National Aeronautics and Space Administration

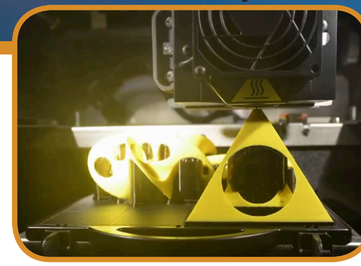
Marshall Space Flight Center
Additive Manufacturing

Engineering Solutions for Space Science and Exploration

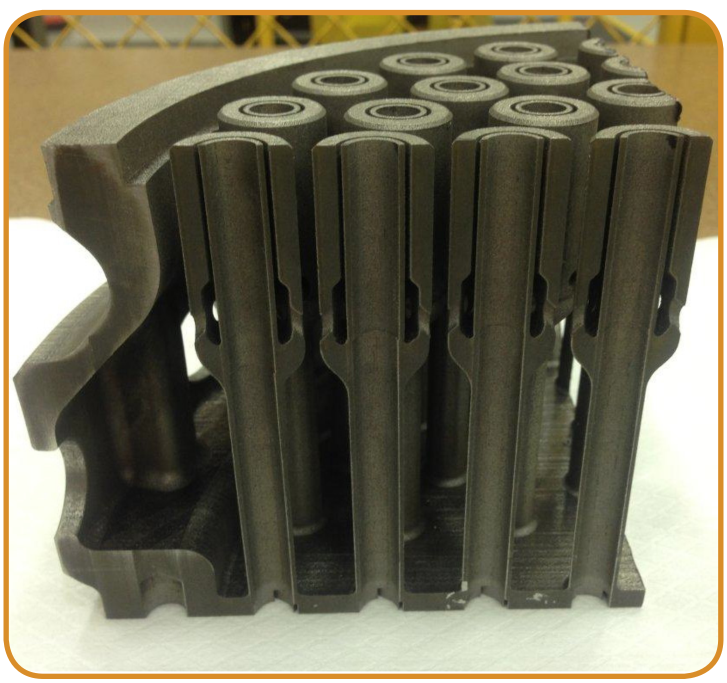

Stereo Lithography


Selective Laser Melting

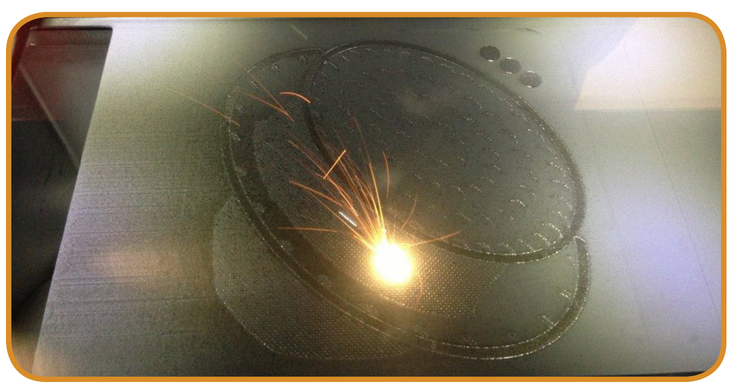

Electron Beam Melting


Fused Deposition Modeling

Additive Manufacturing capability at Marshall Space Flight Center (MSFC) has taken on a superior ranking in terms of world class manufacturing. Complex machining can now be reduced for much of a liquid rocket engine's subassemblies and much other hardware as selective laser melting (SLM) development continues to take place. Advanced AM of refractory materials using electron beam melting has also taken on significant advancement using additive manufacturing. Over the last two decades this field has transformed gone from making inexpensive prototype to manufacturing parts used for production and testing and, now, the development of actual flight, liquid engine components.



Additive manufacturing (AM), also referred to as three dimensional (3D) printing, is a process of making three dimensional solid objects of virtually any shape from a digital model. Parts are built up in layers from many materials such as resins and metallic powders (nickel based alloys, titanium, aluminum and copper to name a few). Traditional manufacturing processes often restrict engineers to avoid designing optimal parts because of limitations in subtractive machining (reshaping standard ingots or blocks of material using mills, lathes, drills, etc.), welding and assembling. Very complex shapes which once were not thought possible to produce are now opened up to designers; internal cooling passages, convoluted and complex helical or vortex shapes have opened up the design world to optimize characteristics of parts once not thought possible. Reduced seams lessen the chance for leaks, reduction of subassemblies reduce machining (titanium is very difficult to machine) and welding steps. AM has significantly reduced the cost and time (between 40-80% depending upon the shape of the part and material) of manufacturing parts.
improved resistance to environmental degradation.



Capabilities

Additive Manufacturing/Rapid Prototyping (AM/RP) Development

- Construction of plastic or metallic parts by adding material layer-by-layer
- The Laboratory has a world class AM/RP facility including the following systems
  - > Stereo lithography (SLA) – polymer components up to 20 × 20 × 23 in
  - > Fused deposition modeling (FDM) – acrylonitrile butadiene system (ABS), polycarbonate or polyphenylsulfone plastic up to 14 × 16 × 16 in
  - > Electron beam melting (EBM) – metallic parts up to 7.87 × 7.87 × 7.09 in titanium
  - > Selective Laser Melting – current capacity of 245mm × 245 mm × 265mm, with expansion planned to 400mm × 500mm × 630mm. Able to produce metallic parts (including aluminum and nickel alloys).

Key Benefits

- > Rapid, complex component manufacturing
- > Development of AM design and manufacturing guidelines for U.S. Industry
- > Exceptional combination of experience and facilities

For more information, please visit www.nasa.gov/centers/marshall/about/business.html

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