LUMAS POLYMERS

FFF FILAMENT PRINTING AND DRYING GUIDE

PRINTING TIPS

NOZZLE CLEANING

Note: this should be done after every several builds

- If available, run through the nozzle cleaning procedure for your machine. If unavailable, use the manual cleaning procedure below.
- Check the tip of the filament as it comes out of the nozzle and see if it is clean or if there are any black spots/divots on the tip.
- If there are black spots/divots on the material after running through the nozzle cleaning procedure (examples in image below), then run through the manual cleaning procedure while using Lumas PA 4500 (or other nylon).

BASIC DRYING TIPS

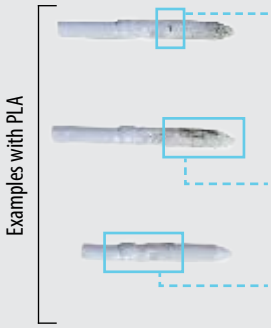
- Dry at 70-75° C. Long drying cycles (>6 hours) are ideal.
- Signs that the material needs to be dried:
  - Material will start to print with more stringing than normal
  - The surface finish will be rough
  - Mechanical properties are not as expected
  - In extreme cases, bubbling, hissing or generation of steam during printing

For more detailed drying advice, see FFF Drying Tips on the following page.

MANUAL CLEANING PROCEDURE

USING LUMAS PA 4500 OR LUMAS PLA 3100:

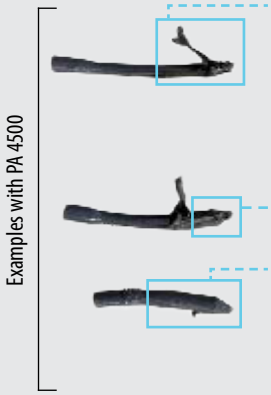
1. Set the nozzle temp to 235° C
2. Push the filament through the nozzle until there is a steady flow of material
3. While continuing to push material through, decrease the nozzle temperature to 115° C.
4. Keep pressure on the filament until the temperature drops below 160° C.
5. Wait for the nozzle to reach 115° C. Allow a few seconds for the filament to equilibrate to this temperature.
6. Using pliers, carefully pull the filament out of the print head.If the tip breaks in the print head during the cold pull, increase the cold pull temperature by 5° C.



The first cold pull while using the nozzle cleaning procedure on an Ultimaker printer. There is a small chunk of material embedded in the cold pull along with more material closer to the tip. This shows that the nozzle is dirty and will need further cleaning.

Showing that after the second cold pull, there is still material stuck in the nozzle.

Shows a divot on the cold pull which indicates that there could be some material still stuck in the nozzle.



The first cold pull using the manual method with PA 4500 or PLA 3100 filamant. It shows that there was still substantial material in the nozzle which sticks better to PA 4500 or PLA 3100 filamant. The purge was performed at 235° C and was dropped to 115° C for the cold pull.

A repeat of the previous cycle.

The final cold pull. At this point, the nozzle is cleared of most residue and is ready to print again. This cold pull was performed at 105° C. A successful cold pull at a lower temperature without the material breaking is a good sign that the nozzle is clean enough to print with.

7. Examine the tip of the material. If it's dirty, repeat the process.

FFF DRYING AND STORAGE TIPS

Most polymer filaments used in 3D printing can absorb moisture from the atmosphere. This decreases visual quality and mechanical properties and can lead to print failures. Materials will begin to absorb moisture as soon as they are exposed to humidity and the effects can be observed in as little as an hour for some materials.

There are two main concerns related to filaments and moisture:

1. How to dry filament that has absorbed moisture, and;

2. How to keep filament dry while printing.

While many of the advanced hobbyist or light industrial level printers incorporate some means of mitigating moisture uptake during printing, there is still a significant lack of effective off-the-shelf drying options. There are many approaches which range in cost and effectiveness. Unfortunately, there is no one-size-fits-all solution. This guide is intended to help you understand the factors that affect moisture uptake as well as some of the most effective means to dry and maintain dryness of filaments.

MOISTURE UPTAKE

The table below describes some of the more common filament base materials, their rate of moisture absorption, the general impact of moisture absorption and typical drying conditions.

POLYMER FAMILY	ABSORPTION RATE	IMPACT OF MOISTURE ABSORPTION	TYPICAL DRYINGTIME/ TEMPERATURE[1,2]
PLA	Slow	Moderate	4 hr / 80° C
ABS / ASA	Moderate	Severe	4 hr / 80° C
TPU	Moderate	Severe	3 hr / 80° C
PETg	Moderate	Moderate	6 hr / 80° C
Polycarbonate	Moderate	Severe	4 hr / 80° C
Nylon 12	High	Moderate	6+ hr / 80° C
Nylon 6	Very High	Moderate	6+ hr / 80° C

Note 1: Typically, manufacturers will recommend drying conditions for their filaments.

Note 2: Many filament materials may tolerate higher drying temperatures, however, the spool may warp or the filament may degrade when exposed to higher temperatures for extended periods of time.

DRYING TIPS

The filament drying rate is a function of temperature, ambient humidity and the tendency of a given material to hold onto water that it has absorbed. The rate of drying increases with temperature and decreases with higher ambient humidity. However, too much heat and the filament may tack together or the spool may warp.

There are several different methods for drying filament. Below is a list from most to least effective.

MOST EFFECTIVE ---------- LEAST EFFECTIVE

IN-LINE DRYER

Active in-line filament dryers like Drywise products sit between the filament spool and the printer extruder/hot-end. The filament is fed through ensuring that dry filament is being used during printing, resulting in consistent material properties all throughout your print. Because you can dry as you print, this is the quickest of the drying methods.

DESICCATING OVEN

A desiccating oven is a closed-loop system that actively removes moisture from the air, heats, and circulates. Set the oven to the manufacturer's recommended drying temperature. Let the material sit in the oven for several hours and re-test moisture content. Repeat until material is dry.

CONVENTIONAL OVEN

Conventional ovens reduce the humidity of the air simply by heating it up, making them less effective than desiccating ovens because they don't actively remove moisture from the air. The same procedure as a desiccating oven applies. Convection will improve drying rate.

DEHYDRATION (PRINTDRY, FOOD DEHYDRATOR)

Set device to recommended temperature for material and allow to dry for several hours or even days. Follow instructions of chosen device for temperature and drying times.

DESICCANT (IN SEALED BAG)

Placing a spool of filament in a sealed moisture-barrier bag with a suitable amount of dry desiccant will slowly dry out the filament, but can take as much as a week or more depending on the weight of filament and desiccant, the moisture content of the filament and the ambient temperature. Placing the sealed bag in a warm environment will improve the drying rate.

DRYING METHODS TO AVOID

The following methods **do not** provide effective drying and may ruin your filament or potentially even be dangerous.

Microwave	3D Printer Build Plate
Toaster Oven	Heat Lamp

STORAGE TIPS

When the filament has been effectively dried, it must be stored in a dry environment during printing or until ready to print. Below are some options listed from most to least effective.

MOST EFFECTIVE ---------- LEAST EFFECTIVE

ENCLOSED BOX WITH DRY GAS PURGE

If you're fortunate enough to have access to a dry gas source (e.g., a nitrogen generator or desiccant-dried pressurized air), plumbing a line and running a trickle purge will keep material dry indefinitely. **Make sure to have an oxygen sensor in the room if using nitrogen.**

DESICCANT DRY BOX

Fill a mesh bag with color changing desiccant and place it in an airtight tote with your filament and close the lid completely. This method works best if the tote is not going to be opened often.

SEALED BAG WITH DESICCANT

As noted in the Drying section above, storing filament in a sealed moisture-barrier bag with dry desiccant will typically keep filament dry, if not provide a slow rate of drying.

REDUCED HUMIDITY STORAGE BOX

Plug in and allow chamber humidity to drop. Once chamber is dry, place dry material inside and close door completely.