EURO PM2023
CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

ABSTRACTS BOOK – GROUP I

MATERIALS

EPMA
european powder metallurgy association

EURO PM2023
CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

MATERIALS

HARD METALS, CERMETS AND DIAMOND TOOLS

EPMA
european powder metallurgy association

EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235756856

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Dr Ing Cinca Nuria (Hyperion Materials and Technologies, Spain)

Co-author(s) : Dr Lavigne Olivier (Hyperion Materials and Technologies, Spain)

Title : Effect Of WC Grain Size On The Corrosion Behavior Of WC-Co Cemented Carbide In Acidic, Neutral And Alkaline Media

Keyword(s) :
Cemented Carbides; Corrosion

Abstract :
The effect of the WC grain size on the corrosion resistance of cemented carbides is not well established in the literature. In this study, the electrochemical behaviour of WC-12wt.%Co hard materials with various starting grain sizes (ultrafine, fine and medium) were evaluated in aerated 3.5 wt.% NaCl media at pH 1, 6 and 11, by means of electrochemical methods (electrochemical impedance spectroscopy and polarization scans). Results showed that the corrosion resistance of the material is strongly dependant on the WC grain size. In acidic and neutral media, the corrosion resistance of the material increased with the increase of the WC grain size, while in alkaline media an inverse trend was observed. Results are discussed in terms of thermal residual stresses, thermodynamical stable phases in function of the pH, and varying sizes of anodic and cathodic areas resulting from different WC grain sizes.

Innovative Aspect(s) :
There seems to be some discrepancy in the literature with the WC grain size effect on corrosion. Involving different pH media in the study, we want to give a more application approach, intended to rationalize the microstructure design with the performance.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235761011

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Miss Fooladi Mahani Saghar (Universitat Politècnica de Catalunya - BarcelonaTech, Spain)

Co-author(s) : Dr Liu Chao, Dr Cai Xiaokang (Xiamen Tungsten Co., Ltd., China), Prof García-Marro Fernando, Prof Jiménez-Piqué Emilio, Prof Llanes Luis (Universitat Politècnica de Catalunya - BarcelonaTech, Spain)

Title : Damage Maps Of Cemented Carbides Under Contact Loading: Assessment By Means Of Hertzian, Conical, And Vickers Indentation

Keyword(s) :
Contact Loading; Contact Damage Map; Hardmetals; Indentation

Abstract :
Resistance to contact loading is a key issue to consider for microstructural design of cemented carbides to be used as tools and wear components. In this work, Hertzian, conical, and Vickers indentation has been implemented to assess contact damage response for three microstructurally different WC-Co cemented carbides; in doing so, distinct load ranges were applied: up to 294 N, 490 N, and 1470 N for Vickers, conical and spherical indentation respectively. Deformation and damage linked to indentations were inspected at both the surface and the subsurface, the latter through sequential tomography. Results are presented as damage maps as a function of applied load. It is found that critical load values for the emergence of cracks and their subsequent evolution are strongly dependent on indenter geometry (linked to specific stress fields) and fracture toughness of the material. Practical implications of these findings, in terms of damage tolerance, are finally discussed.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235762742

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Prof Gordo Elena (University Carlos III Of Madrid, Spain)

Co-author(s) : Mr Sánchez-Escudero Gabriel, Mr Biedma Angel, Dr de Nicolás-Morillas María, Mr Villemur Juan (University Carlos III of Madrid, Spain), Dr Bertalan Claudio, Dr Useldinger Ralph (CERATIZIT Luxembourg S.àr.l., Luxembourg), Prof Llanes Luis (Univ Politècnica de Catalunya, Spain)

Title : Oxidation And Wear Behavior Of Co-free Hardmetals Using Ti(C,N) And WC Ceramic Phases

Keyword(s) :
Alternative Hardmetal; Co-Free; Oxidation; Wear; Mechanical Properties

Abstract :
This paper shows the results of mechanical properties (hardness, toughness, TRS) together with studies of wear and oxidation at high temperatures of a set of composite materials formed by a ceramic phase, Ti(C,N) or WC, and a Co-free metal binder. The materials have been processed by powder metallurgy, including milling, uniaxial pressing, and sinter-HIP. Standard cylindrical specimens have been used for TRS tests. The oxidation tests have been carried out in static air up to 1000°C. To study the wear behaviour, reciprocating sliding tests have been carried out, using WC-Co balls as countermaterial, loads of up to 50 N and test times up to 30 minutes. During the test, the coefficient of friction has been recorded, and after the tests, the mass variation has been measured, in addition to the width and depth of the wear tracks by means of an optical profilometer.

Innovative Aspect(s) :
Research in alternative compositions for hardmetals is usually focus on developing a correct microstructure and reaching appropriate mechanical properties of the novel ceramic-metal combinations. However, the interaction with environment is a key aspect that should be studied. In this work, it is studied the wear and high-temperature oxidation behaviour of a family of hard materials containing FeNiCr as binder phase, and the results compared with a commercial hardmetal. The microstructure and properties (hardness, toughness) of these materials were presented on previous conferences and published in journal articles, but the results shown here are new, and necessary to assess the potential of these compositions for some applications.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

……

EURO PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235762765

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Dipl-Ing Zanon Matteo (Ecka Granules Germany GmbH | Kymera International, Germany)

Co-author(s) : Dr Förner Andreas, Mr Kossakowski Darek (Ecka Granules Germany GmbH | Kymera International, Germany)

Title : Hot Pressing Behaviour Of Newly Developed Premixed Materials For Diamond Cutting Tools

Keyword(s) :
Diamond Tools; Cobalt-Free

Abstract :
A new family of cobalt-free premixed materials for diamond cutting tools was developed as an alternative to both pure cobalt and "prealloyed" powders. This product family was designed to combine high mechanical properties with the compressibility and process simplicity intrinsic to the premixed approach. Hot pressing results are herein presented for several grades and compared to their free sintering performance. Influence of main processing parameters and their impact on physical and mechanical properties is discussed. The matrix interaction with synthetic diamonds and its degree of metallurgical bonding is studied as well, on both a qualitative and quantitative basis.

Innovative Aspect(s) :
There exists a still unmet need in the market for products which show a performance comparable to hydrometallurgical powders but produced via simpler, less energy-intensive, environmentally friendlier processes. Desirable is also a high compressibility, which automatically leads to relatively low shrinkage in free sintering processes, thus allowing for further efficiencies throughout the value chain.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763624

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Prof Dr Lengauer Walter (Vienna University of Technology, Austria)

Co-author(s) : Dipl-Ing Fürst Markus, Dipl-Ing Nahringbauer Peter (Vienna University of Technology, Austria), Dr Tarrago José Maria, Dr Moseley Steven (HILTI Corp., Liechtenstein)

Title : Tailoring Properties Of Ti(C,N)-based Cermets By Modification Of Starting Powders And Sintering Atmosphere

Keyword(s) :
Cermet; Sintering; Hardness; Fracture Toughness; Saw Blade; Metal Cutting

Abstract :
Various Ti(C,N) cermet grades were prepared by the conventional powder-metallurgical route. For each grade the starting powder formulation was varied with respect to the alloy status of the hard phases while keeping the overall starting composition identical. In addition, different sintering atmospheres were applied which influences the final C and N concentration. The sintered bodies were investigated for hardness, fracture toughness, porosity and eta phase formation. Analysis of C, N, O before and after sintering was done and thermal conductivity was measured on the dense-sintered materials. The influence of sintering atmosphere, powder type and carbon doping on N and C content, hardness, fracture toughness as well as on thermal conductivity is discussed. A broad range of different properties was achieved with the identical overall starting composition but different hard-phase powers and sintering conditions.

Innovative Aspect(s) :
Tuning properties without changing overall composition.
Use of sintering atmosphere for influencing properties.
Alternative powders- Materials with low supply risk.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763635

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

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), , Mr Ibarreta Lopez Federico, Mr Martinez Pampliega Roberto (FMD CARBIDE, Fabricacion Metales Duros, S.A.L., Spain)

Title : Effect Of Vacuum Level On The Sintering Behaviour Of TiC-Fe-Mo-Cr Cermets

Keyword(s) :
TiC Cermets; Effect of Vacuum; Mo2C; Oxide Carbothermal Reduction; CCT Curves

Abstract :
The limited availability of materials like tungsten, cobalt or nickel is a risk for the hardmetal industry. TiC based cermets are candidates for replacement of hardmetals in certain hot wear applications. Air quenchable TiC-Fe-Cr-Mo cermets have been produced by vacuum sintering. Molybdenum was added either as Mo2C or as metallic powder. The vacuum level is critical for controlling compositional gradients and porosity removal. Introduction of argon overpressure once deoxidation phenomena are finished is key for avoiding binder evaporation. Mo2C powders induce higher densification that those based on metallic Mo. This is likely related to its finer particle size distribution and its contribution to the carbothermal reduction of oxides during the sintering cycle. CCT curves of selected compositions have been investigated for optimizing the thermal treatments required for achieving the required levels of hardness, strength and toughness.

Innovative Aspect(s) :
Compositional design of TiC-Fe-Cr-Mo cermets free of critical raw materials.
Study of the effect of vacuum during the heating ramp. No need of sinter-HIP equipment.
Analysis of carbothermal reduction of oxides and its relationship with the properties of selected powders.
Elimination of porosity and control of undesired surface gradients- Investigation of CCT curves for optimizing thermal treatments after sintering.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763660

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Mr A Prabin (Kennametal India Limited, India)

Co-author(s) : Mr Auneau Florian (NGL Cleaning Technology SA, Switzerland), Dr Schmutz Patrik (EMPA, Switzerland), Mr Howard IV William (Kennametal Inc., USA), Mrs K S Anvitha (Kennametal India Limited, India)

Title : Corrosion Inhibition On Cemented Tungsten Carbides

Keyword(s) :
Cemented Carbide; Corrosion Inhibitors; Cobalt Corrosion Inhibitors; Cemented Carbide Processes

Abstract :
Cemented tungsten carbide (WC-Co) materials are made of tungsten-carbide grains embedded in cobalt matrix and been used for making metal cutting and mining tools through powder metallurgical processes. Cobalt is known to be sensitive to corrosion in aqueous environment and multiple surface preparation processes on the cemented carbide exposes cobalt to aqueous conditions where the knowledge on corrosion is less known. Thus, the study is aimed to understand the corrosion behavior of cemented carbides with different inhibitors in varying pH and temperature environments. This study also evaluates conditions where the corrosion inhibitor can be removed or reduced for varying cobalt binder, surface conditions for cemented carbide processes and for alternate corrosion inhibitors with lesser health and environmental impact. This will help in improving cemented carbide tool performance in high demanding service conditions and application in oil and gas extraction in tetra-phasic (sea water, sand, liquid and gaseous hydrocarbons) conditions.

Innovative Aspect(s) :
The information on the effect of different inhibitors used in the cemented carbide processes is not available currently. This study aimed to understand the corrosion behavior of cemented carbides with inhibitors and efficiency of the system in varying pH and temperature environments. Among the corrosion inhibitors, benzotriazole and its derivatives are known to be the most efficient, however these compounds are concerned by health issues (some of them are suspected of being carcinogenic) and environmental challenges (benzotriazole is considered as a micropollutant product). This analysis evaluates conditions where the corrosion inhibitor can be removed or used at lower concentrations without any impact on the WC-Co substrate along with inhibition efficiency comparison with alternate corrosion inhibitors.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763766

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Dr De Gaudenzi Gian Pietro (F.I.L.M.S. S.p.A., Italy)

Co-author(s) : Miss Tedeschi Sandra, Mrs Pirone Fransisca, Mr Ruggiero Domenico (F.I.L.M.S. S.p.A., Italy), Ing Tavola Francesco, Prof Dr Bozzini Benedetto (Politecnico di Milano, Italy)

Title : Electrochemical Recovery Of Metallic Values From Hardmetal Scraps: Can It Be Still Taken Into Consideration Or Should We Give It Up?

Keyword(s) :
Hardmetal Scrap; Critical Raw Material Recovery; Circular Economy; Carbon Foot-Print; Electrochemical Impedance Spectroscopy; Electrochemical Behaviour

Abstract :
Circular use of the main hardmetal constituents is mandatory for European industrial economy. Over the past 20 years some recovery processes have been integrated in the extractive metallurgy or directly in the hardmetal production processes. Among attempted recovery routes, electrochemical methods have been studied since the '50's, although they never climbed to the level of an industrial process. In this work, we present the crucial electrochemical knowledge-base that has enabled the definition of an electrochemical demolition process, claiming to overcome the productivity barrier that, so far, has hindered the industrial application of electrochemical scrap treatments. In particular, in this contribution, we concentrate on the systematic investigation, centered on Electrochemical Impedance Spectrometry, of the electrochemical response of HM in the pseudopassive and transpassive condition, an appropriate sequence of which is adopted in our electrochemical demolition process. As a worst-case benchmark, this study revolves around a representative series of corrosion-resistant grades.

Innovative Aspect(s) :
Development of a new, low carbon-footprint, electrochemical process for the recovery of Critical Raw Materials based on the mechano-electrochemical demolition of hardmetal scrap.Application of Electrochemical Impedance Spectroscopy (EIS) in order to examine in depth the transpassive behaviour of a corrosion resistant class of hardmetals. The relationship between pseudo-passive and transpassive behaviour of hardmetals.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

……...

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763795

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Mr Anwer Zahid (KU Leuven, Belgium)

Co-author(s) : Prof Dr Vleugels Jef, Dr Huang Shuigen (KU Leuven, Belgium)

Title : High Entropy Carbide - Ni Based Cermets Prepared By In-situ Carbothermal Reduction Of Transition Metal Oxides

Keyword(s) :
High Entropy Carbide Cermets; Carbothermal Reduction; Pressureless Sintering; Microstructure

Abstract :
Fully dense high entropy carbide (HEC)0.8-Ni0.2 based cermets were prepared by in-situ carbothermal reduction of mixtures of transition metal oxides from Group IV, V and VIB by a one-step reactive sintering technique. The molar ratio of metal oxides and graphite in the starting powder mixtures was varied and the evolution of the microstructure, grain size and morphology of the HEC phase were studied in detail. The in-situ carbothermal reduction of oxides resulted in a high entropy carbide phase with a homogeneous atomic number contrast with an extremely faint core-rim structure. This study demonstrates a facile and cost-effective alternative synthesis approach to prepare chemically complex high entropy carbide based cermets in a one-step pressureless sintering cycle.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764239

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Dipl-Ing Rodrigues Daniel (BRATS Sintered Filters and Metallic Powders, Brazil)

Co-author(s) : Dr Janasi Suzilene (BRATS Sintered Filters and Metallic Powders, Brazil), Mr Miranda Fábio (Univresity od São Paulo, Brazil), Dr Ing dos Santos Ortega Fernando (UNIVAP, Brazil)

Title : Gelcasting Of NbC20Ni Cemented Carbide

Keyword(s) :
NbC-Based Hardmetals; Gelcasting; Cemented Carbides; Near Net Shape Powder Processes

Abstract :
Gelcasting has been successfully used to produce high performance sintered ceramic components, and large shrinkage, during high temperature sintering, is usual to obtain high density parts, since very fine ceramic powders are used as raw material. The same approach can be considered for cemented carbides (hard metals), and near net shape parts can be produced with the use of adequate moulds and, if necessary, with the additional milling operations prior sintering. Fine niobium carbide and nickel powders were used to get aqueous slurries, that were adjusted to mould near net shape parts to get sintered cemented carbides with homogeneous microstructure, and with a good combination of hardness and toughness. The slurry stability was investigated considering mainly solids loading. Nature and amounts of monomers, dispersants and additives were also investigated. Samples and prototypes were sintered in high temperatures under vacuum, and characteristics as density, microstructure and hardness were evaluated.

Innovative Aspect(s) :
The innovative aspect of this paper is the use of a ceramic gelcasting rout to produce a new cemented carbide based on niobium carbide. The advantages of gelcasting, if compared with press and sintering processes, is the possibility to obtain complex shapes even for large pieces. Additionally, more homogeneous carbide and nickel mixtures can be obtained from suspensions, if compared with the conventional milling processes. Homogeneous powder mixtures can provide a better microstructure, with the binder (nickel) insulating the carbides, improving mechanical properties, particularly fracture toughness. The definition of good production parameters, during gelcasting and sintering, can be also considered as innovative.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2 23
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764267

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Dipl-Ing Serra Fanals Marc (Universitat Politècnica de Catalunya (UPC), Spain)

Co-author(s) : Dr García-Marro Fernando, Prof Dr Llanes Luis (Universitat Politècnica de Catalunya (UPC), Spain), Dr Ing Cinca Núria (Hyperion Materials&Technologies, Spain)

Title : Optimization Of Fatigue Strength Assessment In Hardmetals Using A Reduced Number Of Samples By Means Of Dixon And Mood Model

Keyword(s) :
Hardmetals; Fatigue; Fatigue Strength; Finite Fatigue Life; Dixon and Mood

Abstract :
Hardmetals are composite materials comprising carbides embedded in a ductile metallic binder. This combination, with different relative amounts and sizes of ceramic particles, allows obtaining a wide variety of microstructural qualities with excellent mechanical and tribological properties. However, many of the applications in which these materials are used involve cyclic stresses, which often lead to premature failure of components and tools. Therefore, studying the fatigue strength of hardmetals is a topic of great practical interest. A commonly used method to estimate the fatigue strength of structural materials is the "staircase method". Results obtained are usually analyzed by Dixon and Mood approach. Trying to optimize time and resources, this work analyzes the use of a modified staircase method, to optimize the methodology to both evaluate the fatigue resistance by using a reduced number of samples and improve the acquisition of statistical information on the reliability of the fatigue life.

Innovative Aspect(s) :
This work analyzes the use of a modified staircase method (versus the "traditional staircase methodology)", to optimize the methodology, evaluate the fatigue resistance by using a reduced number of samples and improve the acquisition of statistical information on the reliability of the fatigue life. In addition, this work is done within the framework of finite fatigue life, focusing on the first cycles (200,000) of the component's service life.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235764634

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Mr Andersson Tom (VTT, Finland)

Co-author(s) : Dr Lindroos Matti, Dr Ren Sicong, Mr Suhonen Tomi, Dr Laukkanen Anssi, Dr Lagerbom Juha, Mr Lindroos Tomi (VTT, Finland), Dr Rey Rodriguez Pilar (Aimen, Spain)

Title : Estimating Long Term Behaviour Of DED-printed AlCoNiFe Alloy

Keyword(s) :
Crystal Plasticity Modelling; Compositionally Complex Alloy

Abstract :
We present a prediction of longer term behaviour for an alloy designed for application, which require high strength materials even in elevated temperatures, with multiscale material modelling method. Material is designed to have suitable phase composition with CALPHAD-method and neural network tool that is taught with the empirical high entropy alloy design criteria. The material is estimated to be two phase (FCC-BCC) structure in as build condition and after heat treatment gamma-gamma' and BCC-B2 structure. Designed alloy is atomized and test specimens are produced with direct energy deposition method and heat treated to get the desired phase composition. Tensile tests and micromechanical characterization are combined with simulation tools to create a micromechanical model that is used for mechanical property and performance simulations. A workflow to combine the different length scales in order to assess the performance of the material and ultimately the final component is presented.

Innovative Aspect(s) :
New type of dual phase high strength material that has, according the ThermoCalc analysis, 4 phase structure when heat treated properly and that has the potential to have high strength also in higher temperatures. Also new micromechanical tools capable of simulating the behaviour of a material consisting of FCC (gamma-gamma' structure) and BCC (BCC + B2) phases have been developed and applied.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

……

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764988

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Mr von Spalden Mathias (Fraunhofer IKTS, Germany)

Co-author(s) : Dr Ing Pötschke Johannes (Fraunhofer IKTS, Germany), Dr Rosiński Marcin (GeniCore Sp. z o.o., Poland)

Title : Reactive Sintering Of Hardmetal-diamond-composites With Adapted Binder Systems

Keyword(s) :
Hardmetal; WC; Diamond Enhanced Cemented Carbide; DECC; Diamond Tools; FAST; SPS; Coating; Reactive Sintering

Abstract :
In this work, a new approach for preparation of hardmetal-diamond-composites has been evaluated. The main challenge to overcome is the phase transformation of metastable diamond into graphite during sintering. Despite using field assisted sintering to reduce sintering time and temperature as well as an adapted Ni-Cu binder system instead of Co, graphitisation cannot be fully suppressed. To further reduce the amount of graphite formed, two measures were combined in this study. In the first step diamond grains with different coatings (Ti, TiC, W) were used. In the second step hardmetal powder with a slight carbon deficit was prepared to absorb excess carbon through in-situ formation of WC. Together with simultaneous optimisation of the sintering parameters, the introduction of coated diamonds and reactive sintering, graphitisation could be successfully minimized.

Innovative Aspect(s) :
To the authors' knowledge there has not been any approach to minimize the amount of graphite in diamond enhanced cemented carbides by simultaneously applying a FAST process, using an optimised composition of a Co-free binder system as well as coated diamonds and reactive sintering.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

……...

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765016

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Prof Dr de Oro Calderon Raquel (TU Wien, Austria)

Co-author(s) : Prof Dr Schubert Wolf-Dieter (TU Wien, Austria)

Title : Insights On The Microstructural Characteristics Of WC-Co-Ru Cemented Carbides

Keyword(s) :
WC Based Cemented Carbides; Ru Additions; Phase Formation; Mechanical and Magnetic Properties

Abstract :
WC-Co cemented carbides alloyed with Ru are relevant for the hardmetal industry in spite of their high cost. These alloys are used in applications requiring very demanding thermal properties and good performance in aggressive and abrasive media, and for some applications, it is difficult to find an alternative material that could offer a similar performance. This paper will provide important insights on phase formation, solubilities and microstructural characteristics of WC-Co-Ru alloys with different carbon contents that can shed some light on the mechanisms that affect the mechanical performance of these materials.

Innovative Aspect(s) :
Systematic study of the system WC-Co-Ru at different carbon contents.
Phase formation and phase characteristics, solubilities, hardness and magnetic properties.
Effect of cooling rates.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765024

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Ing Mégret Alexandre (University of Mons, Belgium)

Co-author(s) : Ing Rodriguez Paco (Diarotech, Belgium), Prof Dr Vitry Véronique, Prof Dr Delaunois Fabienne (University of Mons, Belgium)

Title : Influence Of The Amount Of Recycled Cemented Carbide Powder On The Mechanical Properties Of WC-Co Parts Sintered By Unconventional Technologies

Keyword(s) :
Recycled Powder; Ball Milling; Unconventional Sintering; Hardness; Grain Size Distributions

Abstract :
The trend in the cemented carbide field is to reduce the use of raw cobalt powder in tungsten carbide parts and to develop new binders: indeed, the cobalt price fluctuates extremely due to different factors, mainly its massive use in batteries of electric vehicles, and its extraction as by-product of copper and nickel mining.The use of a recycled tungsten-cobalt carbide powder skirts the cobalt problem and allows the sintering of WC-Co parts without raw Co powder. In this study, the material is composed of two powders: a powder made from raw materials (WC and Co powders mixed together) and a recycled powder (crushed powder containing 7.5 wt% Co). HIP and SPS are used as sintering technologies before morphological and mechanical characterizations. Mechanical properties of these samples can be tuned with the addition of recycled powder and the parts resulting from the experiments are in total competition with conventional ones.

Innovative Aspect(s) :
The characterization of recycled tungsten carbide-containing powder is rare in the literature. We propose a study of the influence of the amount of recycled WC-Co powder for the carbide tool field. Moreover, different sintering technologies are studied to evaluate the most efficient.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765050

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Mr Biedma Trillo Ángel (University Carlos III of Madrid, Spain)

Co-author(s) : Dr Chirico Rodríguez Caterina del Carmen, Mr Villemur Tamarit Juan, Dr Gordo Odériz Elena (University Carlos III of Madrid, Spain), Dr Herraiz Lalana Enrique, Dr Pérez Rodríguez Marcos, Dr Sanz Moral Luis Miguel (ArcelorMittal Global R&D SLab, Spain)

Title : Effect Of The Addition Of Nanoparticles In The Design Of Hard Metals And Cermets

Keyword(s) :
Alternative Hard Materials; Boron Nitride; Graphene; Microstructure; Mechanical Properties

Abstract :
In the replacement of the traditional WC-Co, the reduction of critical raw materials is sought. However, alternative compositions have not yet become substitutes in their entirety. Instead of adding secondary carbides, the addition of small amounts of nanoparticles may be of interest in improving the design of new alternative cemented carbides and cermets compositions. In this research boron nitride and graphene have been dispersed on the ceramic phase in order to study the effect on the microstructure and mechanical properties of two compositions formed by Ti(C,N)-FeNiCr and WC-FeNiCr and processed by powder metallurgy techniques. It has been found that the introduction of these nanoparticles has produced microstructural variations and has increased the hardness values of the initial compositions. This method and results demonstrate that it is possible to control the mechanical properties of hard metals and cermets with alternative compositions by means of small modifications.

Innovative Aspect(s) :
It has been studied alternative compositions for the traditional WC-Co cemented carbides. The metallic binder phase FeNiCr is a critical raw materials free composition, replacing Co. By the introduction of boron nitride and graphene, other methods are avoided as it is the introduction of heavy metal carbides. Our research provides another point of view when it comes to developing this type of materials through small modifications as it is the introduction of nanoparticles.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765296

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Mr Oliveira Gonçalo (University of Coimbra, Portugal)

Co-author(s) : Mr Mineiro Ricardo, Prof Dr Rocha Senos Ana Maria (University of Aveiro, Portugal), Dr Fernandes Cristina, Mr Figueiredo Daniel (Palbit S.A, Portugal), Prof Dr Vieira Maria Teresa (University of Coimbra, Portugal)

Title : WC-Co Versus TiCN|WC--Co, Ni For Internal Cooling Cutting Tools

Keyword(s) :
Material Extrusion (MEX); WC-Co; Ti(CN)|WC-Co,Ni; Filament of Ceramic Composite

Abstract :
New tool are required for the cutting tool industry to make more efficient and tailored solutions. Material extrusion (MEX) as an additive manufacturing should be used to process cermets based on WC-Co or TiCN|WC and Co, Ni metallic binders. MEX is an interesting technology due to its versatility to make from different feedstocks cutting tools with inside complex geometries. MEX became possible to make hollow tools with more efficient and complex cooling solutions, based on constructal or conformal cooling. However, it is not yet easy to replicate the main MEX parameters developed for organic or metallic materials when the feedstock is based on ceramic powder. The main objective of this study is to contribute to a better understanding of the cermet behaviour as function of ceramic powder. Defects of 3Dobject made from two different powder selected were analysed, along with a debinding strategy that best outfits the elected design.

Innovative Aspect(s) :
WC-Co and Ti(CN)|WC-Co,Ni cutting tools with constructal and conformal internal cooling system.
Filaments based on WC-Co and Ti(CN)|WC-Co,Ni powder, optimized for MEX production requirements.
Near net-shape manufacturing with almost no waste.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765328

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Mr Biedma Trillo Ángel (University Carlos III of Madrid, Spain)

Co-author(s) : Miss Vera Vionnet Camila, Dr Tabares Lorenzo Eduardo, Dr Gordo Odériz Elena (University Carlos III of Madrid, Spain), Dr Schsuchnigg Stephan, Dr Kukla Christian, Dr Cano Cano Santiago (Montanuniversitaet Leoben, Austria)

Title : Multi-Material Cermet-Stainless Steel Parts By Pellets Extrusion Additive Manufacturing

Keyword(s) :
3D Printing; Composite Extrusion Modelling (CEM); Pellets Additive Manufacturing (PAM); Multi-Material Additive Manufacturing (MMAM); Cermets; Stainless Steel

Abstract :
Material extrusion is a versatile group of additive manufacturing techniques which can be used for the production of metal, ceramic or composites, using filaments or pellets of highly-filled polymers. This study explores the feasibility of printing multi-material parts by pellet extrusion. Two different feedstocks have been produced with the same binder system and two different powders: a cermet with composition Ti(C,N)-FeNiCr and 316L stainless steel. Two extrusion heads, each one with a different feedstock, have been used to print three types of samples: monomaterial, bimaterial and gradient material. The debinding and sintering processes are studied by measuring properties after each step: such as shrinkage, relative density, mass loss and hardness, as well as controlling the microstructure and structural integrity of the samples throughout the process.

Innovative Aspect(s) :
The possibility of producing mono and multi-material parts by pellets extrusion additive manufacturing has been studied. Thanks to the combination of two print heads, laminated geometries and even gradients can be obtained, thus creating a distribution of properties within the part.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

……

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765382

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Ing Berger Christian (Fraunhofer IKTS, Germany)

Co-author(s) : Dr Ing Pötschke Johannes, Dr Ing Scheithauer Uwe (Fraunhofer IKTS, Germany)

Title : Correlation Of Different Cemented Carbide Starting Powders With The Resulting Properties Of Components Manufactured Via Binder Jetting

Keyword(s) :
Cemented Carbide; Powder, Additive Manufacturing; FESEM, Hardness, Hardmetal, Binder Jetting

Abstract :
For some years now, the production of cemented carbide via the powder-based additive manufacturing process binder jetting has been pursued. Binder jetting offers the possibility of high production compared to alternative AM processes. Due to the powder-based process, the green bodies usually have a low green density, which means that only higher Co contents with lower resulting hardnesses are possible. By choosing the right starting powder and a suitable post-processing, the previous limits can be extended and the appropriate powder can be chosen depending on the application. In the context of this study, the correlation between different cemented carbide starting powders with different morphologies is investigated and evaluated for their processability in the BJT process and the resulting properties of the sintered components.

Innovative Aspect(s) :
First time consideration of different starting powders (> 4) with strongly different morphology in the BJT process of cemented carbide and their effect on the properties of the sintered bodies. All powders can be processed to full density bodies. Here, hardnesses of over 1300 HV10.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765405

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Prof Miranda Georgina (CICECO - Aveiro Institute of Materials, Portugal)

Co-author(s) : Miss Basílio Liudmila, Mr Guimarães Bruno, Prof Carvalho Óscar (CMEMS - University of Minho, Portugal), Dr Fernandes Cristina, Mr Figueiredo Daniel (Palbit S.A., Portugal), Prof Dr Silva Filipe (CMEMS - University of Minho, Portugal)

Title : Fabrication Of Micro-scale Laser Textured Surfaces On WC-Co Green Compacts

Keyword(s) :
WC-Co; Green Compacts; Laser Surface Texturing; Micropatterns

Abstract :
Laser surface texturing has a high potential for the development of innovative solutions for the cutting tool industry, by allowing the fabrication of high-precision micro-scale geometries. In this study, different cross-hatched micropatterns were explored, by using an Nd:YAG laser to texture WC-10wt% Co green compacts. After dewaxing and sintering, a complete characterization was performed to evaluate topography, roughness, and dimensions of the fabricated textures. This study allowed to conclude on the better scanning strategy and laser parameters for obtaining a given texture geometry with defined dimensions on a reproducible manner. Besides allowing to modify a selected surface area, targeting to higher wettability or increased contact area, this approach has shown not to compromise the integrity and mechanical strength of the compact, allowing to preserve the tool conventional functionality.

Innovative Aspect(s) :
Due to the high hardness of WC-Co, surface modification of this material is very difficult by conventional machining. The adoption of green compacts laser surface texturing allows to overcome the challenges of conventional machining, such as the appearance of micro cracks, due to locally induced thermal mismatches, as well as allowing a high material removal rate, good surface quality, precise dimensions and the production of complex shapes.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765427

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Dr Srinivasan Suresh (University of Warwick, United Kingdom)

Co-author(s) : Prof Marshall Jessica, Mr Gillham Joe, Dr Singh Gurdev (University of Warwick, United Kingdom)

Title : Tungsten Carbide For Radiation Shielding: A Comprehensive Review

Keyword(s) :
Cemented Tungsten Carbides; Radiation Shielding Material; Nuclear Power; Nuclear Medicine

Abstract :
Cemented tungsten carbides (cWC)s are attractive radiation shielding material candidates, from their high density, ease of manufacture and excellent mechanical properties. Recent research indicate that cWCs can have better radiation shielding behaviour compared to conventional candidate materials. The application of tungsten carbide as a radiation shielding material has not been well understood due to the use of highly activating Co and Ni as the main binder alloys and still lacking in the literature. cWCs are of particular interest since the mixture of high and low Z-elements offers effective shielding against gamma and neutron radiation, photons and fast neutron capture|removal cross section. The presence of carbon in cWCs contributes to the moderation of fast neutrons flux, reducing their contribution to total dose rate. In this paper, tungsten carbide applications in nuclear power and nuclear medicine are reviewed. The key challenges and further research for the future direction are highlighted.

Innovative Aspect(s) :

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765436

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Mr Guimarães Bruno (CMEMS - University of Minho, Portugal)

Co-author(s) : Dr Fernandes Cristina, Mr Figueiredo Daniel (Palbit S.A., Portugal), Prof Dr Silva Filipe (CMEMS - University of Minho, Portugal), Prof Miranda Georgina (CICECO - Aveiro Institute of Materials, Portugal)

Title : Chip Morphology Evaluation On Turning Of 316L Stainless Steel Using Laser Surface Textured WC-Co Cutting Tools

Keyword(s) :
WC-Co Cutting Tools; Laser Surface Texturing; Micropatterns; Turning; Chip Morphology

Abstract :
During machining processes, a large amount of heat is generated, especially in the cutting zone, due to deformation of the material and friction of the chip along the surface of the tool, resulting in a wear increase and consequently reducing the lifetime of cutting tools. Surface texturing can help improve their tribological performance by increasing load carrying capacity, providing a better availability of lubricant at the tool-chip interface and reducing the tool-chip contact area. In this sense, this work proposes the fabrication of cross-hatched micropatterns on WC-Co cutting tools by laser surface texturing of green compacts, for improving these tools performance and life. Turning of 316L stainless steel was performed with textured tools to assess and evaluate the chip morphology of the different cross-hatched micropatterns, being these findings benchmarked against conventional cutting tools and correlated with the tool wear.

Innovative Aspect(s) :
The addition of surface textures to WC-Co cutting tools can help improve their tribological performance by increasing load carrying capacity, providing a better availability of lubricant at the tool-chip interface and reducing the tool-chip contact area. In this sense, this work resort to a laser surface texturing of WC-Co green compacts approach, to create cross-hatched micropatterns in cutting tools for improving these tools performance and life.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

……...

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765461

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Ing Cabezas Laura (CIEFMA - Department of Materials Science and Engineering (UPC), Spain)

Co-author(s) : Dr Jiménez-Piqué Emilio, Prof Llanes Luis (CIEFMA – Department of Materials Science and Engineering (UPC), Spain), Dr Pötschke Johannes (Fraunhofer Institute for Ceramic Technologies and Systems, IKTS, Germany)

Title : Micromechanical Mapping Of High Entropy Carbide Based Hardmetals

Keyword(s) :
High Entropy Carbides Based Hardmetals; Massive Nanoindentaion; High-Speed Nanoindentation; Statistical Analysis; Small-Scale Mechanical Properties; Microstructural Assemblage

Abstract :
High Entropy Alloys (HEA), mixture of an equal or relatively large portion of five or more elements are presented as a good replacement providing good wettability, high toughness, wear resistance, and temperature stability. Inspired by the concept of HEA, high entropy carbides (HEC) have gained attention in recent years. Within this context, the microstructure and micromechanical properties of the same (HEC) composed of (Ti, Ta, Nb, V, W) with two different binder, Ni and Co, were characterized. Hardness (H), elastic modulus (E) and H|E cartography maps were obtained by using a high-speed nanoindentation mapping technique, which allows not only to assess the intrinsic mechanical properties of HEC, binder and interphase, but also the successful microstructural assemblage. A total of 40,000 imprints were performed in each grade. The obtained data sets are statistically treated following two deconvolution approaches: 1D and 2D Gaussian fitting, providing the micromechanical behaviour of these novel carbides.

Innovative Aspect(s) :
This study developes a small-scale assesment of the mechanical properties, Hardness and Elastic Modulus, in a hardmetal composed by High Entropy Carbides (HEC) with two different binders, a novel material. This approach is conduct using an advanced micromehcanical technique; high-speed nanoindentation. It allows to develope arrays with thousands of imprints which it means thousands of data. Thanks to that a statistical analysis can be developed, to validate not only the reliable of the intrinsic mechanical properties of HEC particles, binder and interphase region, but also by the successful mirroring of microstructural assemblage within the mechanical maps attained.

Reviewer's name : ……

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : ……

Notes to author : ……

……...

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765471

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Dr Ing Gestrich Tim (Fraunhofer IKTS Dresden, Germany)

Co-author(s) : Dipl-Ing Hering Benjamin, Dr Ing Pötschke Johannes, Dipl-Ing Vornberger Anne, Dr Kaiser Arno, Dipl-Ing Gruner Daniel (Fraunhofer IKTS Dresden, Germany)

Title : Thermophysical Properties Of Hardmetals In Dependence On Used Carbide And Binder Phase Composition

Keyword(s) :
Hardmetals; High Entropy Carbide Cobalt; Tungsten Carbide High Entropy Alloy; Thermal Diffusivity | Heat Conductivity, Electrical Conductivity; Grain Size; Carbon Balance

Abstract :
Alternative compositions of hardmetals with hard phases other than WC and binder phases other than Co are more and more interesting due to both CRM (critical raw materials) and CMR (carcinogenic mutagenic reprotoxic) issues. So far, a basic understanding how other hard phases or binder phases change the thermophysical properties is not known. To address this question hardmetals with similar grain size and amount of metallic binder but different chemical composition are prepared and their magnetic properties as well as the electrical and heat conductivity | thermal diffusivity are analysed. Next to a reference straight tungsten carbide-cobalt grade (WC-Co), other compositions are niobium carbide-cobalt (NbC-Co), a high entropy carbide-cobalt (HEC-Co) and to study alternatives binders WC-Fe-based and WC-HEA (high entropy alloy).

Innovative Aspect(s) :
Newly developed hardmetals (Co-free- | HEA-binders or grades with high entropy carbides) require new methods to evaluate the material properties after sintering with regard to grain size and carbon content. Electrical and heat conductivity | thermal diffusivity may be used for this purpose. In order to obtain more information on the correlation between these properties, different grades of hardmetals are characterised and discussed.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023 CONGRESS & EXHIBITION

01-04 October 2023

Paper Number : EP235763911

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

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

Co-author(s) : Ing Meylan Ludovic, Ing Rodriguez-Arbaizar Mikel, Prof Dr Constantin Raymond, Ing Stucki Michel, Prof Dr Waelder Georg (University of Applied Sciences and Arts Western Switzerland, Switzerland)

Title : Cermet Cutting Tool Inserts Improved By Laser Grinding And HIPIMS Coating

Keyword(s) :
Cutting Tool Inserts; (TiCN)-Mo-Ni; Cermets; Compaction; Sintering; Laser Grinding; HiPIMS Coating; Palmqvist Toughness; Hardness; Wear Resistance

Abstract :
Ti(C,N)-Mo-Ni cermets cutting tool inserts have been produced by cold compaction and sintering of commercial ready to press granules. The insert cutting edges were sharpened by laser grinding before coating with a TiAlN layer by High power impulse magnetron sputtering (HiPIMS). The inserts have been characterized by hardness, Palmqyist toughness, density measurements and SEM observation. Titanium Grade 5 bars were turned to evaluate the coated cermet performance and compared with commercial tungsten carbide inserts treated with the same surface finishing.

Innovative Aspect(s) :
Development of new cermet inserts by sharpening with ultrashort pulse laser, followed by HiPIMS coating.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235764264

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Dipl-Ing Rodrigues Daniel (BRATS S, Brazil)

Co-author(s) : Prof Dr Otávio dos Santos Marcelo (Mauá Institute of Technology, Brazil), Mr Miranda Fábio, Prof Dr Ferreira Batalha Gilmar (University of São Paulo, Brazil)

Title : WC Cemented Carbides: Microstructural Aspects Comparing PBF-L Additive Manufacture And Convencional LPS

Keyword(s) :
WC-Based Hard Metals; Alternative Binder Phases; L-PBF Additive Manufacturing Microstructural Characterization for Hard Metals

Abstract :
This work aims to compare the conventional powder metallurgy, via Liquid Phase Sintering (LPS, with additive manufacture (AM), via PBF-L (Laser Powder Bed Fusion), considering WC cemented carbides and binders like Co, Ni and mixtures of Co and Ni. The mixtures were produced from dried slurries and some powder agglomeration was obtained with the use of organic binder. The great challenge was to improve flowability to obtain bed as homogeneous as possible, so, additionally, a vibrating container was used to spread powder trying an uniform bed. Conventional samples were produced by press and high temperature vacuum sintering. For AM, laser power versus velocity were investigated. Microstructures were evaluated considering carbide distribution and the presence of cracks and porosities. The effects of different metallic binders were presented and discussed Ni and mixtures of Ni and Co presented better results for PBF-L.

Innovative Aspect(s) :
The innovative aspect of this paper is the discussion the microstructures for hard metals comparing conventional LPS processes with PBF-L additive manufacture. The evolution of the LPS processes during more than 100 years establishes fundamentals and technology considering different classes (mixtures of different carbides and metallic binders) and processes to achieve a proper microstructure considering a specific application. For PBF-L we do not have a liquid phase for a enough period of time to wet properly the carbides, and process adjustments or post processing should be necessary to customize microstructure considering different applications.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765435

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Dr Gomes Uilame (Universidade Federal Do Rio Grande Do Norte, Brazil)

Co-author(s) : Mrs Oliveira Gerlânea, Dr Lima Maria José, Mr Santos Fernando (Universidade Federal Do Rio Grande Do Norte, Brazil)

Title : Study Of The Effect Of Sintering Temperature On Hard Metal(WC-15%pNi.)

Keyword(s) :
Hard Metal; Powder Metallurgy; High Energy Grinding; Microhardness; Sintering

Abstract :
The objective of this work was to investigate the effect of temperature on the sintering of the WC-15%pNi composite. The sintered product was obtained through powder metallurgy processing steps, in which tungsten carbide powders – WC with an addition of 15%w. Nickel – (Ni) were ground in a high-energy planetary mill for 8 hours. Samples sintered at temperatures of 1350°C and 1450°C with an isotherm of 30 and 90 minutes were characterized by SEM, EDS, optical microscopy, and microhardness measurements. According to the results, the sample sintered at a temperature of 1450°C and an isotherm of 90 minutes showed the highest microhardness value, equal to 1095.2 HV.

Innovative Aspect(s) :
Carbides are of great technological importance, as they have a high melting point, good wear resistance and extreme hardness. Due to these factors, they have great applicability as special matrices in the aerospace, war, metallurgical and chemical industries. Thus, nickel has been widely used in studies as a substitute for cobalt in hard metal due to its greater resistance to corrosion and oxidation, presenting a lower cost when compared to cobalt and does not present risks to the environment because it is not toxic. In addition to the reported aspects, the use of Ni as a substitute for Cobalt does not cause a reduction in the mechanical properties of the hard metal.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765066

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Prof Dr Filgueira Marcello (Northern Fluminense State University, Brazil)

Co-author(s) : Dr Rosa Joice, Ing Guimarães Renan, Dr Ing Lugon Rafael (Northern Fluminense State University, Brazil)

Title : SPS Manufacture Of Self-Lubricated CNT Added Hardmetals Inserts

Keyword(s) :
Hardmetals; SPS; Carbon Nanotubes; Metalworking; Flank Wear; Mechanical Properties

Abstract :
This work developed a hardmetal insert based on ultrafine tungsten carbide and cobalt, in order to improve its properties with the addition of carbon nanotubes (CNTs). The Spark Plasma Sintering (SPS) was applied as a consolidation technique of the WC-10 wt% Co mixture with 0.00, 0.10 and 0.25 wt% CNTs. The performance of the sintered inserts was evaluated through dry turning operation of a SAE 4140 steel. Flank wear of the inserts was evaluated after each pass, with an improvement in insert performance with the addition of 0.10 wt% CNTs, with a reduction of 13% in the flank wear lenght, compared to the system without CNTs. The physical and mechanical properties were evaluated too, observing the increase of the apparent density (14,27 g|cm³) , the stability of the Vickers hardness (14,96 GPa) and the increase of the fracture toughness (12,17 MPa.m1|2) for the hardmetal with 0.10 wt.% CNTs.

Innovative Aspect(s) :
The innovation merit is the incorporation of cnt to the hardmetal, thus improving mechanical properties, mainly the self-lubrication effect - enabling dry machining, saving costs and considering the environment conservation. Other important innovation is the use of the spark plasma sintering as manufacture route to process the inserts, taking into consideration the 4.0 industry requirements.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023
CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765022

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Prof Dr Senos Ana (University of Aveiro, Portugal)

Co-author(s) : Mr Rodrigues Joaquim, Dipl-Ing Mineiro Ricardo (University of Aveiro, Portugal), Dr Ing Fernandes Cristina (Palbit S.A., Portugal), Dr Sanchez-Herencia António (Instituto de Cerámica y Vidrio, CSIV, Spain)

Title : Development Of Low PcBN Composites By SPS

Keyword(s) :
Spark Plasma Sintering; Thermo-Calc; PcBN; Cermet; Cutting Tool; Microstructural Design

Abstract :
Cubic boron nitride (cBN) is normally used as a composite with ceramic and|or metallic matrixes to form PcBN (Polycrystalline cubic Boron Nitride) materials which are commonly employed in machining applications. While high cBN (70 – 90% vol.) is only produced by HPHT (High Pressure High Temperature) techniques, low cBN (40 – 70% vol.) could also be consolidated by SPS (Spark Plasma Sintering), since a higher volume of metallic binder is present. In this work, a cBN micrometer powder was combined with TiCN and Ni to produce composites with a matrix of hard phases that were predicted by the phase diagrams calculated with a thermodynamic tool. The SPS technique was used for the thermal consolidation of the PcBN compositions, at temperatures below 1600°C, in order to achieve a dense specimen and maintain the BN cubic form which are the requisites for machining applications.

Innovative Aspect(s) :
Thermodynamic calculations and experimental validation in PcBN compositionscBN-TiCN-Ni composites produced by colloidal processing routecBN-TiCN-Ni composites consolidated by SPS.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235763985

Requested presentation type : Poster Presentation

Topic : Materials **Subtopic :** Hard metals, cermets and diamond tools

Author : Prof Dr Filgueira Marcello (Northern Fluminense State University, Brazil)

Co-author(s) : Dr Soffner Layzza, Mr Guimarães Renan (Northern Fluminense State University, Brazil)

Title : A Novel Hardmetal Based On Niobium Carbide

Keyword(s) :
Hardmetals; NbC; FeNiNb Alloy; Alternative Binders; SPS

Abstract :
Successful use of Fe-Ni-Nb alloys as a binder for WC-based hardmetals have been reported. In this work, a novel NbC-based hardmetal NbC-10% wt Fe-Ni-Nb were prepared by spark plasma sintering (SPS), for 5 min, 40 MPa at temperatures 1280°C, 1300°C and 1350°C. The samples produced were investigated focusing on their structure, mechanical and thermal properties. All samples showed an increase in NbC crystallite size and n-phase formation. The processed NbC-FeNiNb hardmetal presented good densification and hardness of approximately 1726 HV30, fracture toughness 12.5 ± 0.1 MPa.m1|2, Young's modulus 385 ± 4 GPa, which is shown as a viable alternative in applications such as cutting tools. TG and DSC analysis confirmed the formation of a liquid phase and more carbides contributing to the mechanical properties of the composite. The thermal properties showed that the thermal diffusivity and thermal conductivity for NbC-FeNiNb was lower than for WC-Co carbide.

Innovative Aspect(s) :
NbC hardmetal composites with Fe-Ni-Nb binder were successfully produced by spark plasma sintering method. As a whole, results point to the successful replacement of Co by FeNiNb developed binder, and to the replacement of WC by NbC in hardmetals.During sintering of the NbC-Fe-Ni-Nb cemented carbide, η phase was formed for all temperatures. At optimal sintering temperature, the highest hardness, KIC, and elasticity modulus were achieved.Thermal expansion coefficient measured between 200 and 750°C reported are 6.14 × 10−6°C−1.Thermal analysis DSC and TG of the studied composites showed the formation of some niobium carbides.Thermal diffusivity and thermal conductivity of NbC-FeNiNb was lower than WC-Co hard metals.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....

EURO PM2023

CONGRESS & EXHIBITION

Technical Programme Committee
15th February 2023

MATERIALS

ULTRAHARD MATERIALS

EPMA
european powder metallurgy association

EURO PM2023 CONGRESS & EXHIBITION
01-04 October 2023

Paper Number : EP235765276

Requested presentation type : Oral Presentation

Topic : Materials **Subtopic :** Ultrahard Materials

Author : Dr Ing Lagerbom Juha (VTT, Finland)

Co-author(s) : Prof Huttunen-Saarivirta Elina (VTT, Finland), Dipl-Ing Lindroos Tomi (VTT, Finland), Dr Laukkanen Anssi (VTT, Finland), Dr Honkanen Mari (Tampere University, Finland), Prof Mohanty Gaurav (Tampere University, Finland),

Title : High-entropy Carbides: Design And Processing

Keyword(s) :
High Entropy Carbide; Mechanical Milling; Sintering; Refractory

Abstract :
High entropy carbides (HEC) are multi-metal carbides involving at least four types of metal atoms at near-equal concentrations. They exhibit crystalline periodicity and a precise carbon sublattice but display disorder in terms of metal cation packing, therefore they also have unconventional mechanical and physical properties. Up till now, the high entropy carbide compositions presented in literature have been rich in critical raw materials (CRM), such as tungsten (W) and hafnium (Hf). In this research, we aim to design and process sustainable high-entropy carbide compositions free of CRMs. The design of HEC chemistries is performed utilizing high-throughput CALPHAD analyses and further property data is extracted using density functional calculations. Equiatomic metal powder mixtures with carbon were ball milled and conventionally sintered at high 2000°C temperature to verify the single-phase high entropy carbide formation. XRD, SEM and EBDS techniques were used to characterize the materials and verify HEC formation.

Innovative Aspect(s) :
High entropy carbides (HEC) are multi-metal carbides involving at least four types of metal atoms at near-equal concentrations. They exhibit crystalline periodicity and a precise carbon sublattice but display disorder in terms of metal cation packing, therefore they also have unconventional mechanical and physical properties. Up till now, the high entropy carbide compositions presented in literature have been rich in critical raw materials (CRM), such as tungsten (W) and hafnium (Hf). In this research, we aim to design and process sustainable high-entropy carbide compositions free of CRMs. The design of HEC chemistries is performed utilizing high-throughput CALPHAD analyses and further property data is extracted using density functional calculations. Equiatomic metal powder mixtures with carbon were ball milled and conventionally sintered at high 2000°C temperature to verify the single-phase high entropy carbide formation. XRD, SEM and EBDS techniques were used to characterize the materials and verify HEC formation.

Reviewer's name : .....

Keynote ☐ Oral ☐ 1☐ 2☐ 3☐ 4☐

Poster ☐ Poster & Reserve Oral ☐

Withdraw ☐ Reason : .....

Notes to author : .....

.....