INTRODUCTION

This guide is going to give you all the information you need surrounding PLA filament. What it is, what it's good for, how to print with it and how to post process it.

PLA is probably the most popular 3d printing filament around. There's a good reason for that popularity. It's one of the easiest materials to work and print with. PLA properties mean it's forgiving to print with, and has excellent finish quality.

In this guide, we're going to take a closer look at PLA and show you how to get the best results possible when using it for your prints.

WHAT IS PLA?

You might be wondering what exactly is PLA? Well its full term is Poly-Lactic Acid and it is a thermoplastic polymer.

Because it is derived from natural sources like corn and sugarcane, PLA is sometimes referred to a bioplastic. The majority of other thermoplastics are distilled from non-renewable resources like petroleum.

In addition, because it is a natural product, it is also long-term biodegradable. This means that when discarded into a composting system, PLA will naturally break down into its constituent parts (typically within a few years) whereas other thermoplastics could take thousands of years to degrade.

WHAT ARE THE BEST APPLICATIONS FOR USING PLA?

As PLA is so versatile, it's a great starting filament to use for the majority of 3D prints. Be weary though, due it being commonplace in the market - there is a lot of poor quality PLA around. People try this, get frustrated that it's weak and brittle and move onto other materials to 3D Print.

Our advice is to use high quality PLA. Don't just write it off as being not strong enough for the variety of prints. You'll be amazed at the difference. There's no need to move onto 'stronger' filaments like ABS, PETG or others until your prints get more advanced.

Typically, we recommend you start printing with PLA until you find you have a reason to experiment with other materials. When you want to print more exciting/usable products you can experiment with flexible materials and PETG (which is a tougher, plastic with higher temperature resistance, but that still retains most of PLA's ease-of-printing).

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WHY PRINT WITH PLA?

Here's why we love PLA 3D printer filament so much:

- It's easy and forgiving to print. Get good quality PLA and it'll flow nicely and won't warp.
- You can print it even on less-advanced printers that don't have a heated bed.
- The finish detail is usually very neat. It isn't prone to stringing or blobbing.
- Post-print finishing is straightforward. It's easy to sand, drill or cut after printing.
- PLA can be pigmented easily, so you'll usually find colour selections better and more vivid.
- It doesn't smell bad when printing (not that you should be smelling it - always print in well ventilated areas).
- You don't need to feel bad throwing it out, because eventually it'll biodegrade.
- PLA print temperature is lower than most other filaments.

It should be noted that the melting temperature of PLA is relatively low - in the neighborhood of 170°C,which makes it a poorer choice for objects that will be used in a higher temperature application. Objects that are 3D printed with PLA will hold up fine when used at room temperature in a normal environment.

Another thing to be aware of is PLA's low glass transition temperature (Tg). which is just 50-60°C. At Tg, two things happen - the material will lose much of its strength, and it will lose its ability to deform elastically (in other words, any deformation done to the material above this temperature is permanent - it won't spring back to its original shape like it does when cold). Many users will experience this if they leave their prints in a hot car in the sun. PLA will distort and warp when it gets hot enough - and retain its warped shape when cooled back down.

This low Tg is actually used to good advantage in some situations. The eNable project (an initiative where volunteers use their 3D printers to make prosthetic hands for children and adults in need) uses thermoforming for one of the assembly steps. In their unlimbited device, the frame is printed flat. It is then dipped in hot water, which softens the plastic just enough for the two wings on the sides to be carefully bent upwards by hand into their final shape.

You can do this yourself too - for example, print a stick figure, dip him in hot water, then move his arms and legs into any shape you desire (careful not to burn yourself).

Hot air is also sufficient to soften PLA. For example, you can print this lion and then style its hair using the heat from a regular hair dryer.

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3D PRINTING WITH PLA

Now that you know what PLA is and you have a general understanding of its strengths and weaknesses, let's take a look at some of the things that you can do to get the most out of using PLA as a print material. In this regard, we're going to look at three critical areas that can affect the success of any 3d printing job – temperature, adhesion and material storage.

In any print job, it's very important that you get the printing temperature just right if you want a good run. Printing with PLA is no exception to this rule.

It's worth noting that higher quality PLAs print at lower temperatures, due to the purity of the resin and lack of contaminants.

PLA benefits from relatively low shrinkage, hence the low-to-no warpage. While the PLA shrinkage varies from manufacturer to manufacturer, it is usually within the 2.0-2.5% range.

WHAT TEMPERATURE TO PRINT PLA?

In general, PLA filament settings have an optimal printing PLA temperature range from about 185°C to about 210°C. If you're using 1.75mm filament as opposed to thicker **2.85mm (or 3.00mm) your optimal print will be closer to the lower end of this PLA filament temperature range.**

If you're using 2.85mm filament, you might want to go closer to the higher end of the temperature range to compensate for the increased thickness of the material.

With any material, and PLA extruder temperature can differ (+/-10%) depending on your machine. It may be wise to independently measure the temp of your extruder nozzle to accurately dial in the extrusion heat.

The best way to find the ideal temperature for your particular printer and particular brand of PLA is to print a temperature tower. This is a mult-floor "tower" where every floor is identical, but printed at a different temperature. The image on the right shows an example (source):

By looking closely at the quality of the print at each temperature, you can choose the temperature at which the filament appears to print the best.

In general, it's a good idea to **start PLA printing temperature at about 180C** and note how the material is being extruded, as well as the quality of the print layers being produced.

Generally speaking, the lower the temperature, the better the print quality (sharp edges become more defined and undesirable stringing is reduced). Bridges also print better (they don't sag as much). However, if the temperature is too low, you risk having weak prints, under-extrusion, and in extreme cases, a blocked nozzle. More on this later.

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Finding the best PLA temperature can be a little trial and error but is nearly always nearer the lower end of the spectrum for higher end filaments.

Your print temperature is probably too high if you notice that strings of material are occurring as your printer is moving between different parts of the print job.

This "stringing" happens because the PLA loses too much viscosity due to being too hot. As a result, the material leaks out of the print nozzle as it moves.

If this happens for you after reducing your hot-end temperature, increase retraction distance slightly and definitely increase cooling. For more information with printing faults, Check out our Ultimate troubleshooting guide available to download in the Useful Tools and PDF's section of your membership.

Your print temperature is probably too low if you notice that the PLA is having trouble adhering to the print surface or to previous layers. Temperature is also likely the cause of problems in the surface of the printed object like gaps, holes and missing layers.

However it's worth noting in our experience, 90% of problems printing with PLA is that it's simply being printed too hot. So if in doubt on your 3D printer settings for PLA, turn it down.

This is an indication that the PLA is under extruding because of a higher material viscosity caused by a PLA 3D printing temperature that is too low.

In either case, dialing in the correct print temperature will increase the chances that you'll end up with an object that is both useful and beautiful.

Be careful you don't boil your PLA. This sounds odd, but it's easy to print good quality PLA too hot.

If you're doing high detail or bridges, you want to control your PLA print temp with fans, to prevent sagging or loss of detail to 'melting' style effects.

When it comes to print speed, every printer is different and optimum settings will depend on what type of printer you're using. However, printing PLA is usually good at any speed between 30mm to 90mm/sec.

For higher quality end results, a lower printer speed is more likely to get you the finished product that you want. As with temperature, the best speed for the object that you're printing will need to be dialed in.

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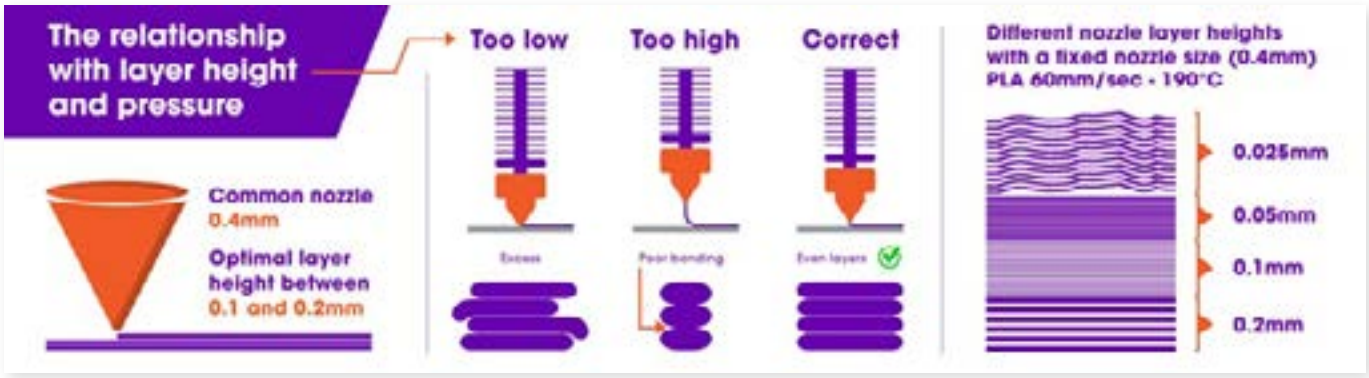
ADHESION



Getting PLA to stick can be a combination of correct distance from the bed, bed surface material and 1st layer fan speed (off).

Getting your print material to adhere to your print surface is key to a successful print run. One of the things that make high quality PLA one of the easier materials to print with is that it somewhat easily **adheres to a wide variety of surfaces** with a minimum of fuss.

Printing PLA without a heated bed is easily done thanks to its good adhesion and low warpage - although to aid first layer adhesion we do recommend a heated bed between 40-50C. If your PLA does warp, you might want to take a look at our article "Warping – Why It Happens and How to Prevent It" **which can be found here.**

Problems with your PLA filament not sticking? Take a look at our article on build plate surfaces and adhesion to get an idea of what **PLA build surfaces** might work best for you.

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