

Milling and Sieving Advancements Enabled By ResonantAcoustic[®] Mixing

Testimonials • Published Articles • Patents & Patent Applications



February 2022

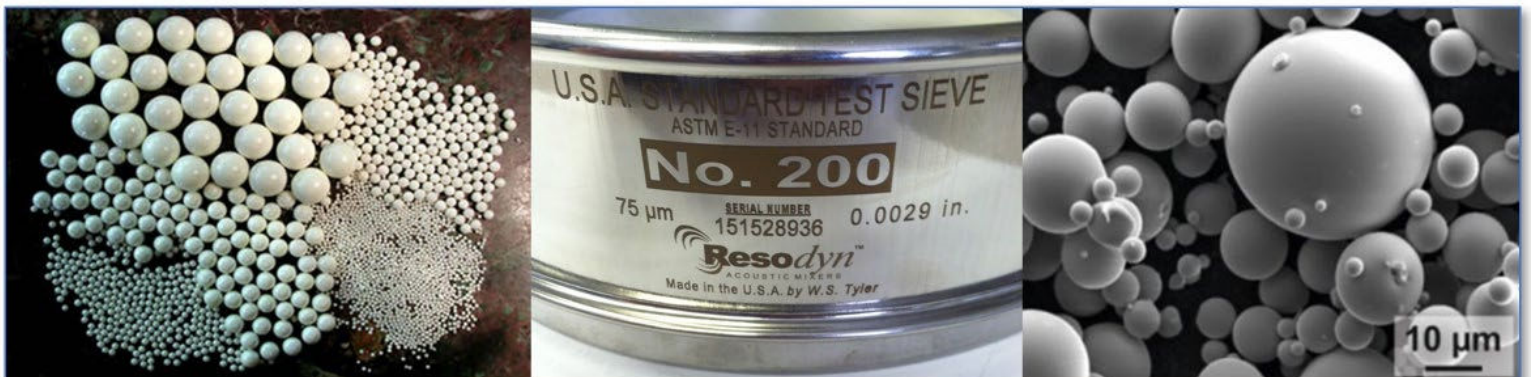
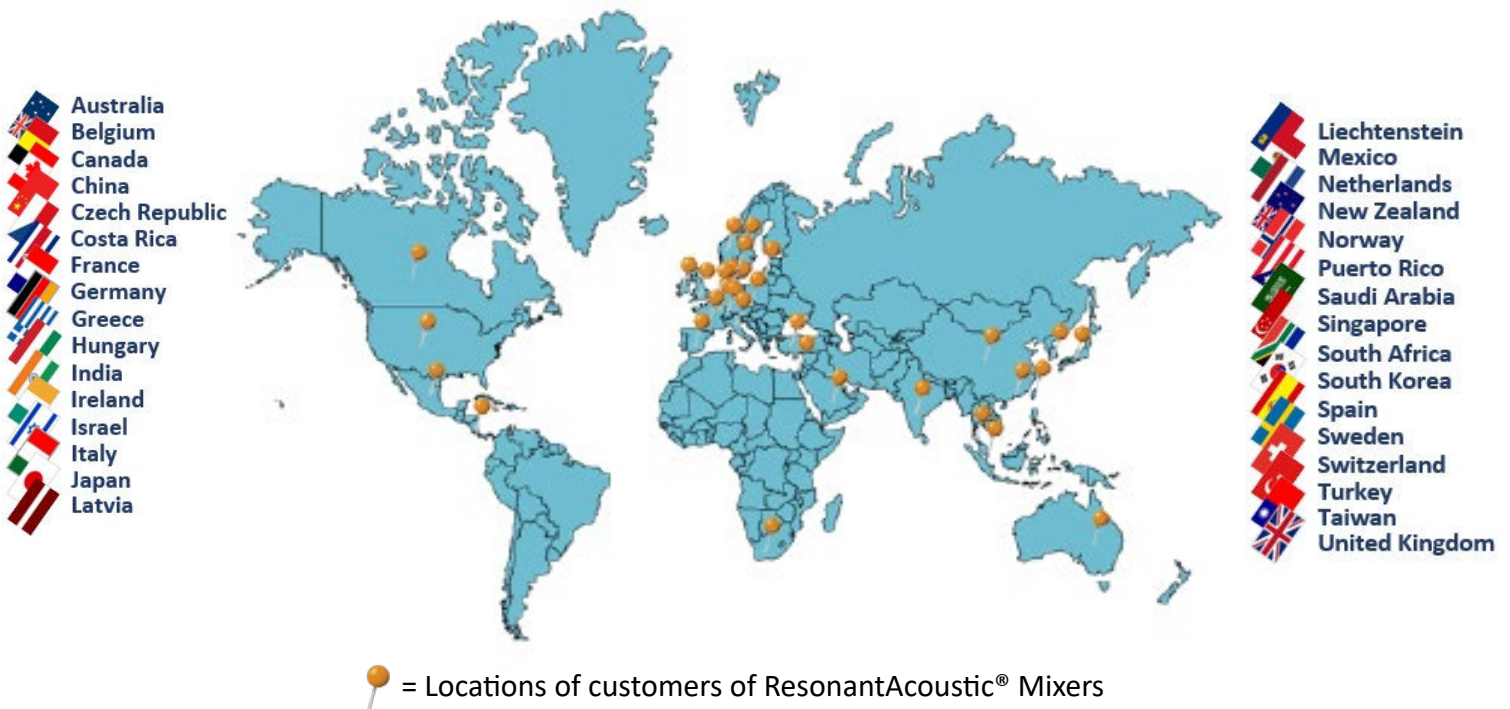
This document is a portfolio of user testimonials, articles, and patents/patents pending that reference Resodyn's ResonantAcoustic[®] Mixing (RAM) technology in a variety of milling and sieving applications.

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.

Milling and Sieving

Sieving machines and mills are used to reduce particles to a uniform size. This not only expands the surface sizes of particles, which increases the speed of dissolution, it evens out differences between particle sizes to ensure homogeneous mixing. 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.

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.



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

"...We're running [a LabRAM II) with powder and no milling media, and getting particle size reduction without damaging the material in any way.""

- Process Engineer
Global pharmaceutical Company

"...[ResonantAcoustic® mixing] exhibits dramatic improvements in efficiency and time and materials savings, making it amenable for use in the early drug discovery and development space..."

- From a 2014 article
International Journal of Pharmaceutics

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

More than a thousand RAM systems are in use in 33 countries around the world. RAM is the world's preferred choice for innovation in materials processing.

PUBLISHED ARTICLES

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
	Simple, scalable mechanosynthesis of metal-organic frameworks using liquid-assisted resonant acoustic mixing (LA-RAM)	<p>"...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..."</p>	2020
	Milling of Energetic Crystals with the LabRAM	<p>"...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..."</p>	2019
	Ball-free mechanochemistry: in situ real-time monitoring of pharmaceutical co-crystal formation by resonant acoustic mixing	<p>"...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..."</p>	2018
	Preparation of an energetic-energetic cocrystal using resonant acoustic mixing	<p>"...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..."</p>	2014
	A new and improved method for the preparation of drug nanosuspension formulations using acoustic mixing technology	<p>"... 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..."</p>	2014

PUBLISHED ARTICLES, cont'd.

Icons	Publication Title (Live Links)*	RAM Application Summary	Year
	Oxide Milling and Blending Using a Resodyn® LabRAM Acoustic Mixer	<p>“...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...”</p>	2012

PUBLISHED ARTICLES



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”

[Simple, scalable mechanosynthesis of metal–organic frameworks using liquid-assisted resonant acoustic mixing](#)

HM Titi, JL Do, AJ Howarth, K Nagapudi, T Friščić - Chemical science, 2020 - pubs.rsc.org

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 ...

[Related articles](#)

[Milling of Energetic Crystals with the LabRAM](#)

LN Kotter, LJ Groven - Propellants, Explosives, Pyrotechnics, 2019 - Wiley Online Library... 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. ...

[Related articles](#)

[Ball-free mechanochemistry: in situ real-time monitoring of pharmaceutical co-crystal formation by resonant acoustic mixing](#)

AAL Michalchuk, KS Hope... - Chemical ..., 2018 - hal.archives-ouvertes.fr

... Resonant acoustic mixing (RAM) is a new technology designed for intensive mixing of powders that offers the capability to process ... at two different relative accelerations of the mixer. In marked contrast to ball-milling techniques, the lack of milling bodies in the RAM experiment ...

[Related articles](#)

[Preparation of an energetic-energetic cocrystal using resonant acoustic mixing](#)

SR Anderson, DJ am Ende, JS Salan... - Propellants ..., 2014 - Wiley Online Library

... -up of cocrystals via resonant acoustic mixing (RAM) for non-energetic material 1,2. ... -mill grinding using grinding media made from stainless steel, ceramic, or Teflon. Solid-state grinding ...

[Related articles](#)

[A new and improved method for the preparation of drug nanosuspension formulations using acoustic mixing technology](#)

DH Leung, DJ Lamberto, L Liu, E Kwong... - International Journal of ..., 2014 - Elsevier

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 ...

[Related articles](#)

[Oxide Milling and Blending Using a Resodyn® LabRAM Acoustic Mixer](#)

Colton J Cauthen, CETL, Steve Hoeffner, CETL 2012

...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

[Mechanical system that continuously processes a combination of materials](#)

Abstract

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 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.

[Sintered polycrystalline cubic boron nitride material](#)

Abstract

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.

[Polycrystalline diamond cutters having non-catalytic material addition and methods of making the same](#)

Abstract

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.



RAM 5 Continuous



RAM 55



OmniRAM Continuous



RAM 5



RAM 5H



OmniRAM



LabRAM II LabRAM I



LabRAM II H

