Resodyn™
ACOUSTIC MIXERS
Innovative Mixing Solutions

Additive Manufacturing Materials Processing Enabled By ResonantAcoustic® Mixing

Testimonials • Published Articles • Patents & Patent Applications

March 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 Additive Manufacturing Materials procesing 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 additive manufacturing materials such as 3D print media.

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Additive Manufacturing Materials

Contactless ResonantAcoustic® Mixing (RAM) technology is proving itself integral to groundbreaking Additive Manufacturing (AM) and 3D printing designs, materials, and processes with its speed, power, and repeatability. Additive manufacturers are using RAM to mix inks with high solids loading, and to develop inks for DIW (direct-ink-write) applications in a wide range of materials. NASA developed a new GRX-810 alloy with almost double the tensile strength, more than double the ductility, and orders of magnitude (10X-2000X) better creep rupture life than conventional superalloys and current 3D-printable metal parts. GRX-810 can be used in space launch systems, heat exchangers in nuclear power plants and other extreme temperature environments, thanks to RAM technology.

Inhomogeneity adversely affects print quality, but RAM homogeneously mixes. RAM can also mill, sieve, and coat 10X-100X faster than conventional methods, yet gently enough for energetic and explosive inks.

Leading developers of 3-D print and other additive manufacturing materials rely upon ResonantAcoustic® Mixing technology to deliver exceptional material quality, unparalleled processing capability, higher productivity, and greater profitability.

= Locations of customers of ResonantAcoustic® Mixers

What the AM industry is saying about ResonantAcoustic® mixing

"... [ResonantAcoustic® mixing] is a fantastic technology. It has revolutionized the way we mix for development of materials for additive manufacturing..."

- Nik Ninos, Research and Development Manager
Calix Ceramic Solutions

"…The LabRAM II has yielded some surprising and exciting results for us. We actually made a new metal alloy for additive manufacturing..."

- Research Scientist
U.S Government Agency

"… We were using reciprocal shakers to dissolve product we sampled off one of our production lines, and it was taking four hours just to prep the material for testing. Once we started using the LabRAM, it cut that time from four hours down to 20 minutes..."

- Lab Supervisor
U.S. Polymer Products Company

RAM: 21st Century Mixing Technology for Additive Manufacturing 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
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Icon Legend

RAM testing, evaluation

Material/chemical properties

Powder/powder

Liquid/powder

Materials processing

Materials/product quality

3D printing

Additive manufacturing

Icons	Publication Title (Live Links)*	RAM Application Summary	Year
	Bi-modal particle size distribution for high energy product hybrid Nd–Fe–B—Sm–Fe–N bonded magnets	"Homogeneity of the bonded magnet was accomplished by thoroughly mixing nylon and magnet powders using the **LabRAM**, **Resodyn Acoustic Mixers** prior to the compression molding. Mixing both components in powder form helped overcome the agglomeration difficulty during the magnetic field alignment process."	2024
	Fine-Tuning Collective Atomic Vibrations in Low-Dimensional Nanocarbon Multilayer Transition Interfaces for 3D Printed Extreme Lattice Metamaterials Performance Improvement	"We have developed a game-changing approach for additively manufactured extreme lattice metamaterials... . In particular, this chain includes combination of a set of techniques:... the **resonant acoustic mixing** of all nanocomponents, growing the high-end ELM elements by high-precision multi-material additive manufacturing as well as using the data-driven digital twins-based nanoscale manufacturing approach."	2023
	Facile manipulation of mechanical properties of Ti-6Al-4V through composition tailoring in laser powder bed fusion	"Plasma atomized Ti-6Al-4 V (Grade 23 with oxygen content no more than 0.13 wt%, 15–45 μm) and spherical CP Ti (Grade 1 with oxygen content no more than 0.18 wt%, 38–63 μm) were blended using **resonant acoustic mixing.**"	2023
	Probing the role of solids loading and mix procedure on the properties of acoustically mixed materials for additive manufacturing	"**Resonant acoustic mixing** has been of particular interest for use in additive manufacturing since viscous, solids-loaded materials can be difficult to mix and inhomogeneity has adverse effects on print quality. In this study, we detail a method to iterate through different formulations and mix procedures and assess mixture quality."	2022
	Apparent viscosity evolution law of trace RDX-based explosive ink in Resonance Acoustic-Mixing process	"To solve the problems of poor mixing consistency, low preparation efficiency and serious material waste of trace and high solid content explosive inks, this paper proposes a new preparation process by combining **Resonant Acoustic-Mixing** technology with rheological apparent viscosity... Under the best preparation process route, the ink could be prepared in only 5 min."	2022

PUBLISHED ARTICLES
Cont'd.

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Icons	Publication Title (Live Links)*	RAM Application Summary	Year
	3D-printed nanoporous ceramics: Tunable feedstock for direct ink write and projection microstereolithography	"The 3YZ inks were made using solids loading in PEGDA ranging from 55 to 70 wt% (18–30 vol%, Table 2). The ink was mixed with spherical zirconia grinding beads (4mm diameter) in an **acoustic mixer** (**LabRAM II**, **Resodyn Acoustic Mixers**, Butte, MT) for 3h at 70 g-force to break up agglomerates and disperse the particles. The **LabRAM II** mixing time was determined by SEM images of the inks at different time points to ensure homogeneous dispersion... "	2021
	Feasibility of Cryomilled 17-4 Stainless Steel Powder as Feedstock for Additive Manufacturing	"...The blending process was carried out with a **Resodyn LabRAM II acoustic mixer** operating for 1 h with 10 g's of acceleration."	2020
	Efficient production of a high-performance dispersion strengthened, multi-principal element alloy	"To produce AM material, equiatomic NiCoCr medium entropy alloy (MEA) powder which exhibited a diameter size range between 10–45 µm and Y_2O_3 particles rated between 100–200 nm were acquired. A **Resodyn LabRAM II ResonantAcoustic™ mixer** was employed to coat the NiCoCr powder with one weight percent of nanoscale Y2O3...[the **LabRAM II**] quickly homogenized the powder, eventually coating the larger NiCoCr powder with a thin film of Y_2O_3 after an hour of mixing in a polyurethane container..."	2020
	Additive manufacturing of ammonium perchlorate composite propellant with high solids loadings	"...20g batches of propellant were hand mixed in a 473 ml jar until the AP was wetted. The mixture was then placed into a [**Resodyn Acoustic Mixers LabRAM**] resonant mixer. The HTPB binder propellant was mixed for 3 min at 80g for three repetitions with further hand mixing between cycles while the UV binder propellant was mixed in the **Resodyn Acoustic Mixer** for 2 min at 80g for 30s followed by a rest period of 30s...the techniques demonstrated in this paper could be used to create a wide range of complex grain structures that were not previously possible to manufacture."	2019
	Additive manufacturing of carbon fiber reinforced silicon carbide solid rocket nozzles	"Suitable green body formulations were developed and tested prior to being printed. The final formulation was viscous enough to hold its shape during the 3D printing process so there was minimal deformation before the part was thermoset. 40 g batches were made in a **Resodyn ResonantAcoustic™** mixer for three cycles of 3 minutes at 80g. The properties of the mixture did not vary over the course of a few days, making it printable within that time frame."	2019
	Resonant Acoustic® Mixing: Processing and Safety	"New processing technologies are allowing researchers, industry and academia to probe new materials space not previously achievable. These technologies include additive manufacturing and **Resonant Acoustic® Mixing (RAM)**, both of which have expanded in their use and application over the last 15–20 years."	2019

PUBLISHED ARTICLES
Cont'd.

Resodyn™ ACOUSTIC MIXERS
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Icons	Publication Title (Live Links)*	RAM Application Summary	Year
	Environmentally Friendly Boron-Based Pyrotechnic Delays: An Additive Manufacturing Approach	"The three reactive systems were formulated with an equivalent amount of dry powder Methocel using a **Resodyn LabRAM mixer** and same method as the dry powder mixtures that did not contain Methocel."	2019
	Two-component additive manufacturing of nanothermite structures via reactive inkjet printing	"…a pre-mixed aluminum copper (II) oxide suspension was mixed at a 6% volumetric solid loading. 15 To prepare the material, nCuO was mixed with nAl and suspended in a solution of DMF and PVP and placed in a 10ml syringe (BD, slip tip). The syringe was loaded into a custom polytetrafluoroethylene (PTFE) holder and secured on a **LabRAM ResonantAcoustic™ Mixer**. The syringe was mixed at 80% intensity for 16 min and inverted after 8 min."	2017
	Printed Energetics: The Path toward Additive Manufacturing of Munitions	"…it was shown that by using a **Resodyn LabRAM mixer**, the nanothermite could be processed directly within the deposition."	2017

PUBLISHED ARTICLES

Resodyn ACOUSTIC MIXERS
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Partial (edited) selection of searched technical articles using the following search terms (articles are live links): "resonant acoustic," "acoustic mixing," "Resodyn," AND/OR: "additive manufacturing," "3-D printing," "3D printing"

Bi-modal particle size distribution for high energy product hybrid Nd–Fe–B—Sm–Fe–N bonded magnets
Harshida Parmar, M. Parans Paranthaman & I. C. Nlebedim
"Homogeneity of the bonded magnet was accomplished by thoroughly mixing nylon and magnet powders using the **LabRAM**, **Resodyn Acoustic Mixers** prior to the compression molding. Mixing both components in powder form helped overcome the agglomeration difficulty during the magnetic field alignment process."

Fine-Tuning Collective Atomic Vibrations in Low-Dimensional Nanocarbon Multilayer Transition Interfaces for 3D Printed Extreme Lattice Metamaterials Performance Improvement
Alexander Lukin
"We have developed a game-changing approach for additively manufactured extreme lattice metamaterials predictive performance improvement and unlocking the new functionalities via fine-tuning atomic vibrational inter-layer interactions within the transition domains of multilayer nano-components....In particular, this chain includes combination of a set of techniques:... the **resonant acoustic mixing** of all nanocomponents, growing the high-end extreme lattice metamaterials elements by high-precision multi-material additive manufacturing as well as using the data-driven digital twins-based nanoscale manufacturing approach."

Facile manipulation of mechanical properties of Ti-6Al-4V through composition tailoring in laser powder bed fusion
Xi Du, Marco Simonelli, James W. Murray & Adam T. Clare
"Ti-6Al-4 V alloy when processed by laser powder bed fusion (LPBF) is a useful material which can be used for the manufacture of complex 3D components for aerospace and medical applications. LPBF fabricated Ti-6Al-4 V typically shows high tensile strength (>1200 MPa) but poor ductility (<10%), explained by the characteristic microstructures that form under high cooling rates and multiple thermal cycles. ... Plasma atomized Ti-6Al-4 V (Grade 23 with oxygen content no more than 0.13 wt%, 15–45 µm) and spherical CP Ti (Grade 1 with oxygen content no more than 0.18 wt%, 38–63 µm) were blended using **resonant acoustic mixing**."

Probing the role of solids loading and mix procedure on the properties of acoustically mixed materials for additive manufacturing
Dylan J. Kline, Michael D. Grapes, Eric A. Avalos, Candace M. Landeros, H. Paul Martinez, Robert V. Reeves, Kyle T. Sullivan & Zachary D. Doorenbos
"Resonant acoustic mixing has been of particular interest for use in additive manufacturing since viscous, solids-loaded materials can be difficult to mix and inhomogeneity has adverse effects on print quality. In this study, we detail a method to iterate through different formulations and mix procedures and assess mixture quality. ... We believe this testing approach can be useful when screening new formulations, developing mixing processes, or for quality control."

PUBLISHED ARTICLES
Cont'd.

Resodyn ACOUSTIC MIXERS
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Apparent viscosity evolution law of trace RDX-based explosive ink in Resonance Acoustic-Mixing process
Pengpeng Zhang, Chongwei An, Jiaqing Mu, Fusheng Cui, Wangjian Cheng, Baoyun Ye & Jingyu Wang
"To solve the problems of poor mixing consistency, low preparation efficiency and serious material waste of trace and high solid content explosive inks, this paper proposes a new preparation process by combining **Resonant Acoustic-Mixing** technology with rheological apparent viscosity. ... Under the best preparation process route, the ink could be prepared in only 5 min. The ink-finished product prepared under the above-mentioned optimal technology had almost no change in its crystal shape, thermal properties, and sensitivity compared with paddle stirring. In this paper, the possibility of preparing explosive inks from **RAM** is practiced, and the powerful mixing ability of RAM is verified."

3D-printed nanoporous ceramics: Tunable feedstock for direct ink write and projection microstereolithography
AL Troksa, HV Eshelman & S Chandrasekaran
"… Typically, ceramic inks for DIW are made from a highly viscous paste composed of ceramic … Ceramic AM can allow for creation of macroporous ceramics based on the geometry being … The 3YZ inks were made using solids loading in PEGDA ranging from 55 to 70 wt% (18–30 vol%, Table 2). The ink was mixed with spherical zirconia grinding beads (4 mm diameter) in an **acoustic mixer** (**LabRAM II, Resodyn Acoustic Mixers**, Butte, MT) for 3 h at 70 g-force to break up agglomerates and disperse the particles."

Feasibility of Cryomilled 17-4 Stainless Steel Powder as Feedstock for Additive Manufacturing
F Kellogg, A Kudzal, C Mock & J Taggart-Scarff
"…Additive manufacturing (AM) is a catchall term for a suite of manufacturing processes that produces parts in a layer-by-layer method. Laser powder bed … The blending process was carried out with a **Resodyn LabRAM II acoustic mixer** operating for 1 h with 10 g's of acceleration…"

Efficient Production of a 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 … A **Resodyn LabRAM II resonant mixer** was employed to coat the NiCoCr powder with one weight percent of…"

Additive manufacturing of ammonium perchlorate composite propellant with high solids loadings
MS McClain, IE Gunduz & SF Son
"...The effective solid propellant burning rate in a rocket depends on surface area and propellant composition. Currently, the surface area geometry in a rocket is limited to what can be practically cast using molds, etc. ... 40 g batches were made in a **Resodyn ResonantAcoustic™ mixer** for three cycles of 3 minutes at 80g. The properties of the mixture did not vary over the course of a few days, making it printable within that time frame."

Additive manufacturing of carbon fiber reinforced silicon carbide solid rocket nozzles
MS McClain, IE Gunduz & SF Son
"…low manufacturing costs, and/or reduced weight. However, manufacturing costs could be further reduced by using additive manufacturing (AM… 40 g batches were made in a **resonant mixer (Resodyn)** for three cycles of 3 minutes at 80 g's. The properties of the mixture did not vary…"

PUBLISHED ARTICLES
Cont'd.

Resodyn™ ACOUSTIC MIXERS
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Resonant Acoustic® Mixing: Processing and Safety
MR Andrews, C Collet & A Wolff
"...New processing technologies are allowing researchers, industry and academia to probe new materials space not previously achievable. These technologies include additive manufacturing and **Resonant Acoustic® Mixing (RAM)** which are being demonstrated to reduce processing times, environmental impact and of course cost. With the introduction of any new technology it is imperative that users, managers and national bodies provide the resources and time to determine, understand and provide guidance associated with the safe..."

Environmentally friendly boron-based pyrotechnic delays: an additive manufacturing approach
IT Walters & LJ Groven
"...Additionally, manufacturing of delay systems can be problematic due to the dispersion of harmful powders into the air. Additive manufacturing of ... Each dry powder formulation was mixed using a **Resodyn LabRAM** at 60 g intensity for 1 min for three total times with a 1 min pause..."

Two-component additive manufacturing of nanothermite structures via reactive inkjet printing
Allison K. Murray, Tugba Isik, Volkan Ortalan, I. Emre Gunduz, Steven F. Son, George T.-C. Chiu & Jeffrey F. Rhoads
"...The syringe was loaded into a custom polytetrafluoroethylene (PTFE) holder and secured on a **LabRAM resonant mixer**... for the dual nozzle manufacturing technique. The ignition progression of a 5 layer sample prepared by dual nozzle printing is shown in Fig. (a). ..."

Printed Energetics: The Path Toward Additive Manufacturing of Munitions
LJ Groven & MJ Mezger
"... In their work, it was shown that by using a **Resodyn LabRam mixer**, the nanothermite could be processed directly within the deposition ... additive manufacturing for energetics—if certain barriers can be overcome. The first major barrier to the development of additive manufacturing ..."

Relevant Patents

Approved and pending applications for work involving additive manufacturing and the use of ResonantAcoustic® mixing technology as the preferred embodiment.

Conditioned metal particles for three-dimensional printing

WO WO2023282912A1 David R. Otis, Jr., Vladek Kasperchik & Mohammed Shaarawi
Priority 2021-07-09 • Filed 2021-07-09 • Published 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 conditioned metal particles.

Porous ceramics for additive manufacturing, filtration, and membrane applications

WO US US20230219058A1 Patrick Campbell, Sarah Baker, Maira R. Ceron Hernandez, Jennifer Marie Knipe & Joshuah K. Stolaroff Lawrence Livermore National Security, Llc
Priority 2017-06-23 • Filed 2023-03-22 • Published 2023-07-13

An ink for three dimensional printing a ceramic material includes metal oxide nanoparticles and a polymer resin, where a concentration of the metal oxide nanoparticles is at least about 50 wt % of a total mass of the ink. A method of forming a porous ceramic material includes obtaining an ink, where the ink comprises a mixture of metal oxide nanoparticles and a polymer, forming a body from the ink, curing the formed body, heating the formed body for removing the polymer and for forming a porous ceramic material from the metal oxide nanoparticles. The forming the body includes an additive manufacturing process with the ink.

Highlighted Use: RAM equipment mixes nanoparticles in a polymer resin.

Spherical microparticles formed using emulsions and applications of said microparticles

US US20210347701A1 James Timothy Cahill, Wyatt Du Frane, Joshua D. Kuntz, Ryan Lu, Amy Wat, Marcus A. Worsley & Congwang Ye Lawrence Livermore National Security, LLC
Priority 2020-05-08 • Filed 2021-05-07 • Published 2021-11-11

A composition includes a plurality of microparticles, where the microparticles comprise agglomerates of nanopowder, wherein the nanopowder includes a material selected from the following: a ceramic material, a metal, an alloy, a polymer, or a combination thereof. The microparticles are characterized by having an essentially spherical shape, nanograin features substantially identical to nanograin features of the nanopowder prior to formation into the microparticles, and a nanoscale porosity defined by the nanograin features. The plurality of microparticles have an essentially uniform size relative to one another. Moreover, the composition has flowability having a Hausner Ratio representing tapped density:bulk density less than 1.25.

Relevant Patents
Cont'd.

Highlighted Use: RAM mixers combine a blend of metal and ceramic with solvent and additives.

A Ceramic Reinforced Metal Composite For Hermetic Bodies For Implantable Devices

EP US US20230085958A1 Christine A. Frysz, Dallas J. Rensel, Brian P. Hohl, Jonathan Calarnel & Xiaohong Tang Greatbatch Ltd.

Priority 2021-09-10 • Filed 2022-09-12 • Published 2023-03-23

A ceramic reinforced metal composite (CRMC) comprising a composition composite as an interpenetrating network of at least two interconnected composites is described. The interpenetrating networks comprise a ceramic matrix composite (CMC) and a metal matrix composite (MMC). The composition composite is particularly useful as an electrically conductive pathway extending through the ceramic body of a hermetically sealed component, for example, a feedthrough in an active implantable medical device (AIMD).

Highlighted Use: RAM mixers combine a blend of metal and ceramic with solvent and additives.

Reducing surface roughness of cured three-dimensional printed objects using a localized heat source

WO WO2023101682A1 Emre Hiro Discekici, Shannon Reuben Woodruff, Alay Yemane & Greg Scott Long

Hewlett-Packard Development Company, L.P.

Priority 2021-12-03 • Filed 2021-12-03 • Published 2023-06-08

Examples of the present disclosure are directed toward methods and system for reducing surface roughness of a cured three-dimensional (3D) printed object using a localized heat source. An example method includes applying a liquid solvent to the cured 3D printed object and heating the cured 3D printed object with the liquid solvent applied thereto to a temperature below a melting point of the cured 3D printed object using a localized heat source to reduce a surface roughness of the cured 3D printed object as compared to the cured 3D printed object prior to the application of heat.

Highlighted Use: RAM mixers combine solvent types.

Kit for three-dimensional printing

WO WO2023101688A1 Emre Hiro Discekici, Emily Levin & Jake Thomas

Filed 2021-12-03 • Priority 2021-12-03 • Published 2023-06-08

A kit for three-dimensional (3D) printing is described. The kit comprises a build material composition; a fusing agent composition including a radiation absorber present in an amount ranging from about 0.01 wt % to about 2.0 wt % of a total weight of the fusing agent composition, wherein the radiation absorber absorbs radiation at a wavelength range within the visible light spectrum; and a fusing assist composition including a first co-solvent; a second co-solvent; and a balance of water.

Highlighted Use: RAM mixers create the fusing agent used.

Fusing agent compositions

WO WO2023101683A1 Emre Hiro Discekici, Emily Levin & Jake H. Thomas

Filed 2021-12-03 • Priority 2021-12-03 • Published 2023-06-08

Relevant Patents
Cont'd.

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Examples of the present disclosure are directed toward fusing agent compositions. An example fusing agent composition includes a radiation absorber, a co-solvent mixture, and a balance of water. In various examples, the radiation absorber is present in an amount ranging from about 0.005 weight percent (wt %) to about 1.0 wt % of a total weight of the fusing agent composition, wherein the radiation absorber absorbs radiation at a wavelength range within the visible light spectrum.
Highlighted Use: RAM mixers create the fusing agent used.

Method of abrading a workpiece

WO WO202202384A1 Polly H. R. Keen
Filed 2021-07-08 • 2022-02-03
A method of abrading a surface of a workpiece comprises providing a vessel containing loose abrasive bodies, loose resilient foam bodies, and at least a portion of the workpiece. At least most of the loose abrasive bodies have a maximum dimension of 3 centimeters. At least most of the loose abrasive bodies have a maximum dimension of 0.1 to 3 centimeters. The vessel is then agitated with sufficient energy such that at least some of the loose abrasive bodies contact and abrade at least a portion of the surface of the workpiece.
Highlighted Use: A RAM mixer works with abrasives and foam bodies.

Method of finishing a workpiece and finishing vessel having deflecting element

WO WO2021205399A1 Polly H. R. Keen, Andrew R. Henry & Jonathan J. O'Hare
Filed 2021-04-09 • Published 2021-10-14
A method of finishing a surface comprises vibrating a finishing vessel in a reciprocating linear manner. The finishing vessel contains working bodies and a workpiece. The finishing vessel includes a processing chamber that has at least one deflecting element. A finishing vessel suitable for use in the method is also disclosed.
Highlighted Use: A RAM mixer provides the force to finish the surface of a part.

Loose abrasive bodies and method of abrading a workpiece using the same

WO US WO2021156730A1 Polly H. R. Keen & Helen E. Pearson 3M Innovative Properties Company
Priority 2020-02-06 • Filed 2021-02-01 • Published 2021-08-12
A method of abrading a surface of a workpiece comprises agitating a vessel containing loose abrasive bodies and the workpiece. At least most of the loose abrasive bodies have a maximum dimension of 0.25 to 3 centimeters. On a respective basis, each loose abrasive body comprises abrasive particles secured to an organic substrate by a binder material. The vessel is agitated with sufficient energy such that at least some of the loose abrasive bodies contact and abrade at least a portion of the surface of the workpiece. A plurality of chopped loose abrasive bodies, wherein, on a respective basis, the chopped loose abrasive bodies each comprise abrasive particles secured to a substrate and have a maximum dimension of 0.25 to 1.5 centimeters is also disclosed.
Highlighted Use: A LabRAM mixer used discarded materials as a superior abrasive to loose particles.

Relevant Patents
Cont'd.

Resodyn ACOUSTIC MIXERS
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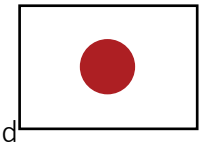
Chemical-free fabrication of graphene reinforced polymer matrix composites



WO US CN JP KR JP7170537B2 Aruna Tsar & Bor Z Jang

Priority 2015-12-10 • Filed 2016-12-07 • Granted 2022-11-14 • Published 2022-11-14

A simple, rapid, scalable, environmentally friendly method of directly producing graphene reinforced polymer matrix composites from graphitic materials: (a) a plurality of graphitic materials in a collision chamber of an energy collision device. Mixing a plurality of particles of the solid polymer support material to form a mixture; (b) exfoliating the graphene sheet from the graphite material and transferring the graphene sheet to the surface of the solid polymer support material particles Operating the energy collision device with a frequency and intensity for a time sufficient to form graphene coated polymer particles or graphene embedded polymer particles inside the collision chamber; (c) graphene coated polymer particles or graphene-reinforced polymer matrix composite from embedded polymer particles Method comprising the steps of forming is provided. Also provided are materials of graphene coated polymer particles or graphene embedded polymer particles produced by this method.

Highlighted Use: A RAM mixer created graphene from ABS pellets and expanded graphite.

Three-dimensional printing

WO US EP WO2020222747A1 Emre Hiro Discekici, Shannon Reubern Woodruff & Carolin Fleischmann

Filed 2019-04-29 • Priority 2019-04-29 • Published 2020-11-05

An example of a build material composition for three-dimensional (3D) printing includes a polyamide material and an antioxidant. The antioxidant consists of an aromatic multihydrazide; or an aromatic sulfonomonohydrazide; or a hydrazide having formula (I) disclosed herein, wherein: R is null, a C1 to C12 unbranched alkyl, a C3 to C8 branched alkyl, a C2 to C8 unbranched alkylene, a C4 to C8 branched alkylene, an alicyclic compound, a polyethylene glycol, or a combination thereof; A is C=O, O=S=O, P=O, or C=S; and n is an integer ranging from 1 to 4; or formula (II) disclosed herein wherein A is C=O, O=S=O, P=O, or C=S.

Highlighted Use: A RAM mixer created a 3D build material from nine different dihydrazides.

Method for resonant-vibratory mixing

US US7866878B2 Harold W. Howe, Jeremiah J. Warriner, Aaron M. Cook, Scott L. Coguill & Lawrence C. Farrar Resodyn Acoustic Mixers

Filed 2007-01-10 • Priority 2007-01-10 • Published 2011-01-11

A method for mixing fluids and/or solids in a manner that can be varied from maintaining the integrity of fragile molecular and biological materials in the mixing vessel to homogenizing heavy aggregate material by supplying large amounts of energy. Variation in the manner of mixing is accomplished using an electronic controller to generate signals to control the frequency and amplitude of the motor(s), which drive an unbalanced shaft assembly to produce a linear vibratory motion. The motor may be a stepper motor, a linear motor or a DC continuous motor. By placing a sensor on the mixing vessel platform to provide feedback control of the mixing motor, the characteristics of agitation in the fluid or solid can be adjusted to optimize the degree of mixing and produce a high quality mixant.

Highlighted Use: RAM technology can mix a variety of materials.

Relevant Patents
Cont'd.

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Apparatus and method for resonant-vibratory mixing

US US7188993B1 Harold W. Howe, Jeremiah J. Warriner, Aaron M. Cook, Scott L. Coguill & Lawrence C. Farrar Resodyn Acoustic Mixers

Filed 2004-01-26 • Priority 2004-01-26 • Published 2007-03-13

An apparatus and method for mixing fluids and/or solids in a manner that can be varied from maintaining the integrity of fragile molecular and biological materials in the mixing vessel to homogenizing heavy aggregate material by supplying large amounts of energy. Variation in the manner of mixing is accomplished using an electronic controller to generate signals to control the frequency and amplitude of the motor(s), which drive an unbalanced shaft assembly to produce a linear vibratory motion. The motor may be a stepper motors a linear motor or a DC continuous motor. By placing a sensor on the mixing vessel platform to provide feedback control of the mixing motor, the characteristics of agitation in the fluid or solid can be adjusted to optimize the degree of mixing and produce a high quality mixant.

Highlighted Use: RAM technology can mix a variety of materials.

Continuous acoustic mixer

US WO EP US10835880B2 Peter Andrew Lucon & Zachary Ruprecht Martineau Resodyn Corp.

Filed 2017-09-05 • Priority 2017-09-05 • Published 2020-11-17

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 equipment can mix for long durations.

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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