EURO PM2024

CONGRESS & EXHIBITION

Technical Programme Committee

8th of February 2024

ABSTRACTS BOOK

TOOLS FOR IMPROVING PM

EPMA

european powder metallurgy association

EURO PM2024

CONGRESS & EXHIBITION

Technical Programme Committee

8th of February 2024

TOOLS FOR IMPROVING PM

DESIGN & MODELLING

EPMA

european powder metallurgy association

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

Paper Number : T01
ID : 6277150

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Design and Modelling

Author : Dr Andersson Michael (Höganäs AB, Sweden)

Co-author(s) : Dipl-Ing Johansson Pernilla (Höganäs Sweden AB, Sweden); Dipl-Ing Heinrich Heike (Höganäs Sweden AB, Sweden)

Title : Modelling Of The Sinter Hardening Behavior Of Astaloy® CrS

Keyword(s) :
Sinter Hardening, Modelling, Hardenability

Abstract :
Sinter hardening is a cost efficient manufacturing process for press and sinter. At the same time material selection is crucial to make sure sufficient hardenability is reached. By selecting a higher alloyed material, hardenability can easily be satisfied, however this also increases the material cost. Thus, it's interesting to be able to optimize the composition. In this paper the potential to use Astaloy® CrS, a newly developed lean chromium grade, is investigated for sinter hardening in different combinations with nickel and graphite. A model is presented, where the cooling rates for sinter hardening conditions are calculated given the component size. The calculated cooling curves are then combined with hardenability data for different compositions to estimate the resulting structures. This way material composition can be optimized given a certain component geometry. Finally, the results are compared with experimental data to validate the model.

Innovative Aspect(s) :
A new modedlling tool to optimize material selection for sinter hardening, and balance aspects such as hardenability vs. cost.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T02
ID : 6278535

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Design and Modelling

Author : Mr Scholzen Philipp (Höganäs, Germany)

Co-author(s) : Mr Andersson Michael (Höganäs AB, Sweden)

Title : Modelling Surface Densification Rolling Of Powder Metal Gears

Keyword(s) :
Gear Manufacturing, Gear Production, Cold Rolling, Surface Densification, Modelling, Simulation, Gears

Abstract :
The powder metallurgical (PM) process chain is a great opportunity for gear manufacturing regarding both material and energy consumption when compared to the conventional gear production. However, the remaining porosity after pressing and sintering results in a lower load capacity of the tooth flank and tooth root. Therefore, PM gears for high performance applications are surface densified to increase the density of the surface of the tooth. This paper presents a new general approach of modelling the surface densification rolling process of PM gears. Using the finite element analysis, the material behavior, geometry, and process kinematics are modelled. The method leads to a prediction of the densification profile as well as geometry and can be used as a tool to optimize the rolling process. The results are evaluated and discussed in relation to the process parameters and material behavior.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T03
ID : 6278578

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Design and Modelling

Author : Mr Tischel Frederik (University of Bremen, Germany)

Co-author(s) : Prof Dr Ploshikhin Vasily (University of Bremen, Germany)

Title : Determination Of Process-related Time-dependent Sinter Strain And Viscosity To Simulate Distortion In Sinter-based Additive Manufacturing

Keyword(s) :
Sintering, Metal Binder Jetting, Ti-6Al-4V, Viscosity, Sinter Strain

Abstract :
Sinter-based Additive Manufacturing (SBAM) methods, such as Metal Binder Jetting, bridge the high productivity rate of series production and freedom of design in additive manufacturing. However, SBAM requires a subsequent sintering process to achieve the desired material properties, resulting in distortion due to anisotropic shrinkage and creep distortion. Numerical simulation can be used to predict and compensate for this distortion. The numerical approach requires the determination of sintering strain and viscosity. These material parameters depend on many factors and thus many experiments are necessary to specify all dependencies.In this study, sintering strain and viscosity are determined as process-related, time-dependent material parameters directly from sinter dilatometer experiments on binder-jetted Ti-6Al-4V samples under different loads. This new way of determining the material parameters makes it possible to sufficiently reduce the overall experimental effort. Futhermore, it allows more accurate calculations of sinter distortion compared to the results obtained using the conventional way.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T04
ID : 6282606

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Design and Modelling

Author : Dr Samarov Viktor (Synertech PM Inc., USA)

Co-author(s) :

Title : Engineering Tools To HIP Large PM Complex NNS Parts From The First Iteration

Keyword(s) :
HIP, Mathematical Modeling, Sustainable Technology

Abstract :
Dimensional capability, uniformity of mechanical properties, suppression of welds, fine grain size, suppression of welds, minimal machining and shorter lead times remain the main advantages of PM HIP. Recent developments in power generation require PM HIPed complex shape parts weighing many tons and very large dimensionally. To make this technology commercially efficient, it is necessary to be able to manufacture such parts from the first iteration. This requires the development through the process optimization and mathematical modeling of several important and innovative engineering tools , to ensure stable technological properties of powders, to control entire process of HIP capsules design and fabrication, to provide well controlled and stable boundary conditions on the surface of the capsules with powder during HIP and to ensure the uniformity of mechanical properties along the cross-section of the HIPed parts.The paper analyzes these engineering tools for development of large and heavy PM HIPed parts

Innovative Aspect(s) :
Ability to manufacture very large PM HIPed parts in one iteration using innovative tengineering tools

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024 CONGRESS & EXHIBITION

Technical Programme Committee
8th of February 2024

TOOLS FOR IMPROVING PM

DIGITILIZATION

EPMA
european powder metallurgy association

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

Paper Number : T05
ID : 6277046

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Digitilization

Author : Mr Power John J (University College Dublin, Ireland)

Co-author(s) : Mr Hartnett Mark (Irish Manufacturing Research, Ireland); Prof Dr Dowling Denis P (University College Dublin, Ireland)

Title : Using In-situ Process Monitoring To Enhance The Homogeneity Of Printed Ti-6Al-4V Alloy Microstructures At Overhangs

Keyword(s) :
Titanium, Process Monitoring, Microstructure, Porosity, Roughness

Abstract :
The evolution of laser powder bed fusion (L-PBF) has provided increased design flexibility in the fabrication of a range of parts, including aerospace components and medical devices. The presence of overhangs in metal alloy print structures, however, can give rise to enhanced levels of print defects such as porosity. This is associated with overheating of the alloy meltpool in the region around the overhang structures. This study demonstrated the effectiveness of in-situ meltpool process monitoring as a route to assist laser parameter optimisation for printed Ti-6Al-4V alloy parts. Informed by the observations from the process monitoring of the laser meltpool, the laser parameters are controlled to prevent overheating in the area around the overhang, yielding a more homogeneous printed part's microstructure. In addition to microstructure optimisation, the enhanced control of the L-PBF process yielded up to an 88% reduction in overhang roughness (Ra) and a 75% reduction in porosity.

Innovative Aspect(s) :
This work demonstrates the ability of an in-process data-based approach to help select the optimal L-PBF laser processing parameters during the printing of Ti-6Al-4V alloy microstructures at overhangs. This approach has been demonstrated to produce a more homogenous microstructure across the build, regardless of its geometry. This is achieved by controlling the laser energy during the L-PBF process to ensure that the alloy meltpools experience broadly homogeneous thermal processing conditions, as evaluated based on in-situ process monitoring. Achieving this has been shown to successfully print alloy parts exhibiting reduced porosity and a more uniform overhang roughness and microstructure. Thus reducing the level of anisotropy of the part's material.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T06
ID : 6281624

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Digitilization

Author : Dr Ing Piotter Volker (KIT, Germany)

Co-author(s) : Ing Klein Alexander (KIT, Germany); Ing Plewa Klaus (KIT, Germany); Mr Walter Heinz (KIT, Germany)

Title : A Rationalization Of Material Characterization And Fluid Modelling Interdependencies

Keyword(s) :
PIM Simulation, Feedstock Data Assessment, Digital Twin

Abstract :
Although key words like digital twin, digitalization, big data etc. are dominating our ideas for the future world of manufacturing there is still the demand for particular determination of real material parameters. Simulation of Powder Injection Molding (PIM) makes no exception, however, due to the high degree of particle filling even marginal changes of the initial values may lead to thorough differences of the results. The matrix of necessary material data (viscosities, pvT-data, etc.) will be evaluated with respect to validity and possibilities for improved material characterization will be proposed. It will be explained how particular material parameter variations influence final simulation results and how the reliability will be affected.

Innovative Aspect(s) :
PIM simulation optimization; PIM material data improvement; Digital twin capability

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024

CONGRESS & EXHIBITION

Technical Programme Committee

8th of February 2024

TOOLS FOR IMPROVING PM

SECONDARY OPERATIONS

EPMA

european powder metallurgy association

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

Paper Number : T07
ID : 6278537

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Secondary Operations

Author : Dr Vattur Sundaram Maheswaran (Höganäs AB, Sweden)

Co-author(s) : Mr Vinnerborg Fredrik (Höganäs AB, Sweden)

Title : Effect Of Density On The Mechanical Performance Of Astaloy® CrS And Fe-Cu-C After Heat Treatment

Keyword(s) :
PM Steels, Astaloy CrS, Cr Pre-Alloyed, LPC, Gas Carburising, Density

Abstract :
Astaloy® CrS is a Cr pre-alloyed water-atomised powder containing 0.85wt.%Cr and 0.15wt.%Mo, developed as a sustainable alternative to Fe-Cu-C PM steels. For applications demanding higher performance, secondary operations such as heat treatments(HT) are necessary. Carburising is one HT process to improve surface hardness, wear resistance and fatigue strength, leading to superior performance. For Fe-Cu-C materials, gas carburising(GC) is conventionally used, but for Cr pre-alloyed materials, low-pressure carburising(LPC) is preferred since it prevents oxidation. This investigation assesses the processing capabilities and the material requirements for successful heat treatment of Astaloy CrS. To achieve this, LPC and GC were performed on both Astaloy CrS and Fe-Cu-C samples with densities ranging from 7.1 to 7.4 g|cm3, sintered at 1120°C. The results indicated that the control over case depth is better for LPC than GC for various densities. Additionally, a correlation between density levels and carburising processes were seen in terms of mechanical performance.

Innovative Aspect(s) :
Astaloy CrS introduced recently as a sustainabel alternative to Fe-Cu-C, and being a lean Cr-alloy the sensitive to oxidation when it comes the conventional gas carburising is evaluated in this work. Also LPC combined with high pressure gas quenching is gaining interests for heat treating Cr-alloyed PM steels, where minimising the distortion is crucial. This study aims to highlight the properties (plane bending fatigue, transverse rupture strength, distortions) obtained after GC and LPC process, which enables for better understanding and optimising the process for increasing the performacnes. Through the increased use of Astaloy CrS will promote sustainability by improving material circularity by replacing Fe-Cu-C.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T08
ID : 6280783

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Secondary Operations

Author : Dr Mellin Pelle (Swerim AB, Sweden)

Co-author(s) : Mr Gårdstam Johannes (Quintus Technologies AB, Sweden); Mr Heino Stefan (Swerim AB, Sweden); Mr Shipley James (Quintus Technologies AB, Sweden); Mr Magnusson Anders (Quintus Technologies AB, Sweden); Mr Forsberg Fredrik (Luleå University of Technology, Sweden); Mr Forssgren Björn (Ringhals AB, Sweden); Mr Waernqvist Per (Ringhals AB, Sweden)

Title : Argon-filled Pore Expansion, As Function Of Material, Initial Pressure And Temperature

Keyword(s) :

Abstract :
We present here a study on capsules that contain a huge 2 cm3 cylindrical cavity. This cavity is sealed under 100% argon, at 50 °C and 1 atm. Using HIP (equipped with URQ) this cavity shrinks (non-uniformly) to an approximate size of 0.1 cm3. Upon stepwise reheating the pressure increases and for IN718 the cavity expands above 900 °C (here pressure is 832 bar) while for 316L the cavity expands above 1000 °C (here pressure is 875 bar). Conditions at which expansion occurs are not far away from HIP conditions, which makes sense. Also, the pressure inside a pore seems like a good indicator for if expansion will occur. We compare these results to studies of pore expansion in L-PBF material (both 316L and IN718) and conclude that the pore pressure in L-PBF material must be lower than atmospheric, since expansion occurs at higher temperatures than for our capsules.

Innovative Aspect(s) :
HIP, Porosity, Argon

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T09
ID : 6281579

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Secondary Operations

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

Co-author(s) : Prof Dr Danninger Herbert (Technische Universität Wien, Austria)

Title : Chromium And Tungsten Sulfides As Machining Aids In PM Steel

Keyword(s) :
PM Steel, Turning, Machining Aid, Thermal Stability

Abstract :
Additives in PM steels are widely used to improve machinability in turning or other machining operations. Commonly, MnS is added because it is cheap and does not have an excessive influence on the mechanical properties. However, MnS tends to form agglomerates and increases the susceptibility to corrosion in the sintered products. Potential alternatives could be sulfides of chromium or tungsten. In the present study these were compared with MnS at two different sintering temperatures. In addition to the thermal stability, both the machinability in turning and the mechanical properties were investigated. It turned out that at least Cr2S3 is a potential candidate as a cutting aid when sintering is done at belt furnace temperatures. Although WS2 seems to be effective, detailed analysis shows that this effectiveness is in fact due to the presence of MnS, which is formed during sintering by an internal getter effect.

Innovative Aspect(s) :
Potential candidates for machining aids are investigated. A comparison between MnS Cr2S3 and WS containing material is performed. Thermal stability by thermoanalytical techniques and analysis of micrographs show interesting aspects. Cr2S3 is stable at sintering temperatures of 1120°C, but transforms to MnS at 1250°C. WS 2 is less stable and already transforms into MnS at 1120°C. The source of MnS ist the dissolved Mn in the basic iron powder.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T10
ID : 6281733

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Secondary Operations

Author : Mr Schenk Oliver (RWTH Aachen University, Germany)

Co-author(s) : Dr Ing Rajaei Ali (RWTH Aachen University, Germany); Mr Bezold Alexander (RWTH Aachen University, Germany); Prof Dr Broeckmann Christoph (RWTH Aachen University, Germany)

Title : Numerical Assessment Of The Effect Of Cold Rolling And Case Hardening On The Fatigue Strength Of Sintered Steel

Keyword(s) :
Fatigue, Case Hardening, Surface Densification, Digital Twin, Astaloy 85Mo

Abstract :
Powder compaction and sintering offer the efficient and sustainable production of net shape components. As the inherent porosity affects the strength and durability, secondary operations such as cold rolling or shot peening may be applied to reduce the porosity. A combination with subsequent case hardening contributes to a further increase of fatigue strength. Numerous experimental studies examined the effect of various parameters of such processes on the fatigue behaviour. However, a numerical approach that accounts for the interaction between individual processes has rarely been reported.In this work, a computational approach is developed, which integrates the numerical modelling of surface densification, case hardening and loading condition to obtain information on the increase of fatigue strength of Astaloy 85Mo. The validity of the model is shown by comparison to available experimental findings on fatigue test bars. The potential of the approach is shown by its application to a sintered gear.

Innovative Aspect(s) :
The proposed approach fully accounts for the effect of the production parameters on density distribution and induced residual stresses. Consequently, the numerical deduction of the final strength includes the microstructural inhomogeneities within a component. In this way, it offers the virtual assessment of the interaction between individual process steps of the powder metallurgical process chain on the performance of a component. The approach can be used to optimize secondary processes and increase the reliability of powder metallurgical components.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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

Paper Number : T11
ID : 6281385

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Secondary Operations

Author : Ms Vezzani Ottavia (University of Ferrara, Italy)

Co-author(s) : Ing Gragnanini Michele (University of Ferrara, Italy); Prof Garagnani Gian Luca (University of Ferrara, Italy); Prof Dr Merlin Mattia (University of Ferrara, Italy); Dr Fortini Annalisa (University of Ferrara, Italy)

Title : Effect Of Post-sintering Heat Treatments On Mechanical And Tribological Properties Of A Ni-Cu-Mo Alloyed PM Steel

Keyword(s) :

Abstract :
Powder metallurgy (PM) steels with diffusion-bonded Ni exhibit microstructural inhomogeneities due to inadequate Ni diffusion during sintering. Sinter-hardening leads to a martensitic microstructure withNi-rich austenite areas. This study aims to assess the microstructural and mechanical effects of three post-sintering treatments. Specifically, to homogenize Ni distribution, two vacuum quenching at 900 °C for 1 h and 3 h followed by inert gas cooling were done. Besides a sub-zero quenching treatment, transforming residual austenite into martensite, was considered. Microstructural evolution wasanalyzed by hardness, X-ray diffraction, and optical and scanning electron microscopy techniques. Mechanical properties were evaluated through Charpy impact, tensile, and pin-on-disk tribological tests. The austenite content reduction and the resulting formation of Ni-rich martensite were found to mainly affect the material properties.

Innovative Aspect(s) :
The novelty of the present paper consists of the investigation of post-sintering heat treatments in relation to microstructural and mechanical properties enhancement. Specifically, the role of Ni content and its distribution are of primary interest.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024 CONGRESS & EXHIBITION

Technical Programme Committee
8th of February 2024

TOOLS FOR IMPROVING PM

SUSTAINABILITY & LIFE CYCLE ANALYSIS

EPMA
european powder metallurgy association

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

Paper Number : T12
ID : 6275974

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Sustainability & Life Cycle Analysis

Author : Mr Gopaluni Aditya (VTT Finland, Finland)

Co-author(s) : Mr Reijonen Joni (VTT Finland, Finland); Mr Antikainen Atte (VTT Finland, Finland); Ms Lotta Hepo-oja (VTT Finland, Finland); Mr Puukko Pasi (VTT Finland, Finland); Mr Gopaluni Aditya (VTT Finland, Finland)

Title : A Comparative Life Cycle Assessment Study Of Laser Powder Bed Fusion, Binder Jetting And CNC Machining Processes

Keyword(s) :
Additive Manufacturing, Metal Powders, Sustainability, LCA

Abstract :
Additive Manufacturing (AM) is considered as one of the most suitable methods for building parts with complex designs. AM is also described as an efficient and sustainable manufacturing method, when compared with traditional manufacturing methods. To understand the credibility of AM as a sustainable and efficient process, a study of the life cycle assessment (LCA) was conducted for the PBF-LB, BJT-M and CNC machining for manufacturing of an impeller. The LCA calculations were made for different scenarios with respect to the powder feedstock. It was observed from the LCA calculations that BJT-M had the largest CO2 footprint compared to PBF-LB, followed by CNC machining across all scenarios. It was concluded that the BJT footprint is higher than the remaining process owing to the extra steps involved in making the part ready for use, mainly sintering. The study was performed to highlight the limitations of sustainability analyses for the BJT-M process.

Innovative Aspect(s) :
AM is always considered a sustainable process with limited evidence related to it. In this study, we aim to gather evidence on the sustainability aspects of PBF-LB|M, BJT-M and CNC machining processes by conducting an LCA study from cradle to gate. The idea behind this study is to establish a methodology for developing a sustainability analysis for the AM. With an established methodology, it would be easier to improve the AM processes when the key areas contributing to the carbon footprint can be identified.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T13
ID : 6277236

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Sustainability & Life Cycle Analysis

Author : Ms Marttila Veera (Technological Research Centre of Finland VTT, Finland)

Co-author(s) : Ms Kivikytö-Reponen Päivi (Technological Research Centre of Finland VTT, Finland); Mr Lagerbom Juha (Technological Research Centre of Finland VTT, Finland); Ms Huttunen-Saarivirta Elina (Technological Research Centre of Finland VTT, Finland)

Title : Life Cycle Assessment Of Recycled WC-Co Through Zinc Processing

Keyword(s) :

Abstract :
Literature has not addressed, currently, the environmental benefits of recycling cemented carbides, such as tungsten carbide cobalt (WC-Co), compared to primary production. However, recycling of materials, such as tungsten and cobalt is crucial given that the European Commission has identified these materials as Critical Raw Materials (CRMs). Primary production of WC-Co requires high amounts of chemicals and energy. In this study, in recycling the WC-Co is processed through zinc processing, which provides a shorter processing route and induces smaller environmental impacts than conventional methods while increasing the material circularity. This study provides a life cycle assessment (LCA) for the recycling of WC-Co powder from WC-Co products. The benefit of recycling WC-Co products compared to primary manufacturing is illustrated by comparing the LCA results to existing literature studies based on primary raw materials. The life cycle inventory is collected within collaboration of Finnish and European companies from hard metal industry.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

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EURO PM2024 CONGRESS & EXHIBITION

Technical Programme Committee
8th of February 2024

TOOLS FOR IMPROVING PM

TEST & EVALUATION

EPMA
european powder metallurgy association

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

Paper Number : T14
ID : 6276968

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Test and Evaluation

Author : Ing Stephan Maxime (CEA, France)

Co-author(s) : Dr Ing Burr Alexis (CEA, France); Dr Ing Roux Guilhem (CEA, France); Dr Ing Ablitzer Carine (CEA, France); Dr Ing Garandet Jean-Paul (CEA, France)

Title : Comparison Of Experimental And Numerical Heap Profiles During Powder Spreading In Additive Manufacturing Processes

Keyword(s) :
Additive Manufacturing, Heap Profiles, In situ Measurements, Discrete Element Method, Parameter Identification

Abstract :
The powder spreadability drives the robustness of powder-bed-based additive manufacturing processes as well as the material performance of the printed parts. The full comprehension of the mechanisms involved during powder spreading is therefore paramount.Past works using the discrete element method (DEM) showed that the impact of friction between the powder and previous layers (building platform or solidified layers) is significant [1]. Thus, we developed an experimental test bench that captures in real time during spreading the heap profile depending on the substrate roughness. Additionally, we also demonstrate that the effective surface energy of the powder can be related to experimental measurements of the angle of the front of the heap.In short, this work shows the relevance of our test bench to understand powder deposition experimentally, but also its potential interest to calibrate DEM simulations for further spreadability optimizations.[1] Stephan et al., 2023, Powder Technology, 429, 118937.

Innovative Aspect(s) :
This work stands out by the novelty of the test bench, which enables in situ measurements of the heap profile during powder deposition on a substrate by using a laser profilometer. Thanks to a 25 µm resolution and a large acquisition frequency over 100 Hz, the determination of the angle of the front of the heap is accurate and time dependent. This work covers a large combination of surface roughnesses and starting powders, which provides a representative diversity of heap profiles to understand the behavior of powder during spreading. In contrast to current studies, the general method that we are proposing allows to experimentally calibrate numerical parameters one by one without interferences of others. This should lead to a better reliability of simulations of powder spreading by DEM.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T15
ID : 6281732

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Test and Evaluation

Author : Prof Amanov Auezhan (Tampere University, Finland)

Co-author(s) : Dr Zohrevand Milad (Tampere University, Finland)

Title : Effect Of Ultrasonic Nanocrystal Surface Treatment On The Reduction Of Surface Porosities In Powder Metallurgy Products

Keyword(s) :
UNSM, Powder Metallurgy, Densification, Porosity Reduction

Abstract :
In this study, the effect of ultrasonic nanocrystal surface modification (UNSM) treatment on the improvement of the surface properties, density, and reduction of surface porosities of the pure iron powder metallurgy (PM) produced samples was investigated for green and sintered conditions. The UNSM treatment resulted in a surface severe plastic deformation (S2PD) and generated a gradient hardness from the surface to the depth. The EBSD analysis also revealed a gradient grain size as well as dislocation density along the depth. It turned out that the UNSM treatment can effectively remove the surface porosities in both green and sintered specimens. A higher affected depth was observed by increasing the static load, vibration amplitude, and the number of scan cycles. The results from this work confirmed that the UNSM technique can be employed as an effective industrial method to enhance the properties and performance of PM products.

Innovative Aspect(s) :
In our previous works, we used the UNSM method as a post-process after sintering copper powder in order to reduce surface porosities. In this study, we employed the UNSM method for the same purpose of surface densification in iron powder metallurgy products.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T16
ID : 6281408

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Test and Evaluation

Author : Ing Hajeck Tobias (IWM RWTH Aachen University, Germany)

Co-author(s) : Prof Dr Beiss Paul (IWM RWTH Aachen University, Germany); Dipl-Ing Bezold Alexander (IWM RWTH Aachen University, Germany); Prof Dr Broeckmann Christoph (IWM RWTH Aachen University, Germany); Mr Burkamp Karl (RWTH Aachen University, Germany)

Title : Hardness Conversion For Sintered Steels: Comparative Analysis And Function Evaluation Across Various Hardness Scales

Keyword(s) :
Hardness Conversion, Macro Hardness, Sintered Steels, Conventional Methods, Rockwell, Vickers, Brinell Scales, Tailored Conversion Functions, Industry Impact, Improved Data Interpretation Tools, Material Assessments

Abstract :
This article explores the task of macro hardness conversion in sintered steels, emphasizing the limitations of conventional conversion methods designed for normal steels with full density. Through systematic experimentation with diverse sintered steel samples, encompassing Rockwell, Vickers, and Brinell scales, this study identifies discrepancies in hardness measurements. To address these challenges, we propose tailored conversion functions specifically crafted for sintered steels, providing accurate and reliable translations between different hardness scales. This research not only highlights the unique hardness dynamics in sintered steels but also contributes essential tools for improved data interpretation and comparability within the industry.

Innovative Aspect(s) :
This paper innovates by focusing on macro hardness conversion in sintered steels, departing from conventional studies on normal steels. Through systematic experimentation with various sintered steel samples and exploration of Rockwell, Vickers, and Brinell scales, the study identifies discrepancies in hardness measurements. The proposal of tailored conversion functions specific to sintered steels represents a key advancement, addressing the unique hardness dynamics of these materials. This innovation provides essential tools for improved data interpretation and comparability within the industry, impacting engineers, metallurgists, and researchers working with sintered steels. The practicality of the research lies in its potential to enhance reliability in material assessments through more accurate conversions and meaningful comparisons of hardness data.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T17
ID : 6278519

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Test and Evaluation

Author : Dr Kuhnt Markus (FOERSTER, Germany)

Co-author(s) : Ms Bordunova Anna (FOERSTER, Germany)

Title : Measurements Of Specific Saturation Magnetization Of Samples With Low Magnetic Moment

Keyword(s) :
Specific Saturation Magnetization, Co-WC Alloys, Measurement Equipment

Abstract :
The measurement of specific saturation magnetization according to IEC 60404-14:2002 has become a standard tool in the powder metallurgy industry. It allows a non-destructive composition inspection of the amount of ferromagnetic material. In recent years, measurements of test specimen with lower magnetic moment (e.g. by reducing the amount of Co-binder or by miniaturization) have received more and more attention.In this study, the accuracy and reproducibility of measurements of samples with a low magnetic moment according to IEC 60404-14:2002 have been investigated. Influences of temperature, sample size, sample movement and slider have been addressed. Different methods of slide compensation will be presented and the influences on measurement accuracy will be discussed.

Innovative Aspect(s) :
The paper shows a detailed evaluation of measurement accuracy, especially focusing on samples with low magnetic moment. Moreover, it discusses different compensation methods for signals from the slider itself. In this way it contributes to a better understanding of the influences of measurement accuracy and with this a way to establish a frame for increased accuracy.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T18
ID : 6282834

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Test and Evaluation

Author : Dr Mellin Pelle (Swerim AB, Sweden)

Co-author(s) :

Title : A Newly Created Reference Material Containing Argon, And Why It Matters

Keyword(s) :
Argon, PM HIP

Abstract :
Detection of argon in PM HIP material is a critical quality control which is now standardized, see EN ISO 5842:2023. This standard requires the use of an argon-containing reference material. Such a material is now available in large quantities thanks to a number of collaborating organizations, and the method to make it is presented here. This constitues the last piece of the puzzle which enables robust and standardized quality control of PM HIP material. The argon content of the now available reference material is 100 ng|g. Detecting such a low content is required because of the way Argon distributes in PM HIP material, which is also presented.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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EURO PM2024 CONGRESS & EXHIBITION

Technical Programme Committee
8th of February 2024

TOOLS FOR IMPROVING PM

OTHER TOOLS FOR IMPROVING PM

EPMA
european powder metallurgy association

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

Paper Number : T19
ID : 6269731

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Other Tools for Improving PM

Author : Dr Forouzan Farnoosh (Höganäs AB, Sweden)

Co-author(s) : Ing Henrich Heike (Höganäs AB, Sweden); Dr Zohrevand Milad (Faculty of Engineering and Natural Resources, Tampere University, Finland); Dr Chasoglou Dimitris (Höganäs AB, Sweden)

Title : Effect Of Ultrasonic Tempering In Comparison With Thermal Tempering On Hardened High Carbon Powder Metallurgy (PM) Produced Samples

Keyword(s) :
High-Power Ultrasonic Treatment, PM , Tempering

Abstract :
In this study, the effect of high power ultrasonic treatment (UST) in comparison with common thermal tempering on PM products after sintering and quenching of the (0.8%C-0.85%Cr-0.15% Mo) alloy is investigated. Results from microhardness, EBSD, and XRD shows a promising level of tempering in the samples just after 4 minutes of UST by decreasing the strain level in the specimen through the dislocation annihilation. In comparison, thermal annealing at 200° C for 1 hr was associated with lower hardness level and formation of M23C6 carbides but almost the same strain level and dislocation denity. Results of this study confirm that the ultrasonic treatment is not only rapid, easy method with much lower energy consumption to stress relief the component after quenching but also keeps the strength level higher in comparison with thermal tempering.

Innovative Aspect(s) :
High-power ultrasound has progressively been used in several manufacturingprocesses. It has been demonstrated that the acoustic energy, similar tothe thermal energy, has a softening effect on metals. However, it is very new techinc and not been investigated on powder metallourgy produced samples for this goal yet as far as the authors knowledge.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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

Paper Number : T20
ID : 6280947

Requested presentation type : Oral Presentation

Topic : Tools for Improving PM **Subtopic :** Other Tools for Improving PM

Author : Ing Puigardeu Aramendia Sergio (Hewlett Packard, Spain)

Co-author(s) : Ing Canto Estany Diana (Hewlett Packard, Spain); Ing Saula Miquel (Hewlett Packard, Spain); Ing Sole Macia (Hewlett Packard, Spain)

Title : Low Level Device Subsystem Telemetry Data Sharing From Every Job To Enable Job Comparasion And Process Control

Keyword(s) :
Additive Manufacturing, Metal Binder Jetting 3d Printing, Process Control, Key Performance Indicators, Process Monitoring

Abstract :
Low level subysystem information is collected during operation process (powder loading, printing, or post printing operation) and shared though a application programming interface (API) in order to enable final user to: Understand how the printer behaved during the experiment; Identify differences between printers|jobs to help identify root cause issues; Ensure device to device repeteability and test reproducibility.

Innovative Aspect(s) :
The implemented solution enables and simplify the process to improve workflows and boost productivity through KPI monitoring; Keep historical records of every printed job for complete tracking; Manage operations more efficiently and prevent unscheduled maintenance

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

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