The Key to NASA's GRX-810

ResonantAcoustic® Coating for Additive Manufacturing

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OVERVIEW

In the race to develop materials for aerospace applications (like liquid rocket engine injectors, combustors, turbines, and hot-section components) that can withstand the extreme heat and stress of flight, NASA engineers achieved a breakthrough with GRX-810. It is a novel oxide-dispersion-strengthened (ODS) alloy capable of withstanding temperatures exceeding 2,000°F (hotter than most volcanic lava) and that lasts up to 2,500X longer than traditional alloys used for these applications. Importantly, GRX-810 is 3D printed using laser powder bed fusion (L-PBF), leveraging additive manufacturing (AM) technology to create the complex shapes required in the aerospace field.

ResonantAcoustic® Mixing was central to this incredible scientific achievement because it introduced nano-particle coating for highly uniform AM feedstock.

Solution

- ResonantAcoustic® Technology
- Coat Metal Powders with Oxide Nanoparticles
- L-PBF Additive Manufacturing
- New ODS Alloy GRX-810

Achievement

- Lasts up to 2,500X longer
- 2X the Strength
- Superior Oxidation and Heat Resistance
- Saved Years in Development

CHALLENGES

Traditional alloy development methods can take years or even decades to optimize. Developing ODS alloys like GRX-810 requires a uniform distribution of nanoscale oxide particles (such as yttria) within a metal matrix.

The traditional method for oxide dispersion was ball milling, a slow and inefficient process that made ODS alloys cost prohibitive [1].

Conventional ball milling introduces metal contamination, causes inconsistent blending and particle segregation, requires long processing times, and struggles to achieve true nanoscale uniformity.

Ball milling creates highly deformed particles that have poor flow and cannot be used for AM.

These issues make it difficult to reliably create high-temperature, oxidation-resistant materials like ODS alloys.

"AM processing with mechanically alloyed powder is problematic because the highly deformed powders have poor flow and, thus, reduced feedstock delivery properties."

- Tim Smith, et al [1]

For NASA's researchers, these challenges stood between them and the next generation of high-temperature alloys that can withstand the rigors of flight.

However, a key enabling technology, ResonantAcoustic Mixing (RAM), dramatically accelerated the process, cutting development time from years to months.

So, what are ODS Alloys?

Alloys and superalloys are materials created by combining a metal with another metal or element.

This combination enhances the properties of the base metals, making alloys stronger, lighter, more durable, and more resistant to corrosion than pure metals.

ODS alloys take this concept even further, dispersing nanoparticles (primarily oxides) throughout the alloy metal matrix for specialized characteristics such as extraordinary strength or exceptional heat resistance.

The unique characteristics of alloys make them indispensable in various industries, especially aerospace applications.

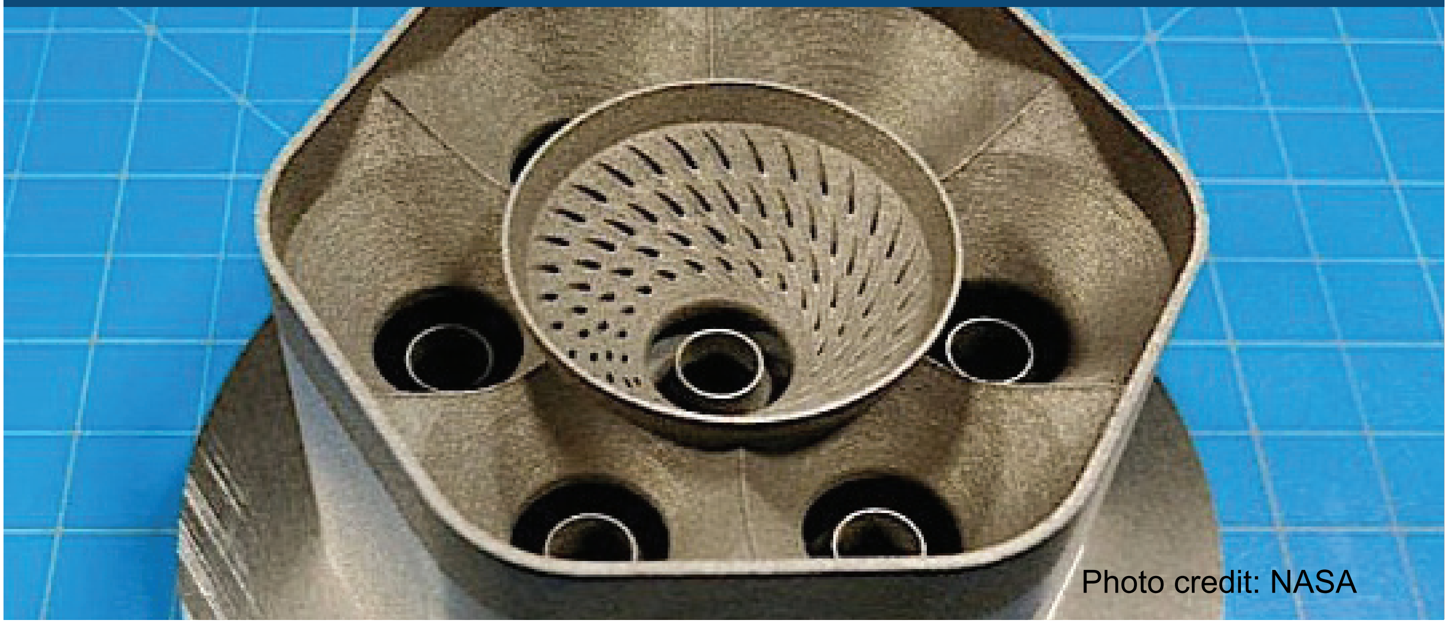

Photo credit: NASA

SOLUTION

ResonantAcoustic Mixing technology, pioneered by Resodyn Acoustic Mixers, uses low-frequency, high-intensity acoustic energy to homogeneously mix and coat powders, pastes, and viscous materials—without blades or impellers. In this case, RAM was employed to uniformly coat metal powder particles with nano-scale oxide particles.

RESULTING IN

- *Highly uniform oxide coating*
- *A flowable, spherical particle mophology*
- *Rapid homogenization (10X to 100X faster mixing) nanoscale unifomity in minutes*
- *Repeatable process*

These unique attributes made RAM the ideal tool for alloy powder preparation. For GRX-810, RAM provided exactly what ball milling could not: **perfect, repeatable oxide coating and dispersion in metallic powder blends.**

"Applying these two processes has drastically accelerated the rate of our materials development. We can now produce new materials faster and with better performance than before."

-Tim Smith [2]

CONCLUSION

According to NASA, the combination of Resonant Acoustic Mixing and additive manufacturing enabled them to develop GRX-810 in less than one year, compared to 10 to 20 years.

The resulting alloy demonstrated: [1][2]

- **Up to 2500X greater durability** than existing alloys under stress tests.
- **2X the strength** at elevated temperatures.

NASA researcher Tim Smith, received the Presidential Early Career Award for Scientists and Engineers for his work with GRX-810. Photo credit: NASA

ResonantAcoustic Mixing was the critical enabler in the creation of GRX-810, proving that acoustic mixing can overcome the limitations of traditional mechanical milling.

NASA's GRX-810 alloy is not only a triumph of materials science, it's a testament to what's possible when innovative tools like Resonant Acoustic Mixing are used to unlock new frontiers.

CITATIONS

1. Efficient production of a high-performance dispersion strengthened, multi-principal element alloy: https://doi.org/10.1038/s41598-020-66436-5
2. NASA's New Material Built to Withstand Extreme Conditions. https://www.nasa.gov/aeronautics/nasas-new-material-built-to-withstand-extreme-conditions/