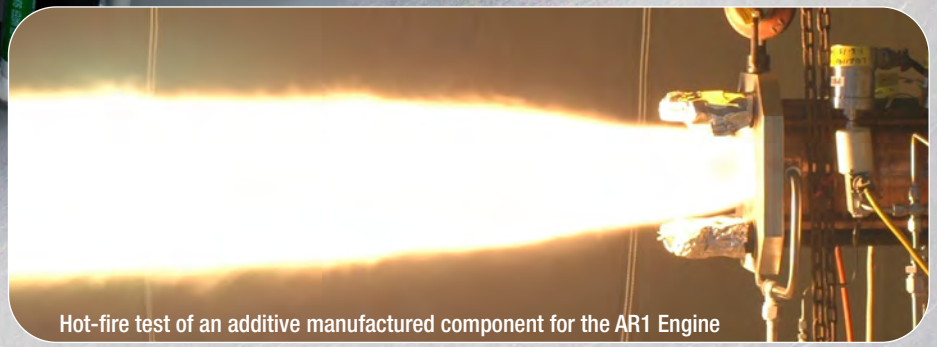
ADDITIVE MANUFACTURING

3-D PRINTING TECHNOLOGY AND APPLICATION

Aerojet Rocketdyne is leading the industry in designing and building aerospace components using 3-D printing technology.

Aerojet Rocketdyne has invested time and resources over the last two decades to evolve additive manufacturing technology to meet the stringent requirements of rocket engine and defense systems applications. That investment is now paying dividends as we begin to incorporate the technology into production programs to significantly reduce lead times, make our products more affordable and enable new approaches to design that were simply not feasible just a few short years ago due to the limitations of traditional manufacturing.

*Material note



Hot-fire test of an additive manufactured component for the AR1 Engine

*The material is based upon work supported by the National Aeronautics and Space Administration under Contract Number NNC10BA13B/ Task Order NNC13TA66T.

At Aerojet Rocketdyne, breakthroughs are practically routine but never ordinary.

www.rocket.com

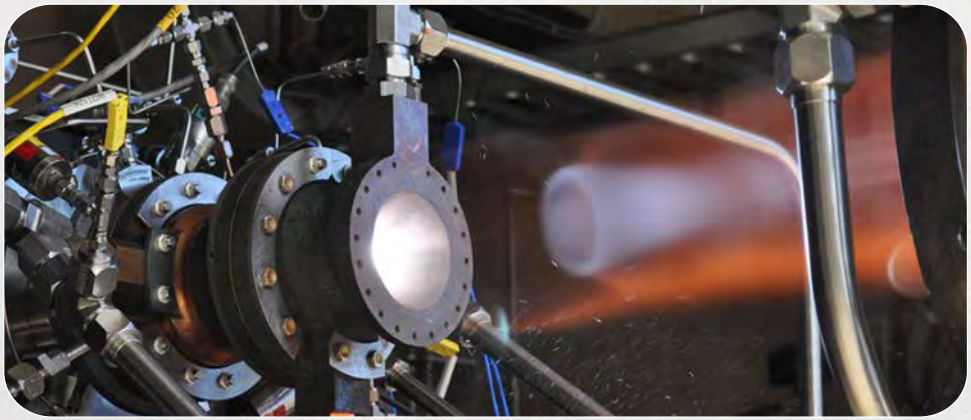
AEROJET ROCKETDYNE

BENEFITS

Cost
The use of additive manufacturing dramatically reduces the amount of touch labor required to build many engine components, which allows us to deliver more affordable legacy products and new product applications to our customers.

Schedule
Components that once took hundreds of hours to produce with traditional manufacturing techniques can now be built in just days using a single machine. This reduces lead times significantly and allows us to bring our products to market more quickly.

Flexibility
Aerojet Rocketdyne's engineering team has refined its approach to the design process to reflect the dramatically expanded possibilities enabled by additive manufacturing. They are free to design products that were once thought impossible due to the constraints of traditional manufacturing.

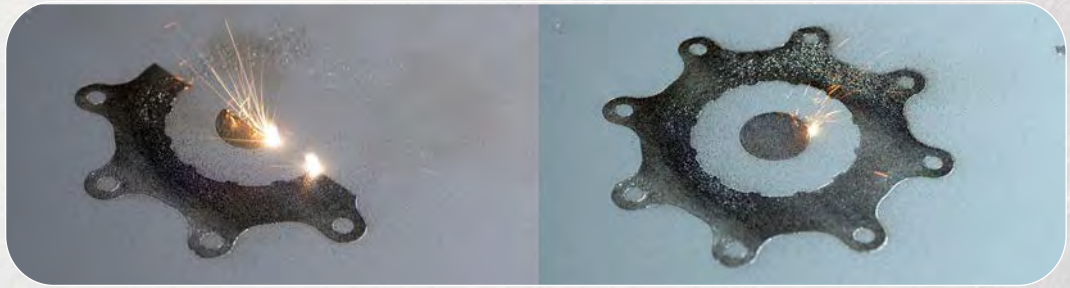


WHAT SETS US APART

Powders
We fully understand powder feedstock that is utilized – including particle size, distribution and chemistry -- to make sure the resulting alloys can perform under the extreme pressures and operating conditions of rocket engines.

Process
We have worked directly with original equipment manufacturers to learn the intricate details about how the selective laser melting process works so we can adjust parameters -- such as laser speed, and core and contour scan strategies -- to achieve optimal microstructures and surface finish features to meet our requirements.

Properties
We have performed detailed analysis of components built using additive manufacturing to fully characterize the materials and properties to make sure they will perform as designed. We actually test the alloys at the extreme operating conditions faced by our products, including temperatures that range from -320°F to 2,100°F. We account for all those operating environments in our designs to ensure they can operate in the extreme environments of space.



Featured Applications

Aerojet Rocketdyne has been recognized by Fast Company magazine as the No. 1 innovator in our industry on its recently published list of The World's Top 10 Most Innovative Companies of 2015 in Space. View article at http://www.fastcompany.com/3041665/most-innovative-companies-2015/

Additive Manufacturing technology is being applied to the following products.

AR1	Bantam Family and XS-1
RL10	CCtCAP
RS-25	Orion Crew Module
RS-68	Various energy products
Bantam Family	Various missile defense and tactical products
MPS-120 CubeSat	

At Aerojet Rocketdyne, breakthroughs are practically routine but never ordinary.

www.rocket.com

AEROJET ROCKETDYNE

la0119 16