MatterWave

Improving Durability and Consistency in Metal Additive Manufacturing

MatterWave is building an in-process phonon excitation module for metal additive manufacturing to address a common problem in laser powder bed fusion: unstable microstructures that require extensive post-build heat treatment. Today, much of metal AM depends on thermal post-processing to manage residual stress and variability, which adds cost, time, and complexity to qualification. MatterWave's approach focuses on influencing the material while the part is being printed, rather than fixing it afterward. The system introduces controlled mechanical energy through the build substrate during printing, allowing phonon excitation to interact directly with the melt pool as the material solidifies. This changes how the metal forms in real time, leading to finer and more consistent microstructures and fewer defects. Early experimental results show up to a 10× improvement in fatigue life compared to conventional builds, along with reduced cracking and improved consistency from layer to layer.

The technology is designed as a retrofit that can be integrated with existing laser powder bed fusion machines without modifying laser optics or scan strategies. By improving material performance during the build, the system can reduce or potentially eliminate the need for post-build heat treatment, shorten qualification timelines, and enable localized control of material behavior within a single part.

MatterWave's initial focus is on fatigue-critical applications in aerospace, defense, and energy, where durability requirements and qualification costs limit broader adoption of metal additive manufacturing. The large installed base of LPBF systems creates a clear opportunity for retrofit deployment with meaningful performance and economic benefits.

What specific application will the technology/innovation be used for?

The technology is used to improve the reliability of metal parts produced by laser powder bed fusion in applications where fatigue life and consistency matter. Typical examples include aerospace brackets and mounts, propulsion and turbomachinery housings, energy-sector manifolds and pressure components, and defense hardware that experiences repeated cyclic loading.

During printing, controlled phonon excitation is introduced through the build substrate to influence how the metal solidifies. This helps reduce cracking, residual stress, and part-to-part variability in common alloys such as 316L stainless steel and Ti-6Al-4V. As a result, parts can achieve required performance with less reliance on post-build heat treatment, reducing production time and qualification effort.

The technology can also be applied selectively within a build. For example, regions of a part that carry higher loads or experience greater thermal stress can be reinforced during printing, while less critical areas are left unchanged. This allows a single printed component to have locally tailored material behavior while maintaining overall structural integrity