



## ULTEM 1010 Resin

### Overview

ULTEM® 1010 resin is a flame-retardant, high-performance thermoplastic for direct digital manufacturing and rapid prototyping. ULTEM 1010 offers good chemical resistance, high heat resistance and tensile strength and the lowest coefficient of thermal expansion (CTE) of any FDM® thermoplastic (Figure 1). Its high strength-to-weight ratio and FST (flame, smoke and toxicity) ratings make it an excellent choice for the commercial transportation industry, especially aerospace, marine and ground vehicles (Figure 2). ULTEM 1010 is offered in a certified grade (ULTEM 1010 CG), which has documentation for food contact and biocompatibility compliance.

These characteristics make ULTEM 1010 a good fit in a variety of applications such as (but not limited to) the following industries:

- **Aerospace** – ducts, housings and composite layup tooling
- **Transportation and automotive** – under-hood and passenger compartment applications such as environmental control ducting, headlamp reflectors and electrical connectors, semi-structural components
- **Healthcare** – medical devices, fixtures and tools
- **Food Processing** – production tooling and packaging
- **Lighting and electronics** – applications requiring high heat and flame resistance such as reflectors, connectors and housings

### REFERENCE MATERIALS

#### DOCUMENTS

- Fortus® Production 3D Printer User Guide
- Best Practice: Curl Management
- ULTEM 1010 Spec Sheet



Figure 1: The high heat resistance and low CTE of ULTEM 1010 make it ideal for tooling applications such as composite layup tooling.



Figure 2: ULTEM 1010 can be used in a number of transportation applications such as vehicle air intake manifolds.

# ULTEM 1010 RESIN

Whether prototyping with FDM ULTEM 1010 or making production parts with ULTEM 1010 CG, consistent, high-quality parts can be achieved by adjusting to the material's specific build characteristics:

- **Pre-processing** – In addition to standard STL processing procedures, proper configuration of the modeler and selection of support structure parameters can be used to significantly improve build quality.
- **Machine preparation and printing** – When packing parts for a job using Control Center™ software, proper placement and orientation of the part on the build platen and machine maintenance considerations are critical to success.
- **Post-processing** – Proper part removal from the build chamber and appropriate support removal technique can improve user experience and part quality.

## NOTE

Unless otherwise noted, all references to “ULTEM 1010” in this document shall mean both ULTEM 1010 and ULTEM 1010 CG.

## 1. Pre-Processing Considerations

### 1.1 Prepare Part File In Insight™ Software.

#### 1.1.1 Material Selection

ULTEM 1010 and ULTEM 1010 CG contain the same formulation. However, ULTEM 1010 CG carries additional documentation certifying compliance with NSF 51 (food contact), ISO 10993/ USP Class VI (biocompatibility). If the application requires these certifications, ULTEM 1010 CG should be used.

The material is selected on the **Configure Modeler** window. In the **Model material** dropdown menu select the grade of material that you will be loading into the machine - ULTEM 1010 or ULTEM 1010 CG (Figure 4).

## NOTE

If a part is processed in Insight software to be built in one grade of ULTEM 1010 material but the other grade is loaded, the user will be able to confirm an override of the mismatch at the Fortus 3D Production Printer user interface panel.

#### 1.1.2 Slice Thickness Selection

There are two slice heights available for ULTEM 1010; 0.254 mm (0.010 in) using a T14 tip and 0.333 mm (0.013 in) using a T20 tip (Table 1). Part geometry should be taken into account when selecting the appropriate slice height. Ensure that the toolpath widths for a given slice height can produce good fill of the part's features. The larger slice thickness can dramatically decrease build time if the toolpath widths and surface finish are acceptable.



Figure 3: Custom medical tooling can be built in ULTEM 1010 because it can withstand steam autoclaving.

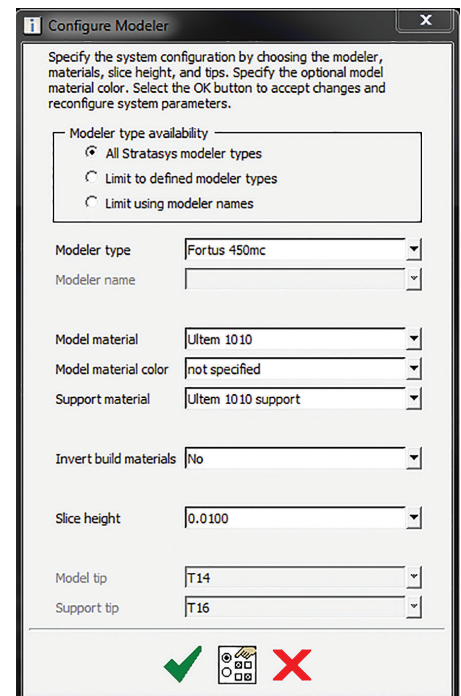


Figure 4: The appropriate grade of ULTEM 1010 is the material selected in the Configure Modeler window

The slice height is selected on the **Configure Modeler** window. In the **Slice height** dropdown menu, select either 0.254 mm (0.010 in) or 0.333 mm (0.013 in).

SLICE THICKNESS	MODEL TIP	SUPPORT TIP
0.254 mm (0.010 in)	T14	T16
0.333 mm (0.013 in)	T20	T16

Table 1. ULTEM 1010 slice thicknesses and the corresponding model and support tips.

### 1.1.3 Support Style Selection

The default support style is Sparse which is recommended for most builds. Changing support style may impact the support removal experience. The support style is configured in **Modeler Setup**.

### 1.1.4 Minimizing Part Curl

On large flat parts (> 305 mm [12 in] long and >12.7 mm [0.5 in] thick), differential cooling may cause parts to curl. There are processing tools that can be used to eliminate or prevent this condition. They include:

#### 1.1.4.1 Anchor Columns

The anchor column is made of model material and will need to be mechanically removed after the build. Placement and quantity will depend on geometry and any curl observed in previous builds. For details, see the section on anchor columns in the *Best Practice: Curl Management*.

#### 1.1.4.2 Remove Perforations (large areas of support)

The default settings for ULTEM 1010 support add perforations (single model layers incorporated in the support at predetermined intervals) for ease of support removal. For geometries where a large amount of stress may induce curling, failure may occur at the perforation layer. Typically, these geometries have large areas of support and curling can be avoided by eliminating perforations. For details, see the section on perforations in the *Best Practice – Curl Management*.

#### NOTE

Consider the part geometry and support removal process when removing perforations. For intricate or detailed parts, removal of perforations is not recommended.

## 1.2 Build Preparation Using Control Center Software

### 1.2.1 Part Placement

Due to the airflow configurations of the Fortus systems, proper part placement can prevent and alleviate quality issues.

## Fortus 400mc™ and Fortus 900mc™

- Single Parts - Place part in the rear left quadrant (Figure 5).
- Multiple Parts - Stagger the parts along the Y-axis to minimize airflow blockage when building multi-part packs (Figure 6).

**TIP**

To minimize dimensional variance between copies of a part, avoid placing them in multiple quadrants.

- Mixed Pack - Place parts with thick-wall sections to the left side of the build sheet and thin-walled parts to the right.

## Fortus 450mc™

- Single Parts - Place near the center of the platen (Figure 7).
- Multiple Parts – Place in the center and move concentrically outwards (Figure 8).
- Mixed Pack - Place the tallest parts in the center and move concentrically outwards. Place parts with thick-walled sections to either side (left or right) of the platen. Avoid placing thin-walled parts to the rear of the platen.

### 1.2.2 Part Orientation

Airflow on the part must be considered because it influences part quality. Parts should be oriented to account for the airflow configuration of the machine on which it is being built. Due to differences in chamber configurations, orientation is slightly different across the Fortus platforms.

**Fortus 400mc:** Align the part's long axis parallel to the Y-axis (Figure 9 ).

**TIP**

For parts with large support structures, orienting the build to maximize the airflow across the support structure may improve part quality.

**Fortus 450mc:** Due to the oven configuration, if part placement recommendations are followed, part orientation has minimal effect on part quality.

**Fortus 900mc:** Align the part's long axis along a diagonal between the front-left and back-right corners (Figure 10).

**TIP**

For parts with large support structures, orienting the build to maximize the airflow across the support structure may improve part quality.

### 1.2.3 Sacrificial Tower

The sacrificial tower is the first part built, which improves the quality of the other parts in the pack. The sacrificial tower is automatically placed in the right-front corner of the packed parts assembly, but can

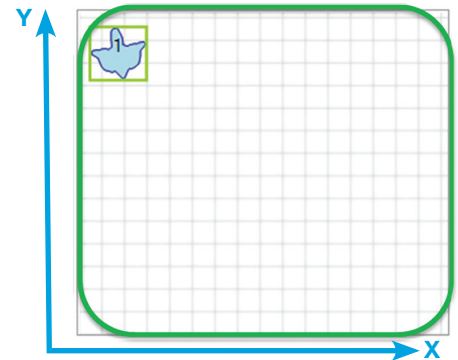


Figure 5: A single part on the Fortus 400mc or 900mc should be placed in the rear-left quadrant of the build platen.

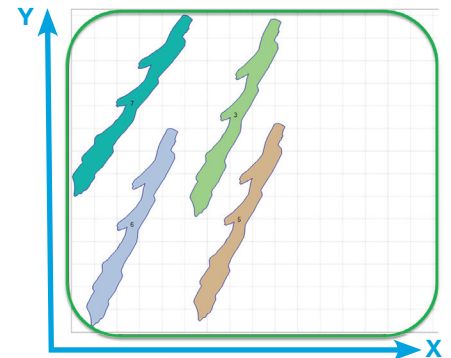


Figure 6: On the Fortus 400mc or 900mc, a pack of multiple parts is staggered and oriented along the y-axis to maximize airflow.

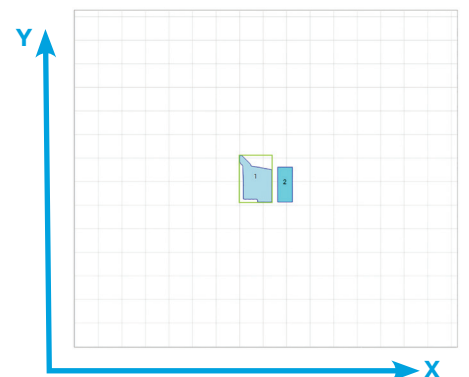


Figure 7: A single part on the Fortus 450mc should be placed in the center of the build platen.

be repositioned by the user. The use of a **Full height** sacrificial tower is recommended with all ULTEM 1010 builds.

**STEP 1:** On the Pack tab, click on the packing **Options** button (Figure 11).

**STEP 2:** In the Sacrificial tower options dropdown menu, select the **Full height** option (Figure 12).

**STEP 3:** Click “OK” to confirm your selection.

## 1.3 Machine Preparation And Printing

### 1.3.1 Machine Preparation

Proper machine preparation is important for safeguarding the machine against damage, but also to ensure good build quality. Follow regular maintenance outlined in the appropriate Fortus System User Guide. Also, ensure that each of the following items is completed before switching over to ULTEM 1010.

#### TIP

On the Fortus 900mc and Fortus 450mc, utilizing the Tip Change Wizard will provide step by step instructions for the tip change process, including basic recommended maintenance.

#### NOTE

The Fortus 450mc will check to ensure the installed hardware is ready to run ULTEM 1010. It will notify you of any incompatibility. If you receive a hardware warning, follow the onscreen prompts or contact customer support.

### 1.3.2 Maintenance

**STEP 1:** Clean the platen, vacuum the build chamber and empty the purge bin.

**STEP 2:** If you are preparing a Fortus 400mc or 900mc, continue to Step 3.

If you are preparing a Fortus 450mc, install the ULTEM 1010 purge ledges designed for use with ULTEM 1010 (Figure 13).

#### NOTE

Failure to change the purge ledges may cause purged material to build up and clog the purge chute.

**STEP 3:** Clean and inspect the tip wipe assembly.

**STEP 4:** If you are preparing a Fortus 450mc, continue to Step 5. If you are preparing a Fortus 400mc or 900mc, inspect the Kapton tape around the upper funnel chute and Y-carriage and replace as necessary.

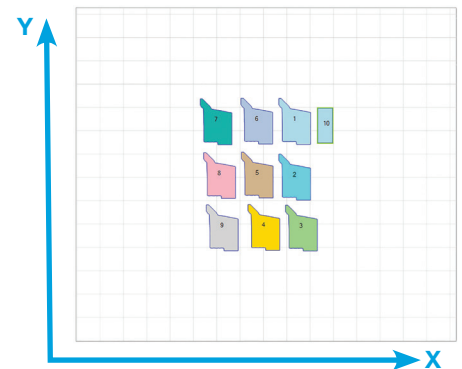


Figure 8: On the Fortus 450mc, a pack of multiple parts is placed in the center of the platen with the parts positioned concentrically outward from the center.

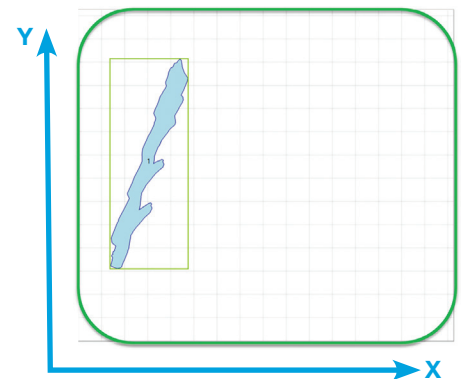


Figure 9: A single part packed in a Fortus 400mc is placed in the rear left quadrant and oriented along the y-axis.

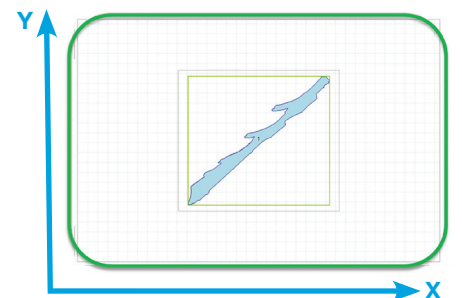


Figure 10: A single part packed in a Fortus 900mc is oriented along a diagonal from the front left corner to the back right corner of the build platen.

**STEP 5:** Verify the flicker and brush assembly is clean and calibrated at the correct height.

**STEP 6:** Install the appropriate model and support tips. Ensure that the tip shrouds are clean and undamaged.

### 1.3.3 Load Material

**STEP 1:** Load the model and support materials.

**TIP**

Load material into each available material bay to prevent excess ambient moisture from entering the filament tubes and degrading build quality.

**TIP**

When utilizing multiple canisters for a single build, match the lot number and manufacturing date to minimize noticeable variation in color at the changeover layer (Figure 14).

**NOTE**

When manually loading material, it is possible to override a material mismatch if the processed material type and loaded material type are different for ULTEM 1010 and ULTEM 1010 CG. However, if a job is started and the materials in each respective bay do not match, auto changeover will not occur. The user will need to manually initiate loading of the material in the other canister.

**STEP 2:** Preheat the build chamber and allow it to stabilize.

- Four hours is recommended for the Fortus 900mc Production 3D Printer.
- For the Fortus 400mc and 450mc, refer to Table 2.

**STEP 3:** Install a high temperature build sheet and verify that vacuum is present.

**TIP**

When using the small build sheets for the Fortus 900mc, place the build sheet so that the front left corner is aligned just over the front left outline of the small build sheet vacuum port (Figure 15). This can prevent vacuum loss due to tension induced by the part being built.

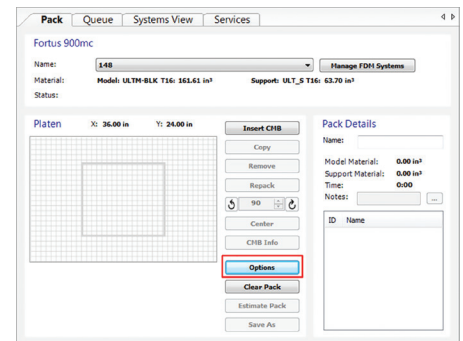


Figure 11: The pack options are accessed from the Options button on the pack tab.

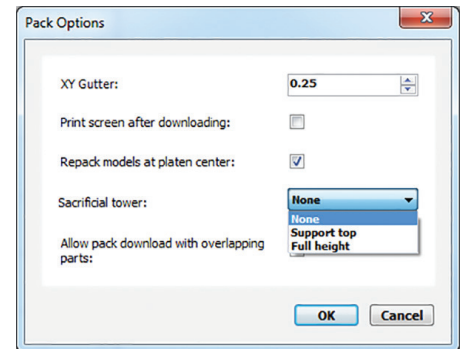


Figure 12: The Full height option is selected in the Sacrificial tower dropdown menu of the Pack Options.

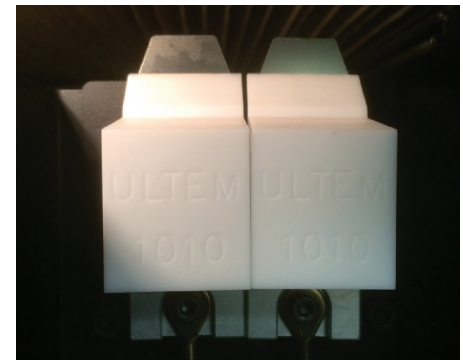


Figure 13: Purge ledges designed for ULTEM 1010 should be installed on the Fortus 450mc as a part of maintenance and preparation.

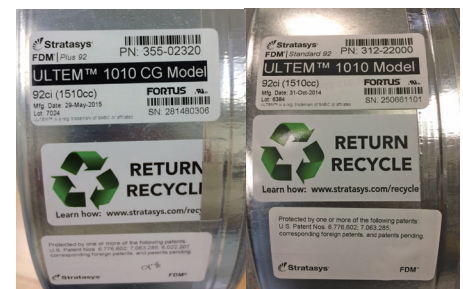


Figure 14: The manufacturing date and the lot number are found on the canister labels (ULTEM 1010 – right, ULTEM 1010 CG – Left).



MATERIAL BEING REPLACED	STABILIZATION TIME (HOURS)	
	FORTUS 400mc	FORTUS 450mc
System Off	8	4
ABSi™, ABS-M30™, ABS- M30i™, ABS-ESD7™	6	3
ASA	6	3
Nylon 12	6	3
PC-ABS	6	Not Applicable
PC, PC-ISO	4	3
ULTEM 9085 resin	6	3
PSF	-	Not Applicable

Table 2. Fortus 400mc and 450mc oven stabilization times in hours when running ULTEM 1010.

**NOTE**

Part quality and support removability are directly related to accurate system calibration. X and Y offset must be within tolerance ( $\pm 0.05$  mm [ $\pm 0.002$  in]). The Z slice variation must be within  $\pm 0.0127$  mm ( $\pm 0.0005$  in).

**STEP 4:** Perform XYZ tip offset calibration.

**NOTE**

Part quality and support removability are directly related to accurate system calibration. X and Y offset must be within tolerance ( $\pm 0.05$  mm [ $\pm 0.002$  in]). The Z slice variation must be within  $\pm 0.0127$  mm ( $\pm 0.0005$  in).

**STEP 5:** Start the job.

## 1.4 Remove Part

Remove the part from the build chamber. Wear appropriate personal protective equipment (PPE) because the parts will be hot ( $> 170$  °C [ $338$  °F]). The build sheet can become quite brittle as it cools down and may break off in pieces.

## 1.5 Remove Support

### 1.5.1 Heated support removal

Support material is easier to remove while it is hot. It is recommended that support removal begin immediately after the model is removed from the build chamber.

- CAUTION**

Wear PPE (leather gloves and safety goggles) as the parts will be extremely hot and support can break off in pieces that may become airborne.

If the part cools before all supports are removed, place the part in a temperature-controlled industrial oven for 10 minutes with the

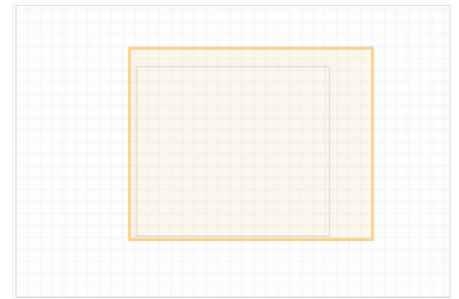


Figure 15: The small build sheet should be placed with the front left corner of the sheet aligned over the front left corner of the vacuum port.

setpoint at 170 °C (338 °F). Extract the part from the oven and remove as much support structure as possible until the part cools or the supports become increasingly difficult to remove (compared to when the part was initially removed from the oven). Repeat the heating process as needed until all support is removed.

## 1.5.2 Support Removal Technique

When removing support material use appropriate tools such as chisels, picks, and pliers (Figure 16) to remove the support with a low (< 30° angle) and slow peeling motion as opposed to a quick peeling or ripping motion.



Figure 16: Remove supports using the proper tools such as a chisel, magnetic handle pick set, pliers, and needle nose pliers.

## 2. Safety

Observe manufacturer's recommendations for safety, material handling and storage. This information can be found in the Safety Data Sheet (SDS).

## 3. Tools & Supplies

- Chisel
- Magnetic handle pick set
- Pliers
- Needle nose pliers
- Personal protective equipment (PPE)
- Industrial oven (optional)

## 4. Materials

- ULTEM 1010
- ULTEM 1010 CG
- ULTEM 1010 support

## 5. Software

- Insight software (document developed with Insight 10.6)
- Control Center software (document developed with Control Center 10.6)

## 6. Printers

- Fortus 400mc
- Fortus 450mc
- Fortus 900mc



## CONTACT

For questions about the information contained in this document, contact Stratasys at [www.stratasys.com/contact-us/contact-stratasys](http://www.stratasys.com/contact-us/contact-stratasys).



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