Resodyn™
ACOUSTIC MIXERS

Powder Metallurgy and Sintered Materials Enabled By ResonantAcoustic® Mixing

Testimonials • Published Articles • Patents & Patent Applications

January 2024

This document is a portfolio of user testimonials, articles, and patents/patents pending that reference Resodyn's ResonantAcoustic® Mixing (RAM) technology in a variety of powder metal applications. This collection of abstracts and links to published articles is intended to provide insight into the value of RAM technology as a means of solving challenges, improving quality, and raising productivity in the development and processing of powder metals.

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Processing of Powder Metals

Powder metal products are used across a spectrum of industries such as aerospace, automotive, marine, and biomedical. Common products created with powder metals include engine components, auto brake shoes/pads, medical devices, and bearings impregnated with lubricants. Powder metals are also used in heat shields for spacecraft, high-voltage electrical contacts, and filters for gases. Powder metal parts are often used as additive manufactured prototypes as well as fully functional components.

NASA recently invented a new 3D-printed super alloy called GRX-810 using RAM. NASA uses RAM to coat Nickel Cobalt Chrome with Yttrium Oxide powder. GRX-810 withstands temperatures exceeding 2000 ^{o}F, which is about 1000 ^{o}C. GRX-810 lasts up to 2500 times longer than traditional alloys. GRX-810 is expected to make billions of dollars.

Developers of leading-edge powder metal products rely upon ResonantAcoustic® Mixing technology to help their customers conceive and deliver innovative new products across a wide spectrum of industries.

= Locations of customers of ResonantAcoustic® Mixers

What powder metal processors are saying about RAM

"... Acoustic mixing opens up the possibility of adding oxides or ceramics to any metal, which creates a huge design space that wasn't previously available..."

- Materials Engineer
U.S. Government Research Organization

*"We tried mechanical alloying, but **ball-milling destroyed the morphology of the powder**. What was spherical and able to flow in the 3D printer became deformed, platelet-like and had a tendency to stick in the 3D printer. Instead, we coat the metal powder with ceramic oxide **using Acoustic Mixing and get a really nice, dense coating on all the powder that doesn't deform the powder, or affect the flow through the 3D printer**."*

- NASA Materials Engineer
TM Smith, et al

***"...[we] mix different rheologies with powder metals, highly viscous, and the LabRAM II has proven it can do that effectively.** We're very impressed with the build quality of the mixer--it's a nice, solid, well-thought-out piece of equipment. It's done very well for us..."*

- Research Scientist
U.S. Government Agency

RAM: 21st Century Mixing Technology for 21st Century Materials

More than a thousand RAM systems are in use in more than 40 countries around the world. RAM is the world's preferred choice for innovation in materials processing.

PUBLISHED ARTICLES

Resodyn ACOUSTIC MIXERS
Innovative Mixing Solutions

Icon Legend

RAM testing, evaluation

Liquid/powder

Nanomaterial

Material/chemical properties

Materials processing

Powder/powder

Materials/product quality

Icons	Publication Title (Live Links)*	RAM Application Summary	Year
	Investigating the effect of the addition of WC into NiTi for stent application	A **LabRAM I acoustic mixer** was used to thoroughly mix the sample powder. A three-step mixing process was used with each step lasting 30 seconds with increased acceleration gravity (g) levels of 40g, 60g, and 70g in each step.	2024
	Directional Recrystallization of an Additively Manufactured Oxide Dispersion-Strengthened Nickel-Base Superalloy	The main goal of this study was to assess whether directional recrystallization can achieve a similar effect in AM ODS alloys. Gas-atomized NiCoCr powders were decorated with oxide dispersoids using **resonant acoustic mixing** then consolidated with laser powder bed fusion.	2024
	Mechanical and tribological performance of copper matrix self-lubricating composite prepared by resonant acoustic mixing powder	CuNi-WS2 self-lubricating composites with 10 wt% WS2 were fabricated by combining r**esonant acoustic mixing (RAM)** powders and pressureless sintering in an H2 atmosphere.	2024
	Manufacturing superfine AP by milling in a lab-scale resonant acoustic mixer (LabRAM)	Small AP particles (≤15 µm) are difficult to obtain from commercial vendors due to restrictions derived from increased explosion hazards for superfine AP (SFAP). An in-house SFAP manufacturing process was devised herein using **resonant acoustic mixing (RAM)**.	2023
	The Production and Development of Acoustically Milled Reactive Ni-Al Composite Powders Consolidated via Cold Spray Deposition	The objective of this research was to evaluate **acoustic milling** as a reactive powder processing method by establishing relationships between milling parameters and the resulting reactive powder. The **acoustically processed** nickel-aluminum (Ni-Al) reactive powder was subsequently consolidated to form a structural energetic material via hydraulic pressing and cold spray deposition.	2022

PUBLISHED ARTICLES

Icons	Publication Title (Live Links)*	RAM Application Summary	Year
	Efficient production of a high-performance dispersion strengthened, multi-principal element alloy	"...additive manufacturing can be leveraged to produce dispersion strengthened (DS), multi-principal element alloys (MPEA) without the use of traditional mechanical alloying or chemical reactions. This new processing technique employed **ResonantAcoustic®** mixing to coat an equiatomic NiCoCr powder with nano-scale yttrium oxides. ...the **acoustic mixing** step successfully coated the NiCoCr powder. In addition, the powder maintains its spherical morphology as compared to the highly deformed platelet-like powder produced through MA making it more suitable for AM...."	2020
	NiZnCu-ferrite coated iron powder for soft magnetic composite applications	"...We use a **Resodyn™ acoustic mixer** to reduce milling time and allow for more uniform mixing, as compared to ball milling or blending. This technique is capable of coating micron-sized powder with nanopowder completely in less than 15 min as shown by **Resodyn™** for Mg powder coated with MgO nanopowder. An acoustic mixer is adopted to adequately coat iron powder with ferrite particles in this work. We coat large iron powder with small NiZnCu-ferrite particles of (0.4 to 0.6 µm) using a small amount (0.5%) of lubricant addition to assist in coating and compaction. This coating method allows for adequate coating layers to be deposited in minimal amounts of time, in order to create faster manufacturing procedures and reduce costs related to processing..."	2018
	Low-Power Laser Ignition of Aluminum/Metal Oxide Nanothermites	"...A second method was subsequently used and does not involve the use of any solvent. A **LabRAM mixer (Resodyn Acoustic Mixers, Inc.)** was used, which can mix powders of different nature using **low-frequency, high-intensity acoustic energy**, creating a uniform shear field throughout the entire mixing container...The mixing procedure was done remotely. All resulting nanothermites were homogeneous..."	2014

PUBLISHED ARTICLES

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Innovative Mixing Solutions

Icons	Publication Title (Live Links)*	RAM Application Summary	Year
	Impact Ignition and Combustion Behavior of Amorphous Metal-Based Reactive Composites	"...Recently published molecular dynamic simulations have shown that metal-based reactive powder composites consisting of at least one amorphous component could lead to improved reaction performance...thermochemical equilibrium calculations were performed on various amorphous metal/metalloid based reactive systems with an emphasis on commercially available or easily manufactured amorphous metals, such as Zr and Ti based amorphous alloys in combination with carbon, boron, and aluminum. Based on the calculations and material availability material combinations were chosen. Initial materials were mixed via a **Resodyn mixer**..."	2013
	Sintering of tungsten powder with and without tungsten carbide additive by field assisted sintering technology	"...The tungsten (W) powder was used in as-received form for the experiment without WC additive. For the experiment with tungsten carbide (WC) additive, WC powder was mixed with W powder by **Resodyn acoustic mixer** to make W–5 vol.%WC andW–10 vol.%WC powder mixtures...By mixing 5 and 10 vol.% WC with W powder, densification was enhanced and finer grain size was obtained. Relative density above 99% with grain size around 3 μm was achieved in W–10 vol.% WC sintered at 1700 °C, 85 MPa, for 5 min..."	2012

* Article links may be limited by copyright restrictions. Detailed links on following pages.
^ Results excerpted/paraphrased from articles.

PUBLISHED ARTICLES

Partial (edited) selection of searched technical articles using the following search terms (articles are live links): "powder metals," AND/OR: "resonant acoustic" "acoustic mixing" "Resodyn."

Investigating the effect of the addition of WC into NiTi for stent application

Neha Agarwal, Gopinath Perumal, Muhannad Ahmed & Dermot Brabzon

A **LabRAM I acoustic mixer** was used to thoroughly mix the sample powder. A three-step mixing process was used with each step lasting 30 seconds with increased acceleration gravity (g) levels of 40g, 60g, and 70g in each step.

Directional Recrystallization of an Additively Manufactured Oxide Dispersion-Strengthened Nickel-Base Superalloy

Christopher P. Carter

To address these issues, several recent techniques such as **resonant acoustic mixing (RAM)** have been combined with metal AM to produce near-net shape parts without relying on time-intensive steps such as mechanical alloying [16]... To increase the lifetime of high temperature materials undergoing creep, this thesis explored the combination of several technologies for strengthening a printed nickel-based superalloy for use in long duration high temperature applications. The three technologies investigated were additive manufacturing (AM), oxide dispersion-strengthening (ODS), and directional recrystallization (DRX).

Mechanical and tribological performance of copper matrix self-lubricating composite prepared by resonant acoustic mixing powder

Youwang Tu, XiuChong Zhu, Xiao Kang, Lei Zhang & Chenxu Liu

The influence of acceleration, a critical process parameter of **RAM**, on the microstructures, mechanical and tribological performance of the composites were investigated, then the mechanism of acceleration on the performance of composites was discussed based on the analysis of the morphology and dispersion of WS2.

Manufacturing superfine AP by milling in a lab-scale resonant acoustic mixer (LabRAM)

Felix A. Rodriguez,J. C. Thomas & E. L. Petersen

An in-house SFAP manufacturing process was devised herein using **resonant acoustic mixing (RAM)**. A 90-µm AP feedstock was utilized to produce SFAP batches with average particle sizes of approximately 2 µm.

The Production and Development of Acoustically Milled Reactive Ni-Al Composite Powders Consolidated via Cold Spray Deposition

Madilyn R. Fesenmaier

The objective of this research was to evaluate **acoustic milling** as a reactive powder processing method by establishing relationships between milling parameters and the resulting reactive powder... This study demonstrated that the reactive properties of Ni-Al powder can be tailored using **acoustic milling**..

Efficient production of high-performance dispersion strengthened, multi-principal element alloy

TM Smith, AC Thompson, TP Gabb & CL Bowman

Additive manufacturing currently facilitates new avenues for materials discovery that have not been fully explored. In this study we reveal how additive manufacturing can be leveraged to produce dispersion strengthened (DS),

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multi-principal element alloys (MPEA) without the use of traditional mechanical alloying or chemical reactions. This new processing technique employed **resonant acoustic mixing** to coat an equiatomic NiCoCr powder with nano-scale yttrium oxides. Then, through laser powder bed fusion (L-PBF), the …

Simple, scalable mechanosynthesis of metal–organic frameworks using liquid-assisted resonant acoustic mixing (LA-RAM)

HM Titi, JL Do, AJ Howarth, K Nagapudi & T Friščić

We present a rapid and readily scalable methodology for the mechanosynthesis of diverse metal–organic frameworks (MOFs) in the absence of milling media typically required for other types of mechanochemical syntheses. We demonstrate the use of **liquid-assisted resonant acoustic mixing (LA-RAM)** methodology for the synthesis of three- and two-dimensional MOFs based on Zn (II), Co (II) and Cu (II), including a mixed ligand system. Importantly, the **LA-RAM** approach also allowed the synthesis of the ZIF-L framework that …

NiZnCu-ferrite coated iron powder for soft magnetic composite applications

KJ Sunday & ML Taheri

We use a **Resodyn™** acoustic mixer to reduce milling time and allow for more uniform mixing, as compared to ball milling or blending. This technique is capable of coating micron-sized powder with nanopowder completely in less than 15 min as shown by **Resodyn™** for Mg powder coated with MgO nanopowder [15]. An acoustic mixer is adopted to adequately coat iron powder with ferrite particles in this work. We coat large iron powder with small NiZnCu-ferrite particles of (0.4 to 0.6 µm) using a small amount (0.5%) of lubricant addition to assist in coating and compaction.

Low-power laser ignition of aluminum/metal oxide nanothermites

CF Petre, D Chamberland & T Ringuette

In this study, three different types of nanothermites, i.e., Al/CuO, MoO3, and Al/Bi2O3, were produced using the widely spread wet (i.e., isopropanol based) method. In addition to the above method,
the three nanothermites were also produced using a **Resodyn LabRAM** mixer.

Impact Ignition and Combustion Behavior of Amorphous Metal-Based Reactive Composites

L Groven, B Mason & S Son

… that metal-based reactive powder … metals, such as Zr and Ti based amorphous alloys in combination with carbon, boron, and aluminum. Based on the calculations and material availability material combinations were chosen. Initial materials were either mixed via a **Resodyn** …pellants. Typically, metal powder used in making metallized propellants, is in the form of micron-sized particles. The liquid propellant is gelled with an additive...

PUBLISHED ARTICLES

Partial (edited) selection of searched technical articles using the following search terms (articles are live links): "powder metals," AND/OR: "resonant acoustic" "acoustic mixing" "Resodyn."

Sintering of tungsten powder with and without tungsten carbide additive by field assisted sintering technology

S Chanthapan, A Kulkarni, J Singh & C Haines

Abstract Tungsten powder (0.6–0.9 µm) was sintered by field assisted sintering technology (FAST) at various processing conditions. The sample sintered with in-situ hydrogen reduction pretreatment and pulsed electric current during heating showed the lowest amount of oxygen. The maximum relative density achieved was 98.5%, which is from the sample sintered at 2000° C, 85 MPa for 30 min. However, the corresponding sintered grain size was 22.2 µm. To minimize grain growth, nano tungsten carbide powder (0.1–0.2 µm) was used …

Resodyn ACOUSTIC MIXERS
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Relevant Patents

Approved and pending applications for work involving the use of ResonantAcoustic® mixing technology.*

*Including patents with RAM as the preferred embodiment

Method for preparing positive electrode active material for lithium secondary battery and positive electrode active material prepared thereby

US EP WO CN JP KR KR20210066745A LG Chemical LTD
Filed 2020-11-27 • Published 2023-12-19 • Granted 2023-12-19
The present invention relates to a positive electrode active material and a method for manufacturing the same, wherein the positive electrode active material includes a lithium transition metal oxide in the form of secondary particles formed by agglomeration of primary particles, and a coating film containing zirconium is formed on the surface of the secondary particles of the lithium transition metal oxide and at an interface between primary particles positioned inside the secondary particles.
Highlighted Use: RAM mixed zirconium oxide and a sintering aid.

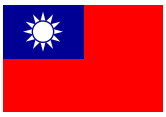
Cemented carbide containing tungsten carbide and fine grained iron alloy binder

US US20230160042A1 US Army Research Laboratory
Filed 2022-08-12 • Published 2023-8-15 • Granted 2023-08-15
A sintered cemented carbide body including tungsten carbide, and a substantially cobalt-free binder including an iron-based alloy sintered with the tungsten carbide. The iron-based alloy is approximately 2-25% of the overall weight percentage of the sintered tungsten carbide and iron-based alloy. The tungsten carbide may be approximately 90 wt % and the iron-based alloy may be approximately 10 wt % of the overall weight percentage of the sintered tungsten carbide and iron-based alloy. The tungsten carbide may comprise a substantially same size before and after undergoing sintering. The iron-based alloy may be sintered with the tungsten carbide using a uniaxial hot pressing process, a spark plasma sintering process, or a pressureless sintering process. The sintered tungsten carbide and iron-based alloy has a hardness value of at least 15 GPa and a fracture toughness value of at least 11 MPa√m.
Highlighted Use: RAM homogenized tungsten carbide and iron-alloy powders.

Method for producing granular zirconium oxide

WO WO2023025588A1 Ivoclar Vivadent AG
Filed 2022-08-09 • Published 2023-03-02
The invention relates to a method for producing granular zirconium oxide from powdered zirconium oxide, and to the use of the granular material for producing dental blanks and dental restorations.
Highlighted Use: As a bladeless tool, RAM is a superior way to ensure agglomeration of powder.

Composition, magnetic particle-containing cured material, magnetic particle-introduced substrate, electronic materials



JP KR WO TW US TW202302466A Fujifilm Corp.
Filed 2022-03-18 •Published 2023-01-16

Relevant Patents (cont.)

The first problem addressed by the present invention is to provide a composition with which it is possible to form a cured product that is superior in terms of achieving high permeability and low magnetic loss, that has a superior hole filling capability, and that also has a superior storage stability. In addition, the second problem addressed by the present invention is to provide a magnetic particle-containing cured product formed by employing the above-described composition. Furthermore, the third problem addressed by the present invention is to provide a magnetic particle-introduced substrate and an electronic material, each of which contains the above-described magnetic particle-containing cured product. The composition according to the present invention contains magnetic particles and an organic solvent, wherein: the magnetic particles contain magnetic particles X in which the sphericity is 100-120; the magnetic particles X contain ferrite particles; among the magnetic particles X, the contained amount of magnetic particles in which the circle equivalent diameters are less than 11 [mu]m is 15-70 mass% with respect to the total mass of the magnetic particles X; and the volume average particle size of the magnetic particles X is 5-50 [mu]m.
Highlighted Use: RAM completely mixed the combined powders and the relevant solvent.

Conditioned metal particles for three-dimensional printing
WO WO2023282912A1 Hewlett-Packard Development Company, L.P.
Filed 2021-07-09 • Publication 2023-01-12
Methods of preparing a particulate build material for three-dimensional printing can include loading fresh particulate build material including from about 80 wt% to 100 wt% fresh metal particles into a mechanical mixer, and mechanically conditioning the fresh particulate build material to generate conditioned particulate build material including conditioned metal particles. The fresh metal particles can have a surface oxide layer, and the fresh particulate build material can have a particle size distribution with a D10 particle size from about 2 µm to about 10 µm, a D50 particle size from about 5 µm to about 20 µm, and a D90 particle size from about 20 µm to about 40 µm. The conditioned particulate build material can include a modified cohesive index (compared to the fresh conditioned particulate build material) ranging from about 25 cohesive index units to about 35 cohesive index units.
Highlighted Use: A LabRAM II turned a "goose bump-like appearance" under a SEM into a visibly smooth one.

Oxide powder and method for producing same, and resin composition
KR CN JP US WO TW TW202225119A Denka Company, Ltd.
Filed 2021-09-24 • Published 2022-07-01
Provided is an oxide powder which is to be mixed with a resin to obtain a resin composition that has a low thermal expansion coefficient, a high thermal conductivity, and a low dielectric loss tangent. This oxide powder contains Ca, Al, and Si. The oxide powder includes a crystal phase of a high temperature-type cristobalite containing Ca, Al, and Si, in an amount of 40 mass% or more with respect to the total mass of the oxide powder. The contained amounts of Ca, Al, and Si in the oxide powder, when expressed as the contained amounts of content, CaO, Al2O3, and SiO2, are 1-5 mol% of CaO, 1-5 mol% of Al2O3, and 90-98 mol% of SiO2 (the total of the contained amounts of CaO, Al2O3, and SiO2 is defined as 100 mol%).
Highlighted Use: A LabRAM II mixed two powders, ethanol and alumina beads.

Positive electrode active material, positive electrode comprising positive electrode active material, and secondary battery comprising positive electrode
WO EP CN US JP KR WO2022050664A1 LG Energy Solution, Ltd.

Relevant Patents (cont.)

Filed 2021-08-31 • Published 2022-03-10
The present invention relates to a positive electrode active material, a positive electrode comprising the positive electrode active material, and a secondary battery comprising the positive electrode, the positive electrode active material comprising: a core; and a coating layer disposed on the core. The core comprises Li1+xMyO2+z, M being at least any one element selected from the group consisting of Ni, Co, Mn, Fe, P, Al, Mg, Ca, Zr, Zn, Ti, Ru, Nb, W, B, Si, Na, K, Mo and V, and -0.2≤x≤0.2, 0<y≤2, 0≤z≤2. The coating layer comprises carbon-based particles, wherein the carbon-based particles comprise a structure having a plurality of graphene sheets connected to each other, and have a D/G peak ratio of 0.9 to 1.3 when measuring the Raman spectrum thereof.
Highlighted Use: A LabRAM II coated carbon-based particles on the surface of a positive electrode material.

Positive active material surface-modified with metal sulfide and lithium all state solid battery including the same

KR KR20210039518A Univ Ulsan Found Ind Coop
Filed 2019-10-01 • Granted 2021-10-06 • Published 2021-10-06
The present application relates to a positive electrode active material surface-modified with a single metal or a double metal sulfide, and a lithium all-solid-state battery including the same. According to an embodiment of the present application, it is intended to increase the reversibility and charge/discharge performance of the lithium all-solid-state battery by surface-treating a positive electrode active material with metal sulfide.
Highlighted Use: The positive electrode active material has a surface modified by a resonant acoustic coating method using the double metal sulfide.

Additively manufactured oxide dispersion strengthened medium entropy alloys for high temperature applications

US US 20200399744A1 National Aeronautics and Space Administration
Filed 2020-06-19 • Published 2020-12-24
ve manufacturing powdered composite material includes metal particles coated with a coating of ceramic particles. The metal particles may include a ternary NiCoCr alloy, with select additions of minor amounts of other elements. The ceramic particles may include yttrium oxide or other oxides. The composite material is suitable for additive manufacturing (AM) into a component for high temperature (>1000° C.) applications. The AM component includes a metal matrix formed from the alloy, with the ceramic particles dispersed in the matrix.
Highlighted Use: RAM created the powder to work in extremely high temperature situations.

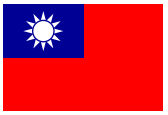
Method and systems for coated cathode materials and use of coated cathode materials

EP US WO CN KR US20210202940A1 Jianyang Li, Chuanjing Xu, Maha Rachid Hammoud, Taehwan Yu, Jun Wang, Derek C. Johnson, Fu Zhou A123 Systems LLC
Filed 2019-04-18 • Published 2021-07-01
A coated cathode material for lithium-ion batteries is disclosed. Methods and systems are further provided for applying a coating to an active cathode material for use in a lithium-ion battery. In one example, the coated cathode material may include a high-nickel content active cathode material, such as lithium nickel manganese cobalt oxide or lithium nickel aluminum cobalt oxide, coated with a coating including one or more high energy density active materials, such as lithium vanadium fluorophosphate and/or a lithium iron manganese phosphate compound. In some examples, the

Relevant Patents (cont.)

high-nickel content active cathode material may include greater than or equal to 60% nickel content.
Highlighted Use: A RAM mixer dry-formed material from an NCM cathode material and metal powder.

Powder and mixed powder



JP WO CN US EP SG TW TW201940456A Denka Company Ltd
Filed 2019-03-15 • Published 2019-10-16
An aspect of the present invention provides a powder containing the three components, ZnO, Al2O3, and SiO2, wherein the contents of three components are respectively 17-43 mol% of ZnO, 9-20 mol% of Al2O3, and 48-63 mol% of SiO2, with respect to the total content of the three components.
Highlighted Use: A LabRAM II merged zinc oxide, alumina and silicon dioxide.

Sintered polycrystalline cubic boron nitride material

WO EP CN US GB JP KR JP JP7053653B2 Element Six UK Ltd
Filed 2018-03-13 • Publication 2018-04-25 • Publication 2018-09-19 • 2019-12-25 Granted
A method of making a polycrystalline cubic boron nitride (PCBN) material comprises mixing matrix precursor powder having an average particle size of less than 250 nm and comprising an aluminium compound with 30- 40 volume % of cubic boron nitride (cBN) having an average particle size of at least 4 µm and spark plasma sintering the mixture at a pressure of at least 500 MPa, a temperature of 1050- 1500oC and a time of 1- 3 minutes. The matrix material may further comprise any of titanium carbonitride, titanium carbide, titanium nitride, titanium diboride, aluminium nitride and aluminium oxide. The particles may be mixed using any of wet acoustic mixing, dry acoustic mixing and attrition milling. The cBN particles may have a multi-modal average size distribution.
Highlighted Use: A RAM mixer combined three different powders across three steps.

Thermoelectric devices and methods of making same

WO WO2018035140A1 Nitto Denko Corporation
Priority 2017-08-15 • Filed 2017-08-15 •Published 2018-02-22
Described herein is a method for making a thermoelectric device, the method comprising: providing a sheet of alternating rows of parallel columns of p- or n- type thermoelectric materials; and electrically communicating the parallel columns such that the rows can be connected in series. Also described is where the columns within each row can also be electrically connected in parallel. Also described herein are thermoelectric devices made according to these methods and/or thermoelectric devices having a similar structure.
Highlighted Use: A LabRAM mixer averaged out multiple sets of thermoelectric compounds.

Method of making a cemented carbide or cermet powder by using a resonant acoustic mixer

EP ES EP2584057B1 Carl-Johan Maderud Sandvik Intellectual Property AB
Priority 2011-10-17 • Filed 2011-10-17 • Granted 2016-08-03 • Published 2016-08-03
A method of making a cemented carbide or cermet agglomerated powder without milling, where the powder constituents are subjected to a non-milling mixing operation, comprising the steps of: forming a slurry of one or more powders forming hard constituents, metal binder powders and a mixing liquid.
Highlighted Use: RAM creates materials for sintering with carbide and cermet powder.

Relevant Patents (cont.)

Cemented carbide containing tungsten carbide and finegrained iron alloy binder

US US20180142331A1 John J. Pittari, III U.S. Army Research Laboratory Attn: Rdrl-Loc-I
Priority 2016-11-10 • Filed 2017-11-09 • Published 2018-05-24
A sintered cemented carbide body including tungsten carbide, and a substantially cobalt-free binder including an iron-based alloy sintered with the tungsten carbide. The iron-based alloy is approximately 2-25 % of the overall weight percentage of the sintered tungsten carbide and iron-based alloy.
Highlighted Use: A LabRAM combined tungsten carbide and iron-alloy powders.

Continuous acoustic mixer

WO EP US US20210069662A1 Peter Andrew Lucon Resodyn Corporation
Priority 2017-09-05 • Filed 2020-11-16 • Published 2021-03-11
A system for continuously processing a combination of materials includes a continuous process vessel having an outlet and one or more inlets. The continuous process vessel is configured to oscillate along an oscillation axis. An acoustic agitator is coupled to the continuous process vessel. The acoustic agitator is configured to oscillate the continuous process vessel along the oscillation axis. An outlet passage is in fluid communication with the outlet. At least a portion of the outlet passage or at least a portion of the continuous process vessel is disposed within a portion of the acoustic agitator.
Highlighted Use: RAM can produce large amounts of material.

Glass-metal composites and method of manufacture

WO EP US CN WO2014197094A2 Carsten Weinhold Schott Corporation
Priority 2013-03-15 • Filed 2014-03-14 • Published 2014-12-11
The shaped composites of the present disclosure have metal powder bonded with glass powder. This feature provides the advantages of metal, metal powder, or glass composite materials, without suffering from the disadvantages. The composite is prepared with simple sintering methods, and can easily be formed into any number of desired shapes with dimensional characteristics and ingredients suited to a particular application.
Highlighted Use: A LabRAM combined glass and metal powders, then added a solvent.

Method of making a cemented carbide or cermet body

WO KR JP US CN EP ES KS US9777349B2 Carl-Johan Maderud, Tommy Flygare, Michael Carpenter, Jane Smith Hyperion Materials and Technologies Sweden AB
Filed 2012-10-17 • Published 2014-09-18 • Granted 2017-10-03
The present invention relates to a method of making a cemented carbide or a cermet body comprising the steps of first forming a powder blend comprising powders forming hard constituents and metal binder. The powder blend is then subjected to a mixing operation using a non-contact mixer wherein a**coustic waves achieving resonance conditions** to form a mixed powder blend and then subjecting said mixed powder blend to a pressing and sintering operation. The method makes it possible to maintain the grain size, the grain size distribution and the morphology of the WC grains.
Highlighted Use: A LabRAM mixed slurries of chromium (II) carbide with polyethylene glycol, water and ethanol.

RAM 5

RAM 5 Continuous

RAM 55

OmniRAM Continuous

OmniRAM H

RAM 5 H

RAM 55 H

OmniRAM

LabRAM II LabRAM I

PharmaRAM I PharmaRAM II

LabRAM II H

Resodyn™ ACOUSTIC MIXERS

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