, Core loss, Density, Permeability

Abstract:
In this work, new advanced materials (soft magnetic composites) were investigated to reduce eddy currents and core loss in electromagnetic devices operating at medium-high frequencies. Soft magnetic powders (Fe-Si and Fe-Ni-Mo) were produced by gas atomization, coated with ceramic materials (alumina and phosphate), and consolidated by hot pressing into powder cores. Hot pressing parameters (time, temperature, and pressure) were studied to maximize the density, while minimizing the damage of the coating. For comparison, powder cores of the same alloys were manufactured by compression molding using an epoxy resin as insulator and bonding phase. The microstructural characterization of the new cores was carried out by high resolution scanning electron microscopy and X-ray diffraction. After consolidation, the electrical resistivity and the static magnetic properties of the materials were measured. Finally, core loss was evaluated at different frequencies. Phosphate ceramic coating provided the best dynamic properties, especially in comparison with the epoxy resin.

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. Soft magnetic composites (SMCs) are a promising candidate to substitute the electrical steel in this range. SMCs have some drawbacks such as low permeability and mechanical strength. Additionally, there is an increasing demand for higher resistivity, which has led to the development of ceramic coatings to substitute the polymeric ones. In this work, the consolidation of SMCs with ceramic bonding phase has been improved via hot pressing. The simultaneous application of high temperature and pressure has increased density and reduced compaction residual stresses, thus improving magnetic properties, lowering core loss, and increasing mechanical strength.

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371900

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Dr Ing Müller-Köhn Axel (Fraunhofer Institute for Ceramic Technologies and Systems IKTS, Germany)

Co-author(s): Dipl-Ing Werner David ; Dr Ing Pötschke Johannes (Fraunhofer Institute for Ceramic Technologies and Systems IKTS, Germany) ; Dr Aleksandrov Fabijanić Tamara (University of Zagreb, Croatia) ; Mr Jeren Ivan (Afa Tim d.o.o., Croatia)

Title: Challenges Of Water Based Hard Metal Extrusion

Keyword(s):
Extrusion, Water-based, Hard metals

Abstract:
Water and cellulose-ether-based extrusion of hardmetals give the opportunity of an environmentally friendly processing. Furthermore, water as a solvent significantly reduces the demands in occupational safety and also costs in suction systems and drying processes. Use of water requires specific binders and additives to achieve the desired processing behavior of extrusion feedstocks as well as the necessary hardmetal properties after sintering. Additionally, water removal during drying of extruded parts demands well controlled conditions to ensure shape retention and defect free green parts. In this presentation necessary organics and processes for a successful feedstock preparation and extrusion will be shown. As an example, it was possible to apply submicron (d50 < 1 µm) WC-10 Co and binder free, nano scaled WC powders. Finally, resulting material properties of extruded and sintered parts will be demonstrated.

Innovative Aspect(s):
Water and cellulose-ether-based extrusion of hardmetals give the opportunity of an environmentally friendly processing. Furthermore, water as a solvent significantly reduces the demands in occupational safety and also costs in suction systems and drying processes.

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371959

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Mr Nakamura Takechika (JFE Steel Corporation, Japan)

Co-author(s): Ms Takehara Marina ; Mr Takashita Takuya (JFE Steel Corporation, Japan)

Title: Analysis Of Iron Loss Of Soft Magnetic Composites And Laminated Cores Under PWM Inverter Excitation

Keyword(s):
Soft Magnetic Composite, Laminated Core, Iron Loss, Inverter

Abstract:
Soft magnetic composites (SMC) are expected to downsize electric motors thanks to high degree of freedom in shape and 3D magnetic circuits. The electric motors are generally controlled under PWM inverter excitation. The iron loss of laminated cores under PWM inverter excitation is generally higher than that under conventional sinusoidal excitation. In this study, the iron loss of SMC and laminated cores under PWM inverter excitation was analyzed. It was revealed that the increase of the iron loss of SMC was smaller than that of laminated cores under PWM inverter excitation. It suggests that the difference of the ratio of the hysteresis loss to the eddy current loss affects the iron loss under PWM excitation.

Innovative Aspect(s):
The iron loss between soft magnetic composites and laminated cores under PWM inverter excitation was analyzed. The increase of the iron loss of SMC was smaller than that of laminated cores under PWM inverter excitation. Soft magnetic composites are considered to be more effective than laminated cores for reducing energy loss of electric motors under PWM inverter excitation.

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371993

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Dr Tosoni Olivier (Univ. Grenoble Alpes, CEA, Liten, France)

Co-author(s): Dipl-Ing Borges Mendonça Elisa (Univ. Grenoble Alpes, CEA, Liten, France) ; Dipl-Ing Reijonen Joni ; Dipl-Ing Antikainen Atte (VTT Technical Research Centre of Finland, Finland) ; Dipl-Ing Schäfer Lukas ; Dr Riegg Stefan (Technische Universität Darmstadt, Germany)

Title: High-coercivity NdFeB Printed Magnets With Laser Powder Bed Fusion Method

Keyword(s):
Additive manufacturing , NdFeB magnets, Coercivity, Laser Powder Bed Fusion

Abstract:
NdFeB permanent magnets are key components for the energy transition and the electrification of transportation, which causes their demand to grow at high pace. Yet, the supply risk for rare earth metals motivates the industry to look for an efficient use of magnets. Designing systems with complex-shaped magnets can help reducing the magnet volume and the rare-earth use if accompanied by the development of net-shape processes, like additive manufacturing (AM). Laser Powder Bed Fusion of NdFeB has been studied since 2016 as a way to produce complex-shaped dense parts without any binder; most of the works are based on a commercial Nd-lean spherical powder. The present work reports results obtained with a 32%-RE composition with an increased copper content. Remanence reaches 0.62T, which is close to the maximum attainable with such an alloy without alignment, while coercivity reaches 1790kA|m, the best reported value up to date.

Innovative Aspect(s):
The approach used in this work is quite different from what has been reported before. First, the development of the powder was made internally and the powder was not spherodized. Instead, the experimental setup allowed to comply with low flowability and was fine-tuned to achieve regular spreading of powder beds. Second, the choice of the alloy has been done considering both reduction of cracks and improvement of magnetic properties, by a screening of several alloys of pre-existing sintered magnet grades. The ability to produce several kilograms of home-made powders with close-to-industrial equipement allowed to take advantage of this prior screening and avoid contaminations linked to transportation and tranfers. Finally, a methodical study of manufacturing conditions and annealing cycles has been performed in order to optimize the magnetic properties of the magnets, in such a way to eventually reach coercivity values well-above the state of the art.

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225372001

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Dipl-Ing Bioud Thomas (Université Grenoble Alpes CEA, France)

Co-author(s): Dr Ollivier Maëlig ; Dr Favergeon Loïc (Mines de Saint-Etienne, France) ; Dr Luca Sorana ; Dr Rolère Sébastien (Université Grenoble Alpes CEA, France)

Title: Organic Contamination During The PIM Process Of High Performance NdFeB Magnets: Mechanims And Solutions

Keyword(s):
PIM NdFeB Magnets Organic Binders Polymers Debinding Contamination

Abstract:
NdFeB permanents magnets are key components for green transition technologies that require high energy|volume ratio. The conventional powder metallurgy process (alloying, powdering, compression and sintering) allow obtaining high magnetic performances however it does not allow the manufacturing of complex shapes and machining produces critical and expensive material waste. The Powder Injection Molding (PIM) process, involving the manufacturing of a feedstock that can be shaped using the conventional injection molding equipment, would solve these issues. Nevertheless, the use of organic binders for injection moulding, and the post-injection debinding steps during the PIM procedure, are sources of carbon and oxygen contaminations that reduce the magnetic properties. In this work, we investigated the organic contamination mechanism in magnets produced by PIM using polyolefin-based feedstocks. The control of the debinding parameters combined with specific feedstock and particle coating engineering steps, allowed us to produce magnets with excellent magnetic properties.

Innovative Aspect(s):
The PIM process for NdFeB magnets has been described in literature however the organic contamination mechanism, due to the high reactivity of the NdFeB with carbon and oxygen, is not yet been described. In this work, we present an original study of the degradation mechanism of the polyolefin feedstock investigated using ATG, ATG-GC|MS,XPS associated with microstructure analysis (SEM, XRD) on the final sintered parts. All these characterization methods allow us to describe the potential sources of contamination correlated with the physical and chemical evolution of the organic compounds throughout the process. The importance of the powder coating as a barrier to oxygen contamination is emphasized for various coating polymers. Excellent magnetic performances (coercitive field of 1500kA|m and remanent field of 0.7 T) have been obtained on isotropic magnets made by PIM, comparable to the performances obtained on the magnets manufactured by the conventional powder metallurgy route.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason: .....

Notes to author: .....

WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225372014

Requested paper 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):

Title: Solvent-on-granules 3D-Printing And Fused Filament Fabrication Of Soft Magnetic Fe-6.5Si Alloy

Keyword(s):
Soft magnetic alloys, Solvent on Granule 3D Printing, 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 Fused Filament Fabrication (FFF). Fe2.7Si and Fe6.5Si feedstocks were produced by mixing elemental powders and multicomponent binders, then shaped to granules (for SG-3DP) and filaments (for FFF). 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 step in 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 FFF 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 Slovent- on Granule 3D Printing, and comparison with filament based 3D Printing.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225372052

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Dr Luca Sorana (Université de Grenoble Alpes, CEA, Liten, France)

Co-author(s): Dr Brombacher Christoph (Vacuumschmelze, Grüner Weg 37, Germany) ; Mr Genevrier Stephane ; Mr Leforestier Jean ; Mr Dayde Hugo ; Dr Tosoni Olivier ; Dr Rado Cyril (Université de Grenoble Alpes, CEA, Liten, France)

Title: Toward The Reduction Of Heavy Rare Earth Elements In High Performance NdFeB Permanent Magnets By The Refinement Of The Strip Cast Flakes Microstructure

Keyword(s):
NdFeB permanent magnets, Microstructure, Strip casting process

Abstract:
Sintered NdFeB permanent magnets (PM) are essential components of electrical machines that require a high energy product|volume ratio for weight reduction and better reliability. However, to compensate the decrease in magnets coercivity with temperature, substitution of Nd by Heavy Rare Earths (HRE) is widely used at industrial scale. This approach seriously increases the dependence on these critical raw materials in EU magnet industry. This work focuses on the reduction of HRE elements in the high performance NdFeB PM, by the refinement of the microstructure of the alloys. The proposed optimization of the NdFeB alloys can boost development of fine-grained NdFeB PM's allowing a significant HRE reduction. The influence of the process parameters as well as of the alloys composition on the coercivity increase will be emphasized. Coercivity increase of 110 kA|m at 150°C have been demonstrated for magnets based on alloys with optimized microstructure and composition.

Innovative Aspect(s):
The reduction of the grain size in polycrystalline NdFeB PM's is a well-established route to increase the coercivity without adding HRE. However, as the grain size is downsizing below 3µm the fabrication of magnets with a homogeneous microstructure and effective decoupling of the magnetic grains, allowing the development of the coercivity, becomes challenging. This study provides an evidence of the correlation between the microstructure of the starting alloys after strip casting process and the coercivity increase in NdFeB PMs. The refinement of the microstructure allows the production of fine-grained magnets with significant reduction of HRE elements (up to 39%). Thereby the potential to save overall time and costs is relevant by optimizing the microstructure of the alloys during the strip-casting step in order to ensure a homogenous distribution of the grain boundary phase in NdFeB permanent magnets.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225372181

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Dr Lindsley Bruce (Hoeganaes Corporation, USA)

Co-author(s): Mr Kraus Neal ; Mr McQuaig Kylan (Hoeganaes Corporatio, USA)

Title: Iron-based Powder Solutions For Soft Magnetic Composite Applications

Keyword(s):
Soft magnetic composites, Electrification

Abstract:
The recent acceleration in interest and market demand in hybrid and fully electric vehicle systems has brought new opportunities to the PM market for use of Soft Magnetic Composite (SMC) materials. As greater acceptance of these materials in both the industrial and automotive market continues, products which serve specific industry needs are being developed and standardized for use. The success of SMC powders for these specific applications is based on three important inputs – base iron, insulating coating and lubricant. Thermal processing of the SMC compact also plays a critical role, as material deformation behavior has a direct impact on magnetic properties. These factors and their influence on final properties will be discussed.

Innovative Aspect(s):
It is critical for the PM industry to know how to process SMC materials as electrification drives part makers away from some traditional components. Enhanced understanding of SMC material behavior will be shared, from powder characteristics to deformation temperature to curing conditions. Certain processing conditions have shown surprising magnetic property results beyond those shared previously in the literature.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225380729

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Dr Boulnat Xavier (MATEIS (UMR 5510, INSA Lyon, CNRS, Université de Lyon), France)

Co-author(s): Dr Pontoreau Maël ; Dr Steyer Philippe ; Prof Pelletier Jean-Marc ; Dr Cardinal Sandrine ; Dr Gremillard Laurent (MATEIS (UMR 5510, INSA Lyon, CNRS, Université de Lyon), France) ; Dr Dezellus Olivier (Laboratoire des Multimatériaux et Interfaces (UMR 5615), France)

Title: Towards The Additive Manufacturing Of Biocompatible Zr-based Metallic Glasses Using Liquid Phase Sintering: Study Of The Reactivity With Zn-based Additives

Keyword(s):
Metallic glass, Interdiffusion, Liquid phase sintering, Diffusion bonding, Direct ink writing

Abstract:
Metallic glasses (MG) are a kind of advanced metallic materials which present attractive mechanical properties and corrosion resistance. The on-going development of powder additive manufacturing techniques offers the opportunity to produce rather large parts composed of MG. As part of the Direct Ink Writing (DIW) technique, the liquid phase sintering of a Zr-based MG (AMZ4, Zr59,3Cu28.8Al10.4Nb1,5) using Zn-based additives has been identified as promising. Indeed, Zn alloys have a melting point (Tf,Zn=420°C) lower than the crystallization temperature of the MG (Tx≈470°C).Here, the study focuses on the understanding of the reactivity between AMZ4 and Zn as a function of temperature and time. A powder mixture and a model interface, systems have been studied combining <I>post-mortem<|I> characterizations (SEM, EDX, XRD, micro-hardness…) with <I>in situ<|I> characterizations (DSC, XRD-HT). The results will permit to determine the best conditions to manufacture designed MG structures by 3D printing.

Innovative Aspect(s):
Since the recent discovery of metallic glasses, more and more studies focus on their characterization, their synthesis or their shaping by additive manufacturing techniques. Thanks to their mechanical properties, MG would find applications in many fields (medical, aeronautics, …).For now, very few studies have been devoted to the reactivity between a MG and metals. Only a few articles about diffusion bonding can be reported. For the first time, the system (Zr-based MG and Zn) has been studied in depth using many characterization methods and not only using typical model interface but also using powder mixtures. The study concludes by drawing the very first isothermal transformation diagram used in this context. Moreover, a new crystalline phase was even identified and characterized. The experimental procedure presented could be replicated to study other systems.

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225367384

Requested paper type: Poster Presentation

Topic: Materials / **Subtopic:** Functional materials

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

Co-author(s): Dr Lukac Frantisek (Ústav fyziky plazmatu AVČR, Czech Republic) ; Dr Sedlacek Josef (FEE CTU, Czech Republic)

Title: Pressure-assisted Sintering Of CaCu3Ti4O12 Dielectrics With Particular Response To Light Irradiation

Keyword(s):
Calcium copper titamate, Photocurrent, Dielectric, Giant permittivity

Abstract:
In this work we examine dielectric properties of CaCu3Ti4O12 (labelled as CCTO) fired by spark plasma sintering (SPS) and attempt to discuss the most important conditions affecting its dielectric behavior and response to light irradiation. At first, we give a quick description of the feedstock powder before it was compacted. The most promising dielectric samples were obtained by an alternative approach (HPF): a high-pressure applied before a conventional sintering. At the dielectric measurements the electric field was applied along the pressure direction (i.e., perpendicular to the cylinder face). The relative permittivity was calculated from measured capacitances for a wide frequency window and the loss tangent was measured simultaneously. The DC resistivity was measured as well. Phase composition and lattice parameters were evaluated by means of X-ray diffraction (XRD). Porosity of the samples was measured predominantly by image analysis of cross-sectional micrographs.

Innovative Aspect(s):
The CCTO samples irradiated by visible range light exhibit decrease of electric resistivity because of excitation of the charge carriers. The HPF processed samples exhibit linear response to the irradiation, whereas the SPS samples show various nonlinearities. We will discuss the oxidation|reduction of pure CCTO and the presence of secondary crystallographic phases to the character of these effects.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022
CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225370292

Requested paper type: Poster Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Ing Aydin Sohret Melda (EGE UNIVERSITY, Turkey)

Co-author(s): Miss Subasi Yasemin ; Prof Dr Akgol Sinan ; Prof Dr Ipek Rasim (EGE UNIVERSITY, Turkey) ; Dr Kusat Kevser (DOKUZ EYLUL UNIVERSITY, Turkey)

Title: Coating The Magnesium Powder Surface With (Hydroxyethyl)methacrylate To Protect It From External Environmental Conditions

Keyword(s):
Magnesium, (Hydroxyethyl)methacrylate, Powder coating

Abstract:
Magnesium is one of the metals with the highest affinity for oxygen. For this reason, it is important to protect the surface of the powders so that they can be sintered without losing the effects of the pre-treatments. The powders are coated with (Hydroxyethyl)methacrylate (HEMA) thermoset polymer. HEMA is a type of polymer that can gain different properties with its manageable radicals. Characterizations of the coated powders were made by SEM, EDS, BET, DSC, TGA analyzes and their sinterability was investigated.

Innovative Aspect(s):
It is predicted that the composites to be obtained by coating Mg powders with HEMA and sintering at low temperature can make a difference in biological applications or hydrogen storage. This research is a preliminary study for these applications.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371966

Requested paper type: Poster Presentation

Topic: Materials / **Subtopic:** Functional materials

Author: Mrs Serbeniuk Tetiana (V. Bakul Institute for Superhard Materials of the National Academy of Sciences of Ukraine, Ukraine)

Co-author(s): Mrs Prikhna Tetiana ; Mr Sverdun Volodymyr (V. Bakul Institute for Superhard Materials of the National Academy of Sciences, Ukraine) ; Mr Oliynyk Viktor (Taras Shevchenko National University of Kyiv, Ukraine)

Title: Development And Properties Of Composite Materials Based On Aluminum Nitride For The Field Of Electronics

Keyword(s):
Composite materials, Aluminum nitride, Microwave radiation, Structure

Abstract:
The correlations between technological conditions of production, structure formation and characteristics of composites were established for composite materials manufactured by the method of free sintering on the basis of a mixture of AlN-Y2O3-C (diamond powder)-Mo powders. In the millimeter range at frequencies from 30 to 70 GHz, the electrodynamic characteristics were measured, namely the real and imaginary parts of the dielectric constant of the developed composite materials and the tangent of the dielectric loss angle was calculated. It is noted that for samples with inhomogeneous structure in the transition from centimeter (30 GHz) to millimeter range (more than 30 GHz) there is a sharp increase in the real part of the dielectric constant, which decreases monotonicallyThe research results showed that despite the presence of electrically conductive inclusions in the structure of materials, composites are still characterized by high dielectric properties, namely, the dielectric constant is 8.5, and tgδ = 0.03.

Innovative Aspect(s):
Using X-ray phase analysis with Rietveld's method, as well as structural studies using SEM and Auger spectroscopy, it was determined that diamond powder was graphitized during sintering, thus forming graphite grains, which together with Mo grains are able to absorb microwave radiation. Moreover, studies have shown that increasing the time of grinding and mixing of the charge based on AlN-C (diamond) -Mo powders from 3 to 9 minutes causes the formation of a homogeneous structure of the material, ie the uniform distribution of inclusions of the electrically conductive phase of carbon and molybdenum in the matrix phase of aluminum nitride. Thus, the new lightweight composite material for the field of electronics what capable of absorbing microwave radiation was obtain when adding small content (about 10%) of the conductive phase.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022
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ABSTRACTS – GROUP 4

NON FERROUS MATERIALS

WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225367219

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Miss Goettgens Valerie (University of Innsbruck, Austria)

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

Title: Feasibility Study Of Fabricating A Partly Amorphous Copper-rich Titanium Alloy Via In-situ Alloying In Laser Powder Bed Fusion

Keyword(s):
Laser Powder Bed Fusion, Additive Manufacturing, Amorphous Alloy, Bulk Metallic Glass, Titanium Copper Alloy, Intermetallic

Abstract:
A binary alloy of 70 wt% Ti and 30 wt% Cu (Ti-30Cu) was fabricated with Laser Powder Bed Fusion (LPBF) via in-situ alloying. The microstructural details of the LPBF samples were investigated with regard to the crystallinity of the alloy as a function of process parameters and cooling rates. The degree of chemical homogenization during LPBF, phase composition, relative density as well as mechanical properties of the produced specimens were evaluated. Furthermore, the LPBF state of Ti-30Cu was compared to a slowly cooled sample from the β-phase field, which approximates the equilibrium state. The experimental studies were compared to thermodynamic calculations performed with ThermoCalc.

Innovative Aspect(s):
Amorphous alloys are generally known to differ from their crystalline counterpart by higher yield stress, higher hardness, and a lower modulus of elasticity. Crystalline alloys with an amorphous phase fraction represent an interesting area of research. LPBF offers a new approach for the production of such samples due to the very high cooling rates. For the first time, a titanium alloy with a reinforcing amorphous Cu phase has been produced.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225367377

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Mr Wang Guangda (Advanced Technology & Materials Co., Ltd (AT&M), China)

Co-author(s): Prof Dr Xiong Ning ; Prof Dr Kuang Chunjiang (Advanced Technology & Materials Co., Ltd (AT&M), China)

Title: Study On Microstructure And Mechanical Properties Of Molybdenum Rhenium Alloy

Keyword(s):
Molybdenum-rhenium, Mechanical property, Microstructure, Fracture morphology, Influence mechanism

Abstract:
Molybdenum rhenium material has better high temperature strength and room temperature plasticity than pure molybdenum metal, and has good chemical compatibility with alkali metal and nuclear fuel. It is a very potential candidate material in aerospace equipment energy system. Three kinds of molybdenum rhenium alloy bars were prepared by powder metallurgy. After forging deformation and stress relief annealing, the mechanical properties of molybdenum rhenium materials at room temperature and high temperature were tested and analyzed. It is found that with the increase of rhenium content, the tensile strength increases significantly, the elongation at room temperature decreases, and the elongation at 1100 ℃ increases slightly. The microstructure and fracture morphology of the material were observed by means of metallography, SEM, EBSD and TEM. It was found that the microstructure of the material had different effects on the room temperature and high temperature properties of the material.

Innovative Aspect(s):
The effects of different rhenium content on the mechanical properties of molybdenum rhenium alloy at room temperature and high temperature were systematically studied. Through micro analysis and data analysis, the effects of microstructure on room temperature and high temperature properties were studied, which is helpful to develop and prepare molybdenum rhenium materials with good room temperature and high temperature properties.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022
CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225368716

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Dr Baulin Oriane (CETIM, France)

Co-author(s): Dr Reynaud Christophe (CETIM, France)

Title: Development Of Metallic Glasses Through Hybrid Sintering Processes: Metal Binder Jetting (MBJ) & Spark Plasma Sintering (SPS)

Keyword(s):
Metallic glass, Metal Binder Jetting, Amorphous materials

Abstract:
The metallic glasses are knowing an increasing interest for the past decades. They exhibit very exceptional properties; however the main drawback is the limited size of the samples. The MBJ is a promising solution to obtain larger dimensions and high-resolution samples. Using SPS after MBJ process, ensure the production of high density, fully amorphous parts. In this study, a printing recipe has been found to get metallic glass green parts using the HERAEUS powder AMLOY ZR01. After finding that the curing and debinding steps have no influence on the amorphous character of the materials, a pre-sintering recipe in a sintering furnace has been developed. Meanwhile, after finding the parameters of the sintering process on the raw powder using SPS, the printed and pre-sintered parts have been sintered using SPS. The influence of carbon residues on the densification and stability of the materials have been discussed.

Innovative Aspect(s):
The innovative aspects of the presentation are: Processing fully dense amorphous alloys using raw| pure AMLOY Zr01 and SPS - Processing fully amorphous samples using Metal Binder Jetting and Spark Plasma Sinteing (way to process amorphous, complex shapes with high performance material, without any drawbacks linked to the supports or high residual stresses, induced by post-treatments) - Study of the interactions between the amorphous powder with carbon residues (ink), especially on the thermal stability

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Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225369761

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Mr Shigeta Yuji (Kyushu University, Japan)

Co-author(s): Dr Aramaki Masatoshi ; Dr Kudo Kentaro ; Prof Dr Ozaki Yukiko (Kyushu University, Japan) ; Prof Dr Nomura Naoyuki (Tohoku University, Japan) ; Prof Dr Kondoh Katsuyoshi (Osaka University, Japan) ; Dr Hoshino Masato ; Dr Uesugi Kentaro (Japan Synchrotron Radiation Research Institute, Japan)

Title: Understanding The Effect Of Process Parameters On Three-dimensional Pore Configurations And Mechanical Properties Of Laser Additive Manufactured Ti Using Synchrotron X-ray Computed Tomography And Homology

Keyword(s):
Additive manufacturing, CP-Ti, Persistent homology, Synchrotron X-ray computed tomography

Abstract:
Three-dimensional (3D) pore configurations were visualized using synchrotron X-ray computed tomography (CT), and persistent homology (PH) in addition to imaging analysis about additive-manufactured titanium (AM-Ti) specimens, prepared by different laser power and scanning speeds. The highest density was obtained at the middle of the laser energy density as a function of process parameters, such as the laser power and scanning speed. In the lower energy density, large irregular pores were observed along to the scanning directions. On the other hand, smaller round shaped pores due to balling phenomena generated in the higher energy density. These morphological parameters and the 3D configurations of pores will be quantitatively discussed in relation to process parameters and tensile strength.

Innovative Aspect(s):
Additive manufacturing is of great interest because of increase in variety applications, such as biomaterial and aerospace parts. It is necessary to correlate process parameters of additive-manufactured materials with mechanical properties for efficient production. To realized quantitative correlation these parameters, numerical data taken from three-dimensional (3D) configurations are desirable. In order to get high resolution 3D configuration images, we used synchrotron X-ray computed tomography. Numerical data was effectively obtained by utilizing persistent homology.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225369904

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Prof Dr Zhang Lin (University of Science and Technology Beijing, China)

Co-author(s): Dr Li Xingyu ; Prof Dr Qu Xuanhui (University of Science and Technology Beijing, China)

Title: Pressureless Two-step Sintering Of Ultrafine-grained Refractory Metals

Keyword(s):

Abstract:
Refining the as-sintered microstructure to ultrafine-grained and ultimately to nanocrystalline grain size and with low porosity and high spatial uniformity is much desired in terms of improved properties and reliability. Therefore, in this work, tungsten samples with 99.3% theoretical density and 290 nm average grain size, with a uniform grain structure, good grain boundary cohesion, and 7.8 GPa hardness that is the highest in all pressurelessly sintered tungsten. The initial powder and the resultant green bodies greatly affect later-on sintering kinetics and microstructural uniformity. The selection of the first- and second-step sintering temperatures, the thermodynamically required critical density to start the second-step sintering, and grain growth kinetics during sintering. were addressed. Moreover, we successfully sintered W-10Re alloy to 98.4% density below 1200 °C while maintaining a fine grain size of 260 nm and molybdenum to 98.3% density below 1120 °C while maintaining a fine grain size of 290 nm.

Innovative Aspect(s):
In two-step sintering experiment, the compacted green body is firstly heated up to a higher temperature T1 without holding to reach a relative density ρ>70-80% It is then cooled down to a lower temperature T2 (typically 100-200 °C lower than T1) and held at T2 until nearly full density is reached. The second-step sintering at T2 is able to allow densification while suppressing grain growth. In the present work, we found the critical role of the initial powders is revealed, which later translated to better sintering kinetics and spatial uniformity. By using modified powders, eliminating T1 holding and optimizing the sintering schedule, we were able to two-step sinter W to ρ=99.3% and Gavg=290 nm, with 7.8 GPa hardness that is highest in all pressureless sintered W. This represents a major advance where~6-fold coarsening is realized from powders to sintered pieces.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022
CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225370397

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Prof Dr Cury Rafael (Plansee Tungsten Alloys, France)

Co-author(s): Mr Mahot Pascal (Plansee Tungsten Alloys, France)

Title: Evaluation Of Tungsten Heavy Alloy Magnetic Properties With Respect To Their Composition For Balacing Weights

Keyword(s):
Tungsten Heavy Alloys, Density, Balacing weight, Magnetic properties

Abstract:
Tungsten heavy alloys are regularly used as a dense material on any application requiring balacing weights. From watch industry to aerospace, some of these alloys must show the ability to function without being affected by magnetic field. Iron and Cobalt are commonly used as an alloying element, along with Ni which is the main alloying element. Those 3 alloying metals are widely known as material which can be affected by such fields. Yet, depending on the concentration and the temperature, the properties might vary. Indeed, it is thus possible to have alloys used at room temperature containing certain amount of iron or cobalt without showing ferromagnetism.

Innovative Aspect(s):
The use of WHA for balacing weights is widely known. The presence of Fe is always questioned and some customers prefer to have W Ni Cu alloys instead. Those alloys can be quite adapted to their application but other options are also available as W Ni Fe or W Ni Co with both Fe and Co in low content in certain temperature ranges.

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Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

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WORLD PM2022
CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225370458

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Dr Liu Yijun (The Manufacturing Technology Centre, United Kingdom)

Co-author(s): Dr Cruchley Nick ; Mr Larkin Owen ; Mr Santos Pedro ; Dr Carpenter Charley (The Manufacturing Technology Centre, United Kingdom)

Title: Improved Thermal Conductivity Of PBF-LB AlSi10Mg Aluminium Structure Through Application Of Post Build Heat Treatments

Keyword(s):
Thermal conductivity, HIPing, PBF-LB

Abstract:
AlSi10Mg is one of the most researched and profitable aluminium alloys in the world of laser powder bed fusion (PBF-LB). AlSi10Mg remains one of the most suitable materials for the production of complex and light weight components requiring high strength and excellent specific thermal conductivity. Such applications include electric motor casings and heat exchangers which will have increasing demand with the upcoming move towards electric vehicles. Currently there is a lack of research into the thermal conductivity of PBF-LB AlSi10Mg. The work presented demonstrates significant improvement in the thermal conductivity of PBF-LB processed AlSi10Mg through a series of heat treatments. All post build heat treatments investigated improved thermal conductivity. A HIPing process combined with standard heat treatments produced the highest increase in thermal conductivity in the temperature range of -70°C to 250°C. This HIP route also resulted in improved tensile properties compared to the traditional heat treated specimens.

Innovative Aspect(s):
This research has looked into how the thermal conductivity of aluminium alloy is maximised but without compromising the overall mechanical properties when an aluminium structure is made with additive manufacturing (PBF-LB). This has become a very important topic in electrification sector in recent years. The thermal conductivity results were compared between traditional thermal processes and recently available advanced HIPing process with capabilities of rapid quenching and high pressure aging. As far as we know, this research would be one of the first researches in this area that has a direct link and impact on relevant industrial sectors.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason: .....

Notes to author: .....

WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371437

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Dr Ing Baffie Thierry (CEA-LITEN, Univ.Grenoble Alpes, France)

Co-author(s): Dr Ing Roux Guilhem ; Dr Ing Flament Camille ; Ing Soulier Mathieu ; Ing Pellat Michel ; Dr Ing Salvan Claudia (CEA-LITEN, Univ.Grenoble Alpes, France) ; Ing De Vernon Claudie (TOLECTRO SAS, France)

Title: Effect Of Powder Batches And Laser Power On The Microstructure And Properties Of As-built And Heat-treated Laser Powder Bed Fusion CuCrZr Samples

Keyword(s):
Additive manufacturing, Laser-Powder Bed Fusion, CuCrZr alloy, Microstructure, Heat treatment, Tensile properties, Thermal conductivity, Electrical conductivity

Abstract:
Recently, we showed that >99% dense CuCrZr parts can be produced by Laser Powder Bed Fusion (L-PBF) process using a large power range (270 to 480W) [1,2]. The as-built (AB) microstructure is anisotropic showing columnar grains aligned along building direction (BD). After a solution annealing and age hardening (SA+AH), solidification cells disappear and the dislocations density decrease, whereas partial recrystallization, twins and Cr nano-precipitates are observed. Even if the microstructure is not fully similar to wrought CuCrZr one, yield strengths are equivalent. This work aimed to develop further the process by: (i) evaluating the impact of incoming powders and lasing parameters on the AB microstructure, (ii) analyzing the microstructural effects of SA+AH and (iii) comparing the mechanical, thermal and electrical properties in both conditions for three powders. [1] C.Salvan et al., Proceedings EuroPM2019, Oct.13-17 2019 [2] C.Salvan et al., Mat. Sci. & Eng. A 826 (2021) 141915

Innovative Aspect(s):
Three powder batches (one produced by gas atomization and two by EIGA, Electrode induction melting Inert Gas Atomization) were used and their properties were compared. A part of the L-PBF samples was produced at high power (>400W), whereas the other was produced at low power (<400W) but with a volumetric energy density close. The microstructures were analyzed thanks to scanning electron microscopy (SEM) and Electron Back Scattering Diffraction (EBSD). SEM observations, grain size distributions, textures and local deformations helped us to understand the initial microstructure and the effect of the heat treatment. Tensile properties were measured at 20°C and 250°C along directions parallel and perpendicular to BD. Electrical conductivity was measured at 20°C and thermal diffusivity up to 300°C. A significant effect of the laser power is observed on the properties, whereas the incoming powder shows rather small effect. Several demonstrators were produced to validate complex components feasibility.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason: .....

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WORLD PM2022
CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371657

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Mr Vanzetti Matteo (Politecnico di Torino, Italy)

Co-author(s): Dr Padovano Elisa ; Prof Dr Biamino Sara ; Prof Dr Lombardi Mariangela ; Prof Dr Bondioli Federica ; Prof Dr Fino Paolo (Politecnico di Torino, Italy)

Title: Optimization Of Process Parameters For Pure Copper Manufactured By Green-laser Powder Bed Fusion Technology

Keyword(s):
Copper, Laser bed fusion technology, Green-laser source

Abstract:
Copper is a very promising and versatile engineering material. Its processing through additive manufacturing technologies has aroused increasing interest thanks to the possibility to obtain components with enhanced thermal, electrical and structural properties. The present work investigates the processing of copper through Laser Powder Bed Fusion technology. To overcome the well-known limit of high reflectivity of this material at IR laser radiation, an equipment with a green-laser source was used. Firstly, Single Scan Tracks were performed, and their main morphological characteristics were evaluated. According to the literature, this approach can provide information about the power and the scanning speed to be used for the processing of a material. Then, bulk samples were produced and characterized to further optimize the process parameters and find their best combination to obtain a fully dense material. This work was performed within the project “IMplementazione della Produzione Additiva CompetiTiva, IMPACT” co-financed by POR-FESR Piemonte 2014-2020.

Innovative Aspect(s):
Traditionally, copper and copper alloys are used for industrial applications where high thermal and|or electrical conductivity is fundamental. These applications often require components showing complex shapes to explicate their functions; generally, this implies the use of rather expensive processing methods. This study aims to process copper through innovative AM technologies which are able to overcome the limit of geometrical complexity. In fact, these processes, starting from a computer-aided-design model offer the possibility to highly customize and optimize the design of a component. However, the processing of Cu-based material by these techniques is very challenge due to its high reflectivity at the infrared wavelength (typically used in many commercial LPBF equipment) and its high thermal conductivity. The innovative approach of this study involves the use of an equipment with a green laser; in fact, copper shows a lower reflectivity and therefore higher absorption at wavelength of green laser radiation.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371687

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Dr Coffigniez Marion (UCLouvain, Institute of Mechanics Materials and Civil Engineering, IMAP, Belgium)

Co-author(s): Dr Duchaussoy Amandine ; Dr Marteleur Matthieu ; Dr Choisez Laurine ; Prof Jacques Pascal (UCLouvain, Institute of Mechanics Materials and Civil Engineering, IMAP, Belgium)

Title: First Insights In The Development Of TRIP|TWIP Ti Alloys Designed For Additive Manufacturing

Keyword(s):
Laser powder bed fusion, β-metastable titanium alloys, TRIP and TWIP effects

Abstract:
β-metastable Ti alloys exhibit, in the wrought state, a very large work hardening rate together with an extraordinary resistance to damage nucleation, resulting in a very high ductility . Such a behavior could enable to counteract the loss of mechanical properties caused by solidification cracking/hot tearing, balling or porosity formation during laser powder bed fusion. The binary Ti-12 wt.% Mo grade was chosen as case study, using both powder mixture and pre-alloyed powder. As-printed microstructures highlight the formation of a nano-cellular structures related to the solidification scheme, as well as a specific Mo solute partitioning when using the powder mixture. Such a specific microstructure brings a large increase in tensile strength due to an inhomogeneous activation of TRIP and TWIP effects. Furthermore, mechanical properties better than the wrought state reference are reached after a simple flash heat treatment.

Innovative Aspect(s):
Most of the time the shaping of parts by L-PBF lead to weaker mechanical properties than those obtained by casting. Here we demonstrate that it is possible to reverse this trend by printing β-metastable titanium alloys presenting both TRIP and TWIP effects.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371922

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Dr Cury Rafael (Plansee Tungsten Alloys, France)

Co-author(s): Dipl-Ing Mahot Pascal (Plansee Tungsten Alloys, France) ; Dr Handtrack Dirk ; Dr Kestler Heinrich (Plansee, Austria)

Title: Additive Manufacturing For Tungsten Heavy Alloys With High Mechanical Characteristics

Keyword(s):
Kinetic energy penetrators, Tungsten heavy alloys, Additive manufacturing, Swagging, Forging, Ammunition

Abstract:
Amour Piercing fin-stabilized discarding sabot is a type of a non-explosive kinetic energy penetrator ammunition used on anti-tank weapons. It requires material showing remarkable characteristics such as high density, high mechanical and impact resistance in order to provide the best penetration possible against targets. Tungsten Heavy Alloys are commonly used for this type of penetrators. Recently, with the increasing interest on Tungsten Heavy Alloy additive manufactured parts, it became mandatory to investigate the influence of this process on material properties. Thus, additive manufacturing was used to obtain bars, which were submitted to solid-liquid sintering under hydrogen and processed under vacuum to avoid embrittlement. These alloys were fully characterized with respect to their microstructure and mechanical characteristics. Results shown that additive manufacturing is a viable process for this type of alloys.

Innovative Aspect(s):
The use of additive manufacturing on ammunition products requesting forging operations. The density aspect (reaching the theoritical density with a 3D printing).

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371926

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Ing De Bortoli Lucia (University of Trento, Italy)

Co-author(s): Ing Amirabdollahian Sasan ; Prof Dr Molinari Alberto (University of Trento, Italy) ; Dr Facchini Luca (Lincotek Additive, Italy) ; Ing Rappo Stefano (Lincotek Medical, Italy) ; Dr Perini Matteo (ProM facility, Trentino Sviluppo, Italy)

Title: A Microstructural Analysis Of The Bonding Layer In The Manufacturing Of Co Alloy | Ti Alloy Bimetallic Components By Directed Energy Deposition

Keyword(s):
L-DED, Ti alloy, Co alloy

Abstract:
In the production of Co alloy | Ti alloy bimetallic components by Laser Directed Energy Deposition (L-DED), one critical issue is the microstructure of the metallurgical bonding layer produced by the melting of the substrate. This layer has a complex microstructure resulting from the mixing of the two alloys in liquid state and solidification. To investigate such a microstructure, specimens with a different content of the two alloys were produced by SPS and melted by laser, with the working parameters typical of the L-DED process. The solidified microstructure is quite complex. The SEM-EDXS and XRD analyses show the partitioning of Ti, Co and the alloying elements in different compounds and phases depending on the relative amount of the two alloys. The tendency to cracking shows a dependence on the microstructure.

Innovative Aspect(s):
The use of L-DED for the production of bi-metallic components made of the Ti6Al4V and Co28Cr6Mo alloys. The systematic investigation of the metallurgical bonding layer where the two alloys are mixed in liquid state and solidified.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225372034

Requested paper type: Oral Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Dr Fernandez-Silva Beatriz (The University of Sheffield, United Kingdom)

Co-author(s): Dr Sagoo Kam (Rheinmetall BAE Systems Land, United Kingdom) ; Dr Levano Oliver ; Prof Jackson Martin (The University of Sheffield, United Kingdom)

Title: Enhanced Ballistic Performance Of Low-cost Titanium Components Reinforced With Ceramic Inserts And Processed Using Field-assisted Sintering Technology

Keyword(s):
Titanium, Ballistic performance, Tile encapsulation, Field-Assisted Sintering Technology

Abstract:
Titanium is widely used for military applications due to its high strength-to-weight ratio and excellent corrosion resistance. However, the high cost of titanium has restricted its use to only the most critical applications. Recent research on low-cost titanium powders have shown its suitability to be consolidated in the solid state to form fully dense metals that meet military and industry specifications. Current investigation has showed the suitability of Field-Assisted Sintering Technology (FAST) to manufacture titanium alloy components for armour applications using surplus additive manufacturing powder feedstock. Furthermore, the ballistic performance on such specimens has shown to be equivalent to conventional Ti-6Al-4V rolled plate. This study is focused on manufacturing titanium components produced by ceramic encapsulation to provide enhanced structural confinement and disruption of ballistic threats. The FAST process was successfully used for the encapsulation of alumina tiles in Ti-6Al-4V, allowing for adequate bonding of the ceramic to the frame assembly.

Innovative Aspect(s):
Use of Low-cost titanium alloys powders for the manufacture of components for defence applications. Structural reinforcement of titanium alloys via encapsulation of alumina tiles. Field-Assisted Sintering Technology (FAST) has been proved to be a suitable technology for the confinement of ceramic tiles within titanium. Multilayered material consisting of different titanium alloys with enbebed ceramic tiles was succesfully achieved via FAST. The combination of a ceramic material with titanium alloys is expected to enhance the ballistic performance on amor applications.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225366643

Requested paper type: Poster Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Dr Mourgout Adrien (Université Sorbonne Paris Nord, France)

Co-author(s): Ing Gandolfi Juliette ; Prof Mawussi Mawussi ; Prof Dirras Guy (Université Sorbonne Paris Nord, France) ; Prof Amar-merah Souad (Université de Paris, France) ; Dr Hattal Amine (Z3DLab SAS, France) ; Dr Perrière Loic ; Ing PIRES Rémy (Institut de Chimie et des Matériaux de Paris-Est, France)

Title: Laser Powder Bed Fusion Processing Of Complex Concentrated Alloys For Bio-implants

Keyword(s):
Complex concentrated alloys, Additive manufacturing, Microstructure, Mechanical properties, Functionalization

Abstract:
As the population in modern societies ages and the risk of bone diseases or bone accidents increase, there is a need for a new generation of materials with superior biocompatibility and adequate mechanical properties. This study combines two innovative metallurgical concepts to provide a material solution for the intended application. To this end, multicomponent and complex concentrated alloys (HEA|CCAs) based on TiNbZr-X (X = Mo, Ta) system are fabricated via additive manufacturing (AM), namely by Selective Laser Melting (SLM) of both formulated powder blends and gas-atomized pre-alloyed powders. After each stage of development by SLM and microstructure optimization by Hot Isostatic Pressing, a full microstructure characterization and mechanical behavior of the resulting samples under different loading conditions are conducted. In addition, mechanical surface functionalization carried by machining with metrological monitoring is carried out as a pre-step before a chemical functionalization for the suitability of materials developed.

Innovative Aspect(s):
The study combines two innovative metallurgical concepts to provide a material solution for a societal issue. To this end, multicomponent and complex concentrated alloys (HEA|CCAs) based on TiNbZr-X (X = Mo, Ta) systems are fabricated via additive manufacturing (AM). Chemical functionalization will pave the way for biochemical functionalization for the intended application.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022
CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225367150

Requested paper type: Poster Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Dr Savich Vadzim (THE STATE SCIENTIFIC INSTITUTION "O.V. ROMAN POWDER METALLURGY INSTITUTE" (SSI PMI), Belarus)

Co-author(s): Dipl-Ing Tarajkovich Aliaksandr ; Dipl-Ing Kuznechik Oleg ; Dipl-Ing Golodok Robert (THE STATE SCIENTIFIC INSTITUTION "O.V. ROMAN POWDER METALLURGY INSTITUTE" (SSI PMI), Belarus)

Title: Properties Of Porous Composite Materials Of The «Titanium Powder - Carbon Fiber» System

Keyword(s):
Titanium sponge powder, Discrete carbon fibers, Porous aerators, Bubbles, Tensile strength

Abstract:
The idea of this work is that by introducing discrete hydrophobic carbon fibers into the initial charge based on sponge titanium powder, they should be evenly distributed across the outer surface and pore aerators. This will create conditions for fragmentation of the wetting perimeter and thereby reduce the size of gas bubbles in the liquid generated by porous aerator capillaries. Experimental porous samples with different carbon fiber content (5-15 mass%) are obtained by pressing composite batch method «titanium powder-discrete carbon fiber» and sintering the presses in a vacuum.

Innovative Aspect(s):
Samples properties studies have shown that carbon fiber introduction results in tensile strength increase in 4-15%, a decrease in pore size of 3-30% and a 5-25% permeability factor.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason: .....

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225367570

Requested paper type: Poster Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Dr Lee Pee-Yew (National Taiwan Ocean University, Taiwan)

Co-author(s):

Title: Fabrication Of Sn-Ti Amorphous Alloy Powders By Mechanical Alloying

Keyword(s):
Mechanial alloying, Amorphous powders, Intermetallic compound, Sn-Ti alloys

Abstract:
Mechanical alloying (MA) has become the mainstream of manufacturing amorphous alloy powders after the traditional rapid solidification technique. However, literature survey indicated that there are still no reports of successful preparation of Sn-Ti amorphous alloy powder by MA or gas atomization method. In this study mechanical alloying was used to synthesize SnxTi1−x alloys from mixtures of SnTi3 and Sn5Ti6 intermetallic compound powders, and also from mixtures of Sn5Ti6 intermetallic compound powders and pure elemental Sn powders. The mechanically alloyed powders were amorphous in the range $0.25 \leqslant x \leqslant 0.60$. This is the global first report on the successful preparation of Sn-Ti amorphous alloy powders. It is found that the morphological development during mechanical alloying of these powders is different from mechanical alloying using only pure ductile crystalline elemental powders. The thermal stability has been investigated. A high crystallization temperature of 580℃ was detected for amorphous SnTi3 alloy powders.

Innovative Aspect(s):
In this study mechanical alloying was used to synthesize SnxTi1−x alloys from mixtures of SnTi3 and Sn5Ti6 intermetallic compound powders, and also from mixtures of Sn5Ti6 intermetallic compound powders and pure elemental Sn powders. The mechanically alloyed powders were amorphous in the range $0.25 \leqslant x \leqslant 0.60$. This is the global first report on the successful preparation of Sn-Ti amorphous alloy powders.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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WORLD PM2022 CONGRESS & EXHIBITION
09-13 OCTOBER

Paper number: WP225371967

Requested paper type: Poster Presentation

Topic: Materials / **Subtopic:** Non ferrous materials

Author: Dr Wang Pei (Institute of Materials Research and Engineering, Singapore)

Co-author(s): Ms Chen Shilin ; Mr Lau Desmond ; Ms Lee Coryl ; Mr Wuu Delvin ; Mr Soh Verner ; Mr Chong Augustine ; Dr Wei Fengxia ; Dr Tan Dennis (Institute of Materials Research and Engineering, Singapore)

Title: Microstructural Evolution And Mechanical Properties Of Laser Powder Bed Fusion Equimolar CoCrNi Medium Entropy Alloy

Keyword(s):
Laser powder bed fusion, Medium entropy alloy

Abstract:
The equimolar CoCrNi medium entropy alloy attracts great interests due to their high strength, high ductility and exceptional fracture toughness at cryogenic temperatures. In this study, the CoCrNi MEA was fabricated using laser powder bed fusion (LPBF). The microstructure of as fabricated sample using optimized LPBF parameters shows strong (101) texturing as compared to other published works. The tensile properties are examined to reveal the anisotropic features of LPBF samples imposed by the texturing effects. Further EBSD analysis are also conducted to understand the microstructural evolution of nano-twinning and phase transformation during deformation. This study provides a new paradigm to guide the alloy design for metal additive manufacturing.

Innovative Aspect(s):
In this work, we have used the LPBF machine equiped with a fine-spot size laser. Different from other reported CoCrNi alloy, we have observed strong (101) texturing along the building direction. This has resulted in anisotropic straing hardening effect for as printed CoCrNi samples. This study can serve as a new paradigm for alloy design for metal AM using LPBF using a fine-spot size laser.

TPC Reviewer name: .....

Keynote ☐ Oral ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐

Poster ☐ Poster & Reserve Oral ☐

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