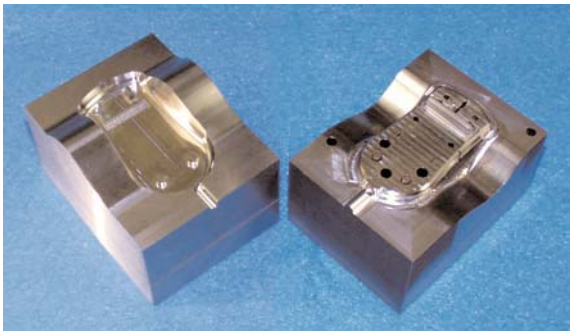
Laser Engineered Net Shaping

Manufacturing Technologies

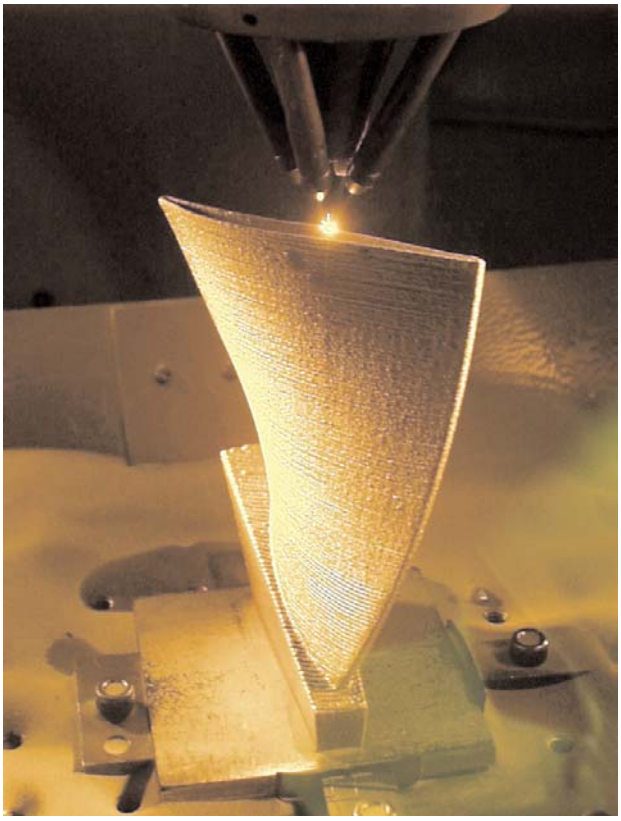
Sandia National Laboratories has developed a new technology to fabricate three-dimensional metallic components directly from CAD solid models. This process, called Laser Engineered Net Shaping (LENS®), exhibits enormous potential to revolutionize the way in which metal parts, such as complex prototypes, tooling, and small-lot production items, are produced.

The process fabricates metal parts directly from the Computer Aided Design (CAD) solid models using a metal powder injected into a molten pool created by a focused, high-powered laser beam.

Simultaneously, the substrate on which the deposition is occurring is scanned under the beam/powder interaction zone to fabricate the desired cross-sectional geometry. Consecutive layers are sequentially deposited, thereby producing a three-dimensional metal component.



H13 Tooling



Processing Blade

This process is similar to other rapid prototyping technologies in its approach to fabricate a solid component by layer additive methods. However, the LENS® technology is unique in that fully dense metal components are fabricated directly from raw materials, bypassing initial forming operations such as casting, forging, and rough machining.

LENS® offers the opportunity to dramatically reduce the time and cost required to realize functional metal parts. As a material additive process, additional cost savings will be realized through increased material utilization as compared to bulk removal processes. LENS® can also be used to modify or repair existing hardware.

Parts have been fabricated from stainless steel alloys, nickel-based alloys, tool steel alloys, titanium alloys, and other specialty materials; as well as composite and functionally graded material deposition. Microscopy studies show the LENS® parts to be fully dense with no compositional degradation. Mechanical testing reveals outstanding as-fabricated mechanical properties.

National Nuclear Security Administration

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

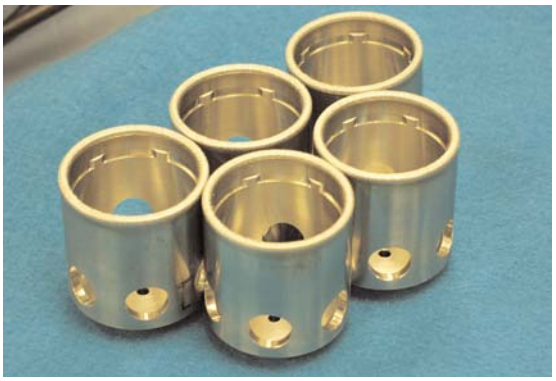
Sandia National Laboratories

Capabilities

- Ability to build fully dense shapes
- Closed loop control of process for accurate part fabrication
- Ability to tailor deposition parameters to feature size for speed, accuracy, and property control
- Composite and functionally graded material deposition
- Three- and four-axis systems for complex part fabrication
- Wide variety of materials that, at minimum, include: stainless steel alloys (316, 304L, 309, 17-4), maraging steel (M300), nickel-based superalloys (Inco designations 625, 600, 718, 690), tool steel alloys (H13), titanium alloy (6Al- 4V), and other specialty materials
- Mechanical properties similar or better than traditional processing methods

Resources

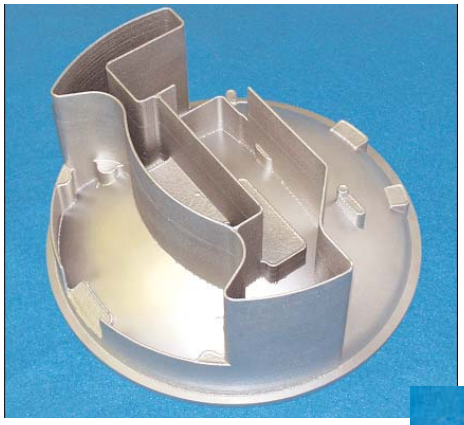
- LENS® (12" x 12" x 12") machine with 4-axis capability
- Specialized path planning software for tailored processing (variable deposition parameters, smart path sequencing, multiple materials)
- Closed loop control system to control the molten pool volume
- CAD solid modeling
- State-of-the-art metrology laboratory including: coordinate measuring machine, video measuring system, and non-contact surface analyzer
- Three-dimensional laser digitizing system
- Complete machine shop including: three-, four-, and five-axis computer numerical control (CNC) mills, CNC lathes, electrical discharge machines (wire and sinker), lathes, mills, and grinders



Fixtures

Accomplishments

- WES housing hybrid fabrication sequence: high aspect ratio features added by LENS® to simple machined surfaces, allowed for quick turnaround of housing for design verification and testing



WES Housing

Impeller

- LENS® precision deposition used to complete set of production Kovar braze fixtures to prevent diffusion bonding
- Composite and functionally graded impeller to show geometric and composition precision in multi-material fabrication
- Verification of mathematical model of cellular structure, enabling prediction of crush behavior (modes, etc.)
- Rear load spreader with 95% improvement in material waste over conventional machining
- Tooling for injection molding with conformal cooling channels to improve thermal characteristics in-use
- Laser marking, with high strength bonding, on weapon components
- Commercialization of the technology

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