What the Data Says: RAM Technology in Additive Manufacturing Research

A Collection of Peer-Reviewed Studies and Technical Papers in Additive Manufacturing

July 2025

This collection features 14 technical papers, presentations, and peer-reviewed research papers showcasing ResonantAcoustic® Mixing (RAM) in real-world additive manufacturing applications. The studies highlight RAM's ability to deliver consistent, repeatable results—especially in complex scenarios like **nanoparticle coating**—to enhance material properties in previously unattainable ways.

Resodyn Acoustic Mixers, Inc. 130 N. Main Street, Suite 630, Butte, MT 59701
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Featured: Efficient production of a high-performance dispersion strengthened, multi-principal element alloy

TM Smith, AC Thompson, TP Gabb & CL Bowman
Scientific Reports
"…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…"

See the Report

Contact Us

Bonus: contact us to see the author's in-depth presentation for the research above.

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

HIGHLIGHTED PUBLISHED ARTICLES

Key Research Findings Using RAM Technology

Resodyn™ ACOUSTIC MIXERS
Innovative Mixing Solutions

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

Journal of Alloys and Compounds

"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**."

3D-printed nanoporous ceramics: Tunable feedstock for direct ink write and projection microstereolithography

AL Troksa, HV Eshelman & S Chandrasekaran

Journal of Materials Research

"… 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."

Additive manufacturing of ammonium perchlorate composite propellant with high solids loadings

MS McClain, IE Gunduz & SF Son

Procededings of the Combusion Institute

"...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."

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

Journal of Applied Physics

"…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). …"

ALL PUBLISHED ARTICLES
Featuring RAM Pharmaceutical Applications

Resodyn™ ACOUSTIC MIXERS
Innovative Mixing Solutions

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
AIP Advances
"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
Materials Proceedings
"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."

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
Powder Technology
"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."

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
Journal of Materials Research
"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."

ALL PUBLISHED ARTICLES

Featuring RAM Pharmaceutical Applications

Resodyn™ ACOUSTIC MIXERS
Innovative Mixing Solutions

Feasibility of Cryomilled 17-4 Stainless Steel Powder as Feedstock for Additive Manufacturing
F Kellogg, A Kudzal, C Mock & J Taggart-Scarff
Defense Systems Information Analysis Center
"…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…"

Additive manufacturing of carbon fiber reinforced silicon carbide solid rocket nozzles
MS McClain, IE Gunduz & SF Son
Aerospace Research Central
"…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…"

Resonant Acoustic® Mixing: Processing and Safety
MR Andrews, C Collet & A Wolff
Propellants, Explosives, Pyrotechnics
"...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
ACS Sustainable Chemistry & Engineering
"…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…"

Printed Energetics: The Path Toward Additive Manufacturing of Munitions
LJ Groven & MJ Mezger
Energetic Materials
"… 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 …"

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

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