

Fig. 1 – A micrograph of a single bead of extruded material with out-of-specification moisture content.

Lens:X 150

Maintaining FDM Material Properties Through Proper Drying and Storage

Overview

For best results when 3D printing with FDM® thermoplastics, Stratasys recommends using filament with a moisture level below 0.04% prior to printing.

Thermoplastics are somewhat hydrophilic and will absorb small amounts of moisture from the atmosphere. This is especially true if proper storage guidelines are not followed. When the filament is heated in the liquefier, this trapped moisture is then converted into steam. The associated phase change from liquid water to a gas results in a volume increase of a factor of ~1700. This leads to increased porosity in printed parts and non-uniform printing, which may result in reduced mechanical performance and poor part surface finish.

Excessive moisture in either model or support material can cause print defects. Generally the condition of the model material is considered more critical.

Signs of Moisture

While the use of a moisture analyzer is the only definitive way to measure filament moisture content, it is possible to get an indication from the printing behavior of the filament.

Possible Signs of moisture:

- Excessive ooze from liquefier tips during printing or machine idle after printing
- Poor surface finish, strings of material or support on printed parts
- Lower mechanical performance, porosity in material

Stratasys does not recommend printing with material with a moisture content above 0.04%.



Drying Process

Theory

It is important to understand that simply holding material at an elevated temperature does not by itself remove moisture. Heat does increase the speed of the diffusion process, but to dry the material, the moisture must be removed by some force which creates the diffusion gradient.

As an example, damp clothing won't dry in a tropical jungle despite the temperature being 35 °C because the air humidity in the environment is extremely high.

Establishing a Diffusion Gradient

This can be accomplished using dry air, dry desiccant or vacuum extraction. In the first two examples there is a continual need to resupply dry air or replace desiccants to prevent the system reaching equilibrium where no further moisture exchange will take place.

The favored method recommended by Stratasys is the use of a vacuum oven. Stratasys has had successful experience with a Thermo Fisher Scientific Model Vacutherm VT 6130M and a 2.1 CFM scroll type vacuum pump. However other drying ovens with similar performance are also acceptable.

Material Drying Safety & Notes

Note



Canisters shall be allowed to cool for 30 minutes after canister drying before inserting into an FDM machine. If it is difficult to pull filament from a recently dried canister, allow canister an additional 15 minutes to cool. Canister moisture levels may be checked during the cooldown period.

CAUTION!



Heat resistant gloves should be worn at all times when the oven is open or HANDLING hot canisters. Oven temperatures will cause burns!

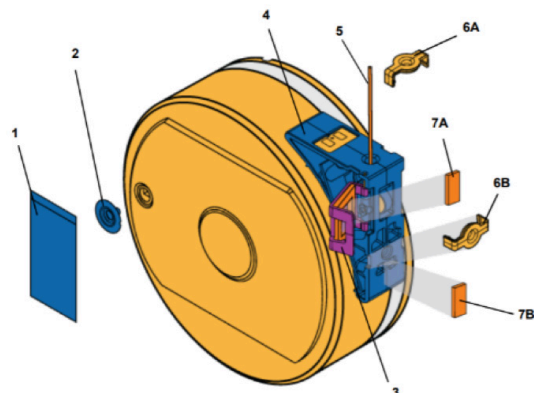
Drying Procedure

The following procedure is applicable to Fortus® material canisters and F123™ Series material spools.

1. (For Fortus material canisters) Remove the plastic plug (item 6A – Fig. 2) from the canister operating position and set aside outside the oven. Do not open any other openings in the canister. Keep tape and seals in place.

(For F123 Series Material Spools) Remove the spool from the mylar bag, ensure the loose end of the filament is secured on the spool.

2. Place the canisters or spools vertically in a vacuum oven with the filament hole facing the oven door as shown. Best practice is to dry and store vertically to prevent cross winding.
3. Turn on the continuous vacuum generation system attached to the oven.
4. An oven setpoint temperature of 70 °C is suitable for all FDM materials and FDM support materials except PLA, which must be dried at 40 °C.
5. Allow the material to dry for a minimum of 16 hours. Drying beyond 48 hours is unlikely to produce further benefit. 24 hours is considered standard.
6. After the allotted time, slowly release the vacuum.
7. Reseal the canisters and pack in Mylar bags if immediate use is not required.
8. Allow canisters to cool for a minimum of 30 minutes before printing.



Item	Description	Item	Description
1	Foil Tape	6A	Plastic Plug (operating position)
2	Anti-Rotation Plug	6B	Plastic Plug (storage position)
3	Thumbwheel Door	7A	Foam Gasket (operating position)
4	Canister Snout	7B	Foam Gasket (storage position)
5	Filament		

Fig. 2 – Main elements of an FDM filament cartridge.

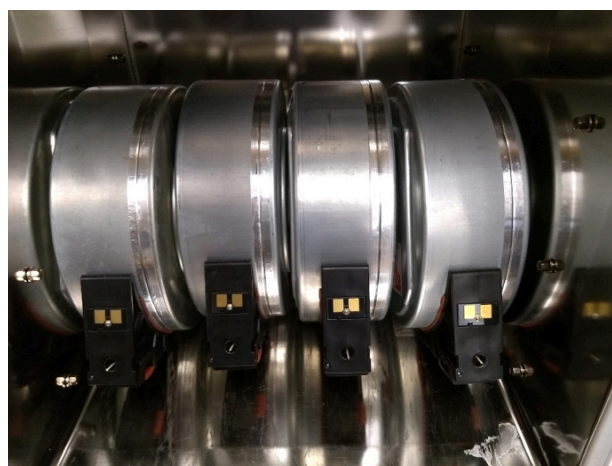


Fig. 3 – Filament canister placement in a vacuum drying oven.

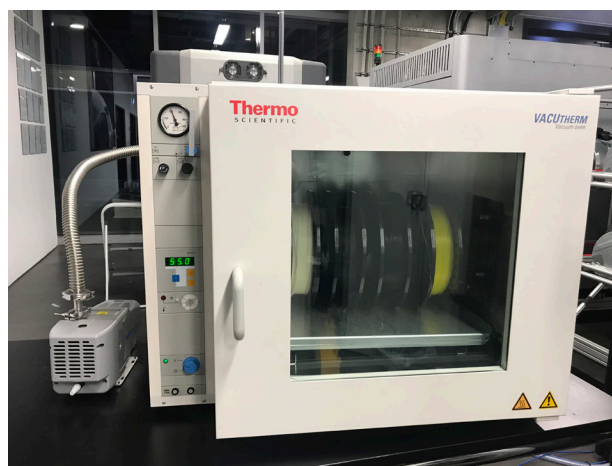


Fig. 4 – Spools of FDM filament in a vacuum drying oven.

Material Handling

Best Practice

Material Canister Handling and Storage

Stratasys does NOT include an expiration date on its thermoplastic materials. Prior recommendations to use the material within three years from the manufacturing date has been deemed unnecessary, as thermoplastics typically do not degrade over time unless exposed to high temperatures, UV, ozone, or other adverse environmental conditions.

To maintain the material in its optimal condition, Stratasys recommends that the material be stored in its original packaging, in a cool (65 – 75 °F), dry environment (<50% RH). For storage, canisters, cartridges, and spools should be sealed in their Mylar bag before use.

Storage Best Practice

- Ensure Mylar bags are not torn, punctured and properly resealed to be airtight
- Inspect the aluminum tape on the canister and verify it is intact, free from slits or punctures
- Always replace the foam gasket and plastic plug to the storage position

If material cannot be stored under optimal conditions (see ranges above) it is recommended that a moisture test be performed, and the drying process implemented to ensure that the moisture level is below 0.04% moisture prior to printing.

Materials Installed in the Printer

Printer User Guides

- F900™ 3D Production System User Guide 402737-0001_REV_E
- Fortus 450mc™ 3D Production System User Guide 400218-0002_REV_G
- Fortus 380mc™ 3D Production System User Guide 821358-0003_REV_E
- F123 Series User Guide - 401691-0001_REV_F

For periods when printer is idle

F900 printers:

Always ensure the drive block is properly seated & sealed around the canister opening. Canisters may stay loaded in the machine indefinitely if the system is left on as the air-dryer system will constantly purge sufficient moisture from the filament lines.

Fortus printers:

Always ensure the drive block is properly seated & sealed around the canister opening. If the canister is unlikely to be consumed by printing after seven days, remove the canister and shelf store as described above.

F123 Series printers:

If the printer is to remain idle for more than 72 hours it is recommended to unload the material from the head and retract it out of the filament tube.

For FDM® TPU 92A™ the maximum recommended idle time is reduced to 48 hours. For Diran™ 410MF07 and SUP4000B™ support material the maximum recommended idle time is reduced to 24 hours.

When Fortus and F900 printers are powered down

The air dryer system will no longer be active and it is recommended to remove the canisters and shelf store as described above.



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