HP Multi Jet Fusion Technology content for Service Bureaus

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HP Multi Jet Fusion is built on decades of HP's investment in inkjet printing, jettable materials, precision low-cost mechanics, material science, and imaging. With custom materials and innovations in how a large working area can be printed and cured rapidly, HP Multi Jet Fusion delivers advantages in build speed and control over part and material properties that are beyond the capabilities of other 3D printing processes. By jetting HP *functional agents* using HP print heads, material in the working area can be fused, detailed, and transformed point-by-point.

Synchronous, scalable architecture for high productivity

A key innovation in HP Multi Jet Fusion is a high-speed, synchronous architecture that builds parts layer-by-layer. As shown schematically in Figure 1, dual carriages scan across the *Working area* in perpendicular directions: one carriage recoats the working area with fresh material, and the other prints HP functional agents and fuses the printed areas. This separates the processes of recoating and printing/fusing so that each process can be separately optimized for performance, reliability, and productivity.

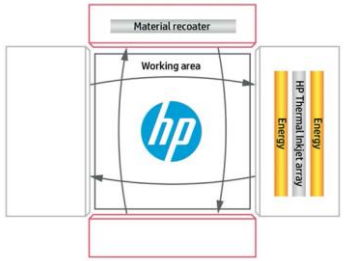

Figure 1. Schematic of HP Multi Jet Fusion synchronous printing architecture

In an HP Jet Fusion 3D Printer, a part, or a set of parts, is built layer-by-layer over a working area inside an HP Jet Fusion 3D Build Unit. After job completion, the build unit is rolled into an HP Jet Fusion Processing Station for cooling, unpacking thevparts, and recovery and refreshing the build material[1]. While those processes are completing, a build unit that has been refreshed by the HP Jet Fusion Processing Station can be rolled back into the printer for continuous production[2].

The depth of the build unit and working area determine the dimensions of the largest part that can be produced. For example, HP Jet Fusion 3D 4200 and 3200 printers have a working area of 16H X 16W X 12D inches (406H X 406W X 305Dmm) for a build volume of 3072 cubic inches (50 liters). For specifications on processing speed and working area for HP Jet Fusion 3D Printers, consult product data sheets at hp.com/go/3Dprint.

[1] Fast Cooling is enabled by HP Jet Fusion 3D Processing Station with Fast Cooling, available in April 2017. Material handling includes automated mixing of fresh and recycled powder, sieving, and loading. Consistent performance is achieved with reusing powder with a 20% powder refresh rate.

[2] Continuous printing requires an additional HP Jet Fusion 3D Build Unit (standard printer configuration includes one (1) HP Jet Fusion 3D Build Unit).

Building parts with HP Multi Jet Fusion

The build begins by laying down a thin layer of powdered material across the working area. For example, in Figure 1, the *material recoater carriage* scans from top-to-bottom. Next, the *printing and fusing carriage* with an *HP Thermal Inkjet (printhead) array* and *energy sources* scans from right-to-left across the working area. The leading energy source preheats the working area immediately before printing to provide consistent and accurate temperature control of each layer as it is printed. The printheads now print functional agents in precise locations onto the material to define the part's geometry and its properties. The printing and fusing carriage now returns left-to-right to fuse the areas that were just printed. At the ends of the scans, supply bins refill the recoater with fresh material and service stations can test, clean, and service the printheads on the printing and fusing carriage as needed to ensure reliable operation. After finishing each layer, the surface of the work area retracts about the thickness of a sheet of office paper[3] and the material recoater carriage scans in the reverse direction for optimum productivity. The process continues layer-by-layer until a complete part, or set of parts, is formed in the build unit.

Fusing and Detailing Agents

With HP Multi Jet Fusion, each layer of a part is defined by an area that is fused (or transformed) surrounded by unfused powder. HP 3D High Reusability PA12 powder was designed to minimize powder waste and can be reused in a later build[4]. For high strength and surface quality, it is important that the new layer bonds to any previously-fused material below it and the edges are smooth and well-defined. This is accomplished with multiple agents applied by the array of HP printheads. Figure 2 takes a close-up look at the process described in Figure 1.

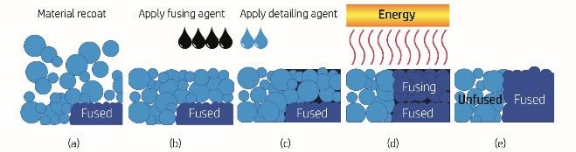

Figure 2. Schematic of HP Multi Jet Fusion printing process, cross-sectional views

The process begins by recoating the material in a thin layer across the work area, as shown schematically in Figure 2a. Figures 2b-d represent what happens on the first scan of the printing and fusing carriage. Temperature at multiple points across the work area have been measured, and in Figure 2b energy is applied to the fresh layer to control the material temperature immediately before printing agents. In Figure 2c, Fusing Agent ("F") is selectively printed where particles will be fused together. In Figure 2d, Detailing Agent ("D") is selectively printed where the fusing action will be either reduced or amplified. In this example, the Detailing Agent reduces fusing at the boundary to produce a part with sharp and smooth edges. Agents are printed at 1200 dpi (X and Y) in HP Jet Fusion 3D 4200 and 3200 Printers. In Figure 2e, the material is exposed to fusing energy, and selected areas now fuse. The fused material bonds to the layer below if that layer was fused on a previous cycle. Because HP Multi Jet Fusion can produce parts with Z-axis tensile strength comparable to the tensile strength in the X and Y planes[5] it overcomes the limitation of reduced Z-axis strength found in some other 3D printing technologies. Figure 2f shows the fused and unfused areas at the edge of a part. The working area now retracts in preparation for the next recoating, printing, and fusing cycle[3].

[3]The retraction of the working area, on the order of 100 microns, allows a new layer to be printed. The actual range of layer thicknesses that can be produced depends on the HP Jet Fusion 3D Printer. For example, the HP Jet Fusion 3D 4200 Printer can produce layer thicknesses between 0.07 – 0.12mm (0.0025 – 0.005 in.). For the latest technical specifications visit hp.com/go/3Dprint .

[4]With up to 80% powder reusability, HP Jet Fusion 3D print solutions with HP 3D High Reusability PA12 deliver consistent performance with the highest postproduction surplus powder reusability compared to any other powder-based 3D printing technology using PA12 material.

[5]Tensile strength at 45-50 MPa (XYZ), Modulus 1600-1900 MPa (XYZ). ASTM standard tests with PA12 material. See hp.com/go/3Dmaterials for more information on materials.

Video and imagery

HP Multi Jet Fusion technology tutorial video: https://youtu.be/VXntl3ff5tc

Embed code:

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Imagery: