Milling and Sieving Advancements Enabled By ResonantAcoustic® Mixing

Testimonials • Published Articles • Patents & Patent Applications

July 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 milling and sieving 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 and quality of milling and sieving.

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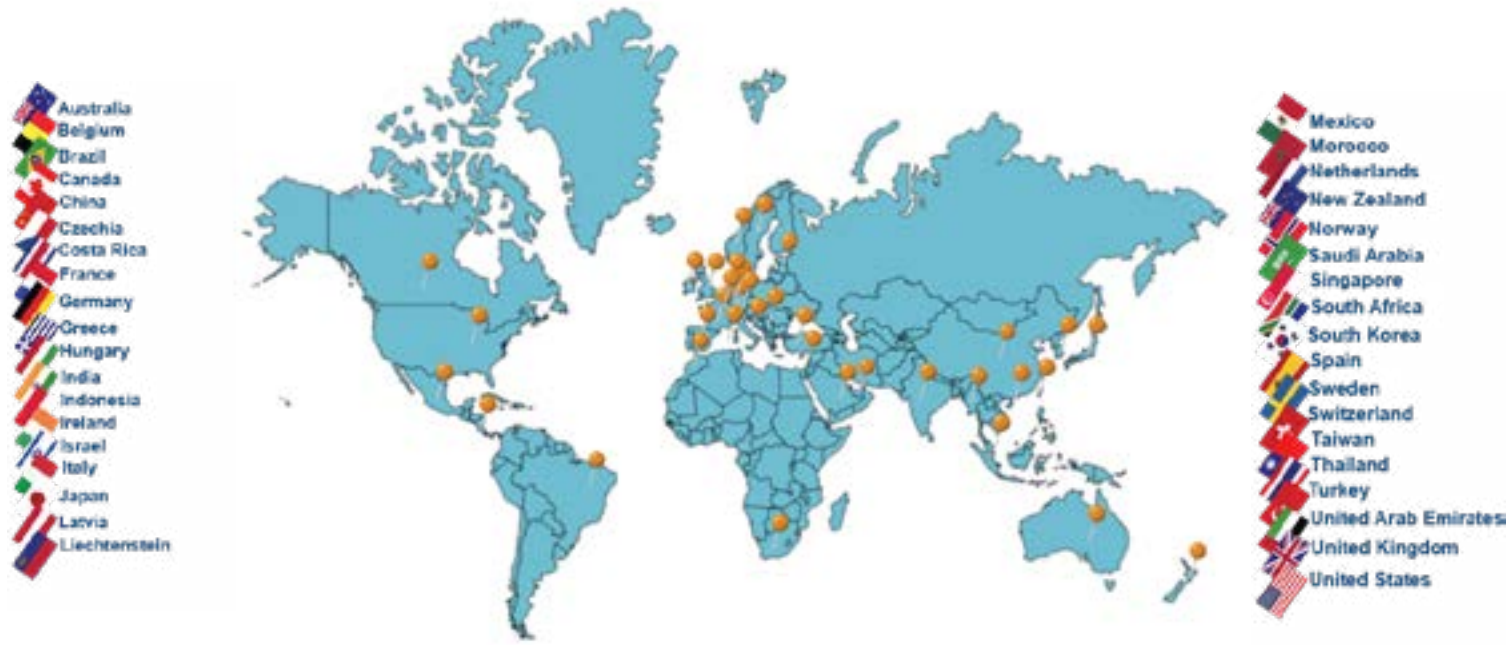
Milling and Sieving

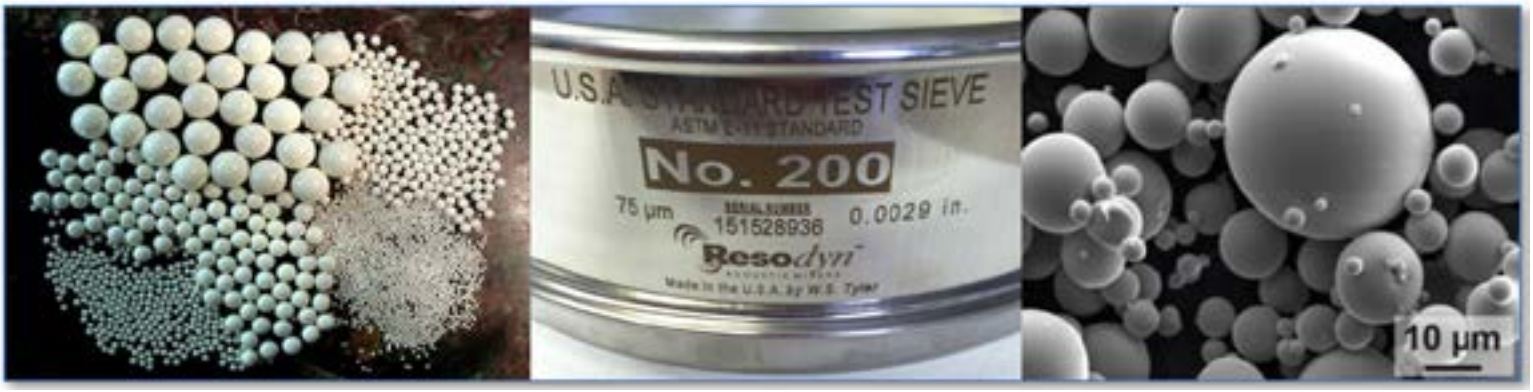
Milling and sieving is often used in pharmaceutical materials processing, but other industries benefit from the ability to mill particles with minimal impact on the integrity or desirable properties of materials being milled. ResonantAcoustic© Mixing (RAM) allows for a unique milling and sieving system, one that does not rely on additives.

RAM technology is unique in that it can operate effectively without milling media. This allows for the milling of materials normally too delicate for more traditional methods. It also eliminates undesired reactions between the processed materials and milling media, as is common with stainless steel grinding media.

Developers of products that depend on milling and sieving performed by ResonantAcoustic® Mixing technology are innovating and conceiving competitive new products across a wide spectrum of industries.



= Locations of customers of ResonantAcoustic® Mixers



What users of ResonantAcoustic® technology for milling and sieving applications say about RAM

"It's very difficult to incorporate oxides into a metal with good dispersion. Before acoustic mixing, we had to perform a milling process that not only took days to complete, it was very messy and expensive. ***Using the LabRAM is a much cleaner process. We're now able to incorporate oxides much faster and much more efficiently."***

- Materials Engineer
U.S. Government Agency

"The use of a 96-well plate for nanomilling screening has been reported before using an orbital shaker, but ***long milling times of 24 h and at least 10 mg of drug compound per well were required****. In contrast, the use of* ***acoustic mixing reduces the processing time to <2 h on only 1–2 mg of drug compound per well****. As a result, using a standard microtiter plate,* ***96 different formulation parameters can be evaluated in parallel in <2 h****...*

"With typical top down milling approaches, there is a limit to how concentrated the drug suspension can be before increases in viscosity result in decreased milling efficiency. ***At higher drug loadings, the naproxen suspensions become extremely viscous and formed a thick, solid paste that coated the impeller and prevented efficient milling from occurring****... The acoustic milling approach allows for the preparation of high dose nanosuspension formulations that could not be obtained using conventional milling equipment."*

- A New and Improved Method for the Preparation of Drug Nanosuspension Formulations Using Acoustic Mixing Technology, Leung, D. et.al., Merck & Co.
International Journal of Pharmaceutics, 2014

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

Milling

Material/chemical properties

Materials processing

Powder/powder

Materials/product quality

Icons	Publication Title (Live Links)*	RAM Application Summary	Year
	Processing of reactive Ni–Al powders via the LabRAM	"Powder production limitations associated with HEBM, including the addition of process control agents, have inspired the exploration of an alternate manufacturing technique: acoustic dry milling with the **Resodyn Laboratory Resonant Acoustic Mixer (LabRAM)**... The method shows promise for the production of reactive powder for a host of applications."	2024
	Halogen-bonded cocrystals via resonant acoustic mixing	"However, an eleventh stoichiomorphic cocrystal of p-DIT-FB and TMP is obtained exclusively via **RAM**, suggesting that the combination of **RAM** and milling approaches may afford a broader exploration of the polymorphic and stoichiomorphic landscape than the use of a single technique in isolation."	2024
	The effects of resonance acoustic mixing modulation on the structural and emulsifying properties of pea protein isolate	"Consequently, the emulsifying activity index of PPI (from 10.45 m2/g to 14.2 m2/g) and the physical stability of **RAM**-PPI emulsions were effectively enhanced, which was confirmed by the small and uniformly distributed oil droplets in the micrographs of the emulsions"	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
	Resonant acoustic mixing (RAM) for efficient mechanoredox catalysis without grinding or impact media	**"RAM** proceeds without formal grinding or impact media, is faster than the analogous ball-milling strategy, and is readily scalable."	2023
	Milling of Energetic Crystals with the LabRAM	"This study focuses on the feasibility of safely dry milling micron-size energetic crystals on the **LabRAM** acoustic mixer, while optimizing milling parameters for effective size reduction."	2023

PUBLISHED ARTICLES, cont'd.

Resodyn ACOUSTIC MIXERS
Innovative Mixing Solutions

	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
	A New Approach for Preparing Stable High-Concentration Peptide Nanoparticle Formulations	"The subcutaneous administration of therapeutic peptides would provide significant benefits to patients... Each sealed well plate was then placed on a **Resodyn LabRAM II Resonant Acoustic mixe**r (**Resodyn Acoustic Mixers**, Butte, MT, USA) and milled at 50 G acceleration for 2 h."	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
	Eco-friendly soft magnetic composites of iron coated by sintered ferrite via mechanofusion	"Also the high-energy ball milling has been shown to be a potential, room temperature method for applying a coating to substrates inside milling vial [7], [14], [16]. Recently, the unique and simple dry particle coating route appears to be the **resonant acoustic mixing**, allowing the reduction of mixing time."	2022
	Picking up good vibrations: Exploration of the intensified vibratory mill via a modern design of experiments	"The aim of this work was to strengthen the understanding of the intensified vibratory mill by unravelling the milling process in terms of the particle size reduction and heat generation via a modern design of experiments approach... Originally commercialised as a mixing platform, the **ResonantAcoustic® Mixing** platform has been mostly employed as a dry mixing process, whereas its application in wet milling is less studied."	2021
	Simple, scalable mechanosynthesis of metal–organic frameworks using liquid-assisted resonant acoustic mixing (LA-RAM)	"...We believe that the ability to form the ZIF-L product might be associated to LA-RAM (**LabRAM**) being a milder mechanochemical methodology, in which mechanical activation takes place by direct contact of reactant particles rather than through impact and abrasion by external milling media that are used in other types of mechanochemistry. Importantly, in each of these cases [the **LabRAM ResonantAcoustic® mixer**] methodology appears to be superior to ball milling, which provided poorer control of product composition in the synthesis of a mixed-ligand MOF, and also did not yield ZIF-L..."	2020

PUBLISHED ARTICLES, cont'd.

Resodyn ACOUSTIC MIXERS
Innovative Mixing Solutions

	Milling of Energetic Crystals with the LabRAM	"...Processing energetic materials with the **LabRAM ResonantAcoustic® mixer** has been widely published; however, using it as a vibratory mill has only recently been explored... This study focuses on the feasibility of safely dry milling micron-size energetic crystals on the **LabRAM acoustic mixer,** while optimizing milling parameters for effective size reduction..."	2019
	Ball-free mechanochemistry: in situ real-time monitoring of pharmaceutical co-crystal formation by resonant acoustic mixing	"...In marked contrast to ball-milling techniques, the lack of milling bodies in the **RAM** experiment does not hinder co-crystallisation of the two starting materials, which occurred readily and was independent of the frequency of oscillation..."	2018
	Preparation of an energetic-energetic cocrystal using resonant acoustic mixing	"...**RAM** was applied to the preparation of an energetic-energetic cocrystal comprised of CL-20 and HMX in a 2:1 mol ratio...the cocrystalline product from the **RAM** preparation is consistent with the product from solution crystallization..."	2014
	Oxide Milling and Blending Using a Resodyn® LabRAM Acoustic Mixer	"...in bench-scale **acoustic mixer** autogenous size reduction studies using roll mill processed Cerium Oxide, testing showed no indication of significant particle size reduction. For double roll mill processed cerium oxide, homogeneity was observed throughout the cylindrical container after blending. Mixing on the **LabRAM** appeared to break up most of the 'pancake-shaped' particles..."	2012
	A new and improved method for the preparation of drug nanosuspension formulations using acoustic mixing technology	"... the development of **acoustic mixing** as a new and improved drug sparing method for the generation of drug nanosuspension formulations. This approach exhibits dramatic improvements in efficiency and time and materials savings, making it amenable for use in the early drug discovery and development space..."	2014

PUBLISHED ARTICLES

Resodyn™ ACOUSTIC MIXERS
Innovative Mixing Solutions

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

Processing of reactive Ni–Al powders via the LabRAM

Madilyn R. Jerke, Grant A. Crawford, Lori J. Groven

The influence of **acoustic milling** time, intensity, and media size with respect to microstructure and reactive behavior of Ni–Al powders were evaluated in this work. After just 20 min of milling, a reactive composite Ni–Al microstructure was produced. Milling intensity and media size were directly proportional to the formation of more homogeneous composite powders. The reaction onset temperature was decreased to 446°C, or ≈200°C lower than that of unprocessed material. The method shows promise for the production of reactive powder for a host of applications.

Halogen-bonded cocrystals via resonant acoustic mixing

Alireza Nari, Jeffrey S. Ovens & David L. Bryce

Resonant acoustic mixing is a relatively gentle mechanochemical technology that employs pressure waves to induce chemical and morphological transformations. We report here on the production of eleven halogen-bonded (XB) cocrystalline architectures via neat and liquid-assisted **resonant acoustic mixing** (**RAM**).

The effects of resonance acoustic mixing modulation on the structural and emulsifying properties of pea protein isolate

Zhaorui Li, Yungang Cao, Yibing Wang, Yingjie Li, Zhenbin Liu, Zhenbao Zhu, Huan Zhang, Junrong Huang & Youling L. Xiong

The effects of **resonant acoustic mixing (RAM)** with different treatment times (0, 5, 10, 15, 20 and 30 min) on the structural and emulsifying properties of pea protein isolate (PPI) were investigated for the first time. Increasing the RAM treatment time from 0 to 20 min decreased the α-helix/β-sheet ratio and particle size of the PPI samples by 37.84 % and 46.44 %, respectively, accompanied by an increase in solubility from 54.79 % to 71.80 % ($P < 0.05$).

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.

Resonant acoustic mixing (RAM) for efficient mechanoredox catalysis without grinding or impact media

Farshid Effaty, Lori Gonnet, Stefan G. Koenig, Karthik Nagapudi, Xavier Ottenwaelder & Tomislav Friščić

Resonant acoustic mixing (RAM) enables mechanoredox catalysis with BaTiO3 as the piezoelectric catalyst on model diazonium coupling reactions. **RAM** proceeds without formal grinding or impact media, is faster than the analogous ball-milling strategy, and is readily scalable. X-ray diffraction and spectroscopy indicate that reusability of BaTiO3 as a mechanoredox catalyst under ball-milling or **RAM** might be limited by boration.

Milling of Energetic Crystals with the LabRAM

Lance N. Kotter & Lori J. Groven

Processing energetic materials with the **LabRAM acoustic mixer** has been widely published; however, using it as a

vibratory mill has only recently been explored. The size reduction of energetic crystals remains a tremendous processing challenge as it is often time and energy intensive. The **LabRAM** has the potential to reduce the time and energy required for milling through the use of low frequency waves.

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.

A New Approach for Preparing Stable High-Concentration Peptide Nanoparticle Formulations
Chloe Hu, Nanzhi Zang, Yu Tong Tam, Desmond Dizon, Kaylee Lee, Jodie Pang, Elizabeth Torres, Yusi Cui, Chun-Wan Yen & Dennis H. Leung
Thus, there remains a need for a general approach to formulate peptides at high concentrations. Herein, we report on a new approach using r**esonant acoustic milling** [14] for preparing peptide nanoparticle formulations at high concentrations, avoiding the use of high amounts of harsh excipients while enabling good absorption in vivo after a subcutaneous injection. Moreover, while typical milling techniques subject material to high shear stress, this low-shear approach results in intact peptide nanoparticles with good chemical and physical stability.

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**...

Eco-friendly soft magnetic composites of iron coated by sintered ferrite via mechanofusion
Zuzana Birčáková, František Onderko, Samuel Dobák, Peter Kollár, Ján Füze, Radovan Bureš, Mária Fáberová, Bernd Weidenfeller, Jozef Bednarčík, Miloš Jakubčin, Juraj Szabó & Michaela Dilyová
Also the high-energy ball milling has been shown to be a potential, room temperature method for applying a coating to substrates inside milling vial [7], [14], [16]. Recently, the unique and simple dry particle coating route appears to be the **resonant acoustic mixing**, allowing the reduction of mixing time [9].

Picking up good vibrations: Exploration of the intensified vibratory mill via a modern design of experiments
Elene De Cleyn, René Holm, Tatsiana Khamiakova & Guy Van den Mooter
Consequently, new milling technologies such as the intensified vibratory mill (IVM) in which the **ResonantAcoustic® Mixing** platform is used, are introduced in the field. Originally commercialised as a mixing platform, the **ResonantAcoustic® Mixing** platform has been mostly employed as a dry mixing process, whereas its application in wet milling is less studied.

Simple, scalable mechanosynthesis of metal–organic frameworks using liquid-assisted resonant acoustic mixing
Hatem M. Titi, Jean-Louis Do, Ashlee Howarth & Karthik Nagapudi
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.

Milling of Energetic Crystals with the LabRAM

Lance N. Kotter & Lori J. Groven

This study focuses on the feasibility of safely dry milling micron-size energetic crystals on the **LabRAM acoustic mixer**, while optimizing milling parameters for effective size reduction. … and should be assessed prior to milling using the Resodyn **LabRAM**. …

Ball-free mechanochemistry: in situ real-time monitoring of pharmaceutical co-crystal formation by resonant acoustic mixing

Adam A.L. Michalchuk, Karl S. Hope, Stuart R. Kennedy & Maria Valeria Blanco

Resonant Acoustic Mixing (**RAM**) is a new technology designed for intensive mixing of powders that offers the capability to process powders with minimal damage to particles. This feature is particularly important for mixing impact-sensitive materials such as explosives and propellants.

Preparation of an energetic-energetic cocrystal using resonant acoustic mixing

Stephen R. Anderson, David am Ende, Jerry S. Salan & Philip Samuels

Resonant acoustic mixing (**RAM**) was applied to the preparation of an energetic-energetic cocrystal comprised of CL-20 and HMX in a 2 : 1 mol ratio. We have prepared the cocrystal using the **RAM** technology in a resource-efficient manner providing near quantitative yield. The cocrystalline product from the **RAM** preparation is consistent with the product from solution crystallization.

A new and improved method for the preparation of drug nanosuspension formulations using acoustic mixing technology

Dennis H. Leung, David J. Lamberto, Lina Liu, Elizabeth Kwong, Todd Nelson, Timothy Rhodes & Annette Bak

Drug discovery and development is a challenging area. During the drug optimization process, available drug compounds often have poor physicochemical and biopharmaceutical properties, making the proper in vivo evaluation of these compounds difficult. To address these challenges, drug nanoparticles of poorly soluble compounds have emerged as a promising formulation approach. Herein, we report on a new drug sparing technology utilizing low shear **acoustic mixing** to rapidly identify optimized nanosuspension …

Oxide Milling and Blending Using a Resodyn® LabRAM Acoustic Mixer

Colton J. Cauthen & Steve Hoeffner

...study also investigated the potential application of **acoustic mixing** in the HB-Line process, where it would be used for large (3kg) payload blending. Based on these potential applications, tests were done to assess the ability of the acoustic mixer to mix small and large payloads and to size reduce plutonium oxide surrogate materials both autogenously and with milling media ...

Relevant Patents

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

*Including patents with RAM as the preferred embodiment

PET recycling process

WO WO2024218494A1 Alain You Li, Hui Luo, Maria Magdalena Titirici, Qilei Ssong & Dingchang Yang

Priority 2023-04-19 • Filed 2024-04-18 • Published 2024-10-24

Described herein is a process for recycling polyesters such as polyethylene terephthalate (PET) into terephthalic acid (TPA) and ethylene glycol (EG) using mechanical or acoustic energy coupled with a low temperature aging process. Also described herein is a process for electrolytic conversion of ethylene glycol (EG) into clean hydrogen (H2).

Highlighted Use: "In this example, a LabRAM II Resodyn acoustic mixer was used to depolymerise PET plastic into its monomers terephthalic acid (TPA) and ethylene glycol (EG)."

High-entropy tetraboride/hexaboride material and preparation method thereof

CN CN117865685A Zhang Rui, Li Mingliang, Zhu Jinpeng, Ji Chenchen, Wang Hailong Zehengzhou University

Filed 2024-01-11 • Published 2024-04-12

The invention relates to a high-entropy tetraboride/hexaboride material and a preparation method thereof, belonging to the technical field of ultrahigh-temperature ceramic materials. The nominal molecular formula of the material is (Y 0.2 La 0.2 Ho 0.2 Er 0.2 Yb 0.2)B 4 /(Y 0.2 La 0.2 Ho 0.2 Er 0.2 Yb 0.2)B 6 And (Y) 0.2 La 0.2 Ho 0.2 Er 0.2 Yb 0.2)B 4 And (Y) 0.2 La 0.2 Ho 0.2 Er 0.2 Yb 0.2)B 6 The mass ratio of (3) is 38.91-49.50:61.09-50.05. Mixing raw material powder by using an **acoustic resonance mixer** in a wet method, uniformly mixing and drying; then dry-pressing to form, vacuum constant-temperature roasting to obtain the invented product, when it is required to make powder, the sound is used. Crushing the agglomerates by using a chemical resonance mixer. According to the invention, the La-based high-entropy boride powder is synthesized for the first time by adjusting the element proportion, and the prepared material has clear crystal morphology, controllable proportion and uniform element distribution, so that the high-entropy solid solution component is reserved, and the material has good thermal stability; compared with a single-component material, the material has the advantages that the material is subjected to selective oxidation in the oxidation process due to the high entropy effect, and the oxidation resistance is more excellent. The preparation method can uniformly disperse the raw material powder, is simple and is easy to expand the mass production.

Highlighted Use: RAM milling deagglomerates and refines powder.

Nano silicon particulates, method to make them and articles made therefrom

WO WO2023167931A1 Gregory Alan Marus, Meysam Shahami, Saheem Absar & Brandon Dang Advano, Inc.

Priority 2022-03-01 • Filed 2023-03-01 • Published 2023-09-07

Nanosized silicon or alloys thereof are formed by milling in solvents comprising at least one polar protic solvent

Relevant Patents (Cont.)

(e.g., an alcohol) or polar aprotic solvent (e.g., a nitrile) where the average milling media size is at least about 5 times to 200 times larger than the initial average silicon particle size. The method more efficiently mills silicon and achieves smaller nanosized particles with less input power or time and stable dispersions in the absence of a surfactant allowing for the direct formation of secondary particles. The milled silicon particles are useful as electrodes in electrical devices such as batteries.
Highlighted Use: RAM mills silicon into nanoparticles.

Disordered rocksalt cathode material and method of making it
WO WO2023235475A1 Tanghong YI Wildcat Discovery Technologies, Inc.
Priority 2022-06-03 • Filed 2023-06-01 • Published 2023-12-07
It has been discovered that improved disordered rocksalts comprise of Mn are made by method comprising mixing a lithium compound with a metal precursor compound comprised of Mn having an oxidation state of 2 to form a mixture and heating the mixture to a temperature to form a disordered rocksalt structure. The method may realize improved cycle life with altered metal and oxygen redox of the disordered rocksalt.
Highlighted Use: RAM mills the precursors to lithium oxide cathodes.

High-efficiency acoustic resonance mixing method for composite high-energy ball milling
CN CN115815607A Meng Xiangxu, Zhao Jiong, Zhang Yang, Zhao Yanjun, Hao Suye, Han Ruifeng, Wei Jun
Filed 2022-12-21 • Published 20203-03-21
The invention discloses a high-efficiency **acoustic resonance mixing** method of composite high-energy ball milling, which is characterized in that a spherical medium material with the diameter of 0.1-10mm is added into a raw material, the spherical medium vibrates violently together with powder during mixing, and the agglomerated powder is collided in the motion process, so that the effective crushing, deagglomeration and thinning of the agglomerated powder can be realized, and the effective dispersion can be further realized; meanwhile, before mixing materials, vacuumizing is carried out, so that deagglomeration of agglomerated powder can be assisted, and a uniformly mixed raw material can be finally obtained, and the requirement of an ultra-high performance superhard material product on high mixing uniformity of the raw material can be met; the superfine powder materials mixed by the method, such as superfine oilstone powder materials, wafer thinning grinding wheel powder materials and the like, can realize uniform distribution of superfine raw materials, meet the requirement of uniform mixing of products and further improve the product performance.
Highlighted Use: RAM provides a more efficient form of ball-milling for energetic materials

Mechanical system that continuously processes a combination of materials
US US9808778B2 Lawrence C. Farrar, Scott L. Coguill, Peter A. Lucon & Janice Lucon Resodyn Corporation
Priority 2012-05-31 • Filed 2013-08-13 • Granted 2017-11-07 • Published 2017-11-07
The present application is directed towards systems and methods for continuously reacting a combination of materials by use of an acoustic agitator and a continuous process vessel. The system can react, fluidize, mix, coat, dry, combine or segregate materials. The continuous processing system can include an acoustic agitator capable of being removably coupled to a continuous process vessel. The continuous process vessel can include a first inlet for introducing at least one process ingredient, a plurality

Relevant Patents (Cont.)

of plates configured for directing a flow of the at least one process ingredient through the continuous process vessel and capable of transferring acoustic energy generated by the acoustic agitator into the at least one process ingredient, an outlet for discharging a product of the at least one process ingredient, and a fastener for removable coupling the continuous process vessel to the acoustic agitator.

Highlighted Use: RAM produces material over an extended period of time.

Sintered polycrystalline cubic boron nitride material

GB WO CN US WO KR JP CN GB2560641A Can Antionette, Myriam Megne Motchelaho Anne & Miranda-Fernandez Miriam Element Six UK LTD

Filed 2018-03-13 • Granted 2019-12-25 • Published 2019-12-25

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: RAM mixed aluminum and cubic boron oxide to create a polycrystalline matrix.

Polycrystalline diamond cutters having non-catalytic material addition and methods of making the same

WO EP US ZA US10337256B2 Valeriy Konovalov & Abhijit Suryavanshi Diamond Innovations, Inc.

Priority 2015-01-23 • Filed 2016-01-21 • Published 2017-11-29

Polycrystalline diamond cutters for rotary drill bits and methods of making the same are disclosed. A polycrystalline diamond compact includes a polycrystalline diamond body having a working surface, an interface surface, and a perimeter surface. The polycrystalline diamond compact also includes a substrate bonded to the polycrystalline diamond body along the interface surface. A non-diamond volume fraction of the polycrystalline diamond body is greater at the interface surface than at the working surface.

Highlighted Use: RAM combined diamond and other powders to create a tougher, more stable mining drill bit.

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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