What is the best PLA filament supplier for my 3D printing needs?

by 3D Matter

In partnership with:

Thanks also to **CKAB** *for providing some of the filament samples.*

There are so many new PLA suppliers appearing every month that it is hard to keep track of the market offering. Here at 3D Matter we wanted to help users understand which are – in our opinion – the best PLA suppliers based on performance, quality and process. We teamed up with DOOD, a company developing 3D printers, to develop a testing process on their machines. Here are the high-level results from our study:

		Country	Price (€/kg)	Performance	Quality	Process	Conclusion
Regular PLA	ReprapWorld.com		20	B	C	B	Quite a good filament considering it was the cheapest option considered
	eSUN易生		22	B	D	B	Filament quality is quite poor but it can be an economical option when decent strength is needed
	Dutch Filaments		22	B	B	B	Dutch Filaments offers the best filament in the low-cost category
	RepRapper		22	D	C	B	Results were not great on our printer in particular for the filament performance
	colorFabb		48	B	C	A	Quality of prints was disappointing considering the brand renown, but it is quite flexible and is easy to use
	filo3D		58	B	B	B	Very good filament, but quite expensive
	MakerBot		59	A	B	A	Makerbot meets the high expectations for its filament by offering the best filament overall, though a bit pricey
	Faberdashery		86	A	C	B	Great mechanical performance but quality wasn't quite good enough to justify such a high price point
Modified PLA	CONSO-3D *Wood blend*		60	C	A	B	Nice wooden aspect, and a blend that can stretch much more than other filaments
	Proto-pasta *Carbon fiber blend*		65	C	A	B	Great prints, but the promise of a more rigid filament makes it very brittle
	colorFabb copperFill *Copper blend*		67	C	A+	C	Outstanding prints once post-processed, really metal-like in aspect but not a strong material

A+ Outstanding A Excellent B Good C Fair D Poor

Regular PLA filaments show a wide range of price points, but it didn't seem justified considering the slim differences between them. Not considering price, Makerbot tested best on the aggregate assessment. With price in mind, Dutch Filaments offers a great filament at a low cost.

Modified filaments are quite different from regular ones and therefore may qualify for a higher price point. While the performance is not on par, the quality of the prints is significantly improved and unique. They offer very promising prospects for filament 3D printing.

About the testing procedure

Here are the key evaluation criteria for the performance, quality and process tests:

PERFORMANCE
mechanical resistance of the material
	• Tensile test and compression test to determine:
	  • Strength
	  • Elongation at break
	  • Rigidity
		

QUALITY *how good the finished product looks*	• General aspect • Surface finish • Feature detail accuracy • Consistency across prints	
PROCESS *ease of using the filament*	• Spool supplied vs. coil only • Ease to feed into the printer • Frequency of filament getting tangled • Post-processing requirements	

The tests were carried out while controlling for all environmental parameters, all filaments being printed on the same printer with the same settings:

- Temperature: 200C
- Speed: 120mm/s (performance), 40mm/s (quality)
- Layer height: 0.25mm (performance), 0.15mm (quality)

Detailed results: Performance test

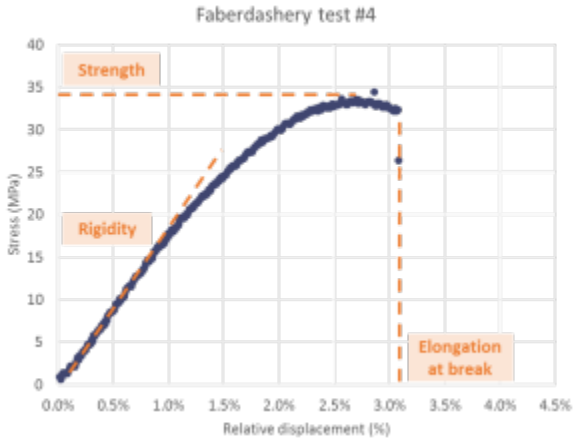
Box: testing procedure

The performance test is comprised of tensile tests and compression tests performed on multiple specimens of each filaments (see below). The tests were performed at room temperature.

We plotted stress-strain curves using a universal testing machine (UTM) to obtain the 3 key evaluation criteria: strength, elongation at break and rigidity

Criteria	**Definition**	**Value range**
Strength	Maximum stress the specimen undergoes before breaking	10 – 36 MPa
Elongation at break	Maximum length the specimen has been stretched before breaking	1.5% – 3.5% for most filaments 25% for the wood blend
Rigidity	Pressure needed to stretch/compress the specimen reversibly (calculated here through the Young Modulus)	2.1 – 3.5 GPa

Example stress-strain curve: 4th test for the Faberdashery filament



We performed the tests at the Navier lab of the Ecole des Ponts Paristech. The data was aggregated and averaged to build the following table *(note: the "low / medium / high" characterization used here is relative within this filament selection and does not represent an absolute assessment)*:

		Country	Price (€/kg)	Assessment	Strength	Elongation at break	Rigidity
Regular PLA	ReprapWorld.com		20	B	Medium	Low	Medium
	eSUN易生		22	B	Medium	Low	Medium
	Dutch Filaments		22	B	Medium	Medium	Medium
	RepRapper		22	D	Low	Low	Low
	colorFabb		48	B	Low	High	Low
	filo3D		58	B	Medium	Medium	Low
	MakerBot		59	A	High	High	Medium
	Faberdashery		86	A	High	Medium	Medium
Modified PLA	CONSO-3D *Wood blend*		60	C	Very low	Very high *(10x other filaments)*	Low
	Proto-pasta *Carbon fiber blend*		65	C	Low	Very low	High
	colorFabb copperFill *Copper blend*		67	C	Very low	Low	Very high

If you would like to get more details about the actual numbers behind this table, as well as the stress-strain curves, please contact us at arthur@my3dmatter.com

In this table we try to offer an aggregate assessment of the filaments' performance but please bear in mind that the performance of the material will depend on the application it is used for. Therefore the aggregate assessment can be misleading if only one criterion is sought after (e.g. the application does not require any strength but needs to be rigid).

Performance variations between regular PLA filaments are not tremendous but more expensive filaments tend to show better performance.

Regular PLA filaments show significantly better strength than the modified PLA samples studied. Modified PLA filaments also show very different rigidity and elongation from regular PLA filaments, leading to interesting potential niche applications.

Detailed results: Quality test

We printed the .stl file called “the owl” (downloaded from Thingiverse) multiple times per filament. Then we had four different people rank each batch from “best looking” to “worse looking”, and also group them by quality categories. Based on these rankings, the following conclusions were drawn:

		Country	Price (€/kg)	Assessment	Comments	Example test
Regular PLA	ReprapWorld.com		20	C	Fairly good prints but glossy finish highlights imperfections	
	eSUN易生		22	D	Significant imperfections. Color aspect not as good as more expensive filaments	
	Dutch Filaments		22	B	Very good prints, with a nice matt finish	
	RepRapper		22	C	Surface finish and general aspect is ok but quality was uneven between prints	
	colorFabb		48	C	Considering the brand’s renown, prints were surprisingly inconsistent. The accuracy was generally not very good	
	filo3D		58	B	Very good prints, even though consistency between prints wasn’t the best	
	MakerBot		59	B	Nice filament that shows print lines less than the rest of the regular PLA filaments	
	Faberdashery		86	C	Decent prints but quite disappointing considering the price point	
Modified PLA	CONSO-3D *Wood blend*		60	A	Very nice wood-like aspect, and wooden surface is more forgiving of imperfections	
	Proto-pasta *Carbon fiber blend*		65	A	Excellent matt finish, the best filament print before post-processing	
	colorFabb *copperFill* *Copper blend*		67	A+	Quite magnificent once post-processed, it ranked first in the quality test. Needs regular polishing to keep its shine	

As a general comment, the quality difference between regular PLA filaments was small compared to the differences linked to printer quality and printer settings. For example, a change in the extruder quality, in the printing speed or in the layer height will influence the quality outcome much more than a change in regular PLA supplier.

Bigger differences come with modified filaments: the nature of the material printed leads of course to a different appearance, but the finish was also clearly better. The copper blend from Colorfabb (see below) was outstanding once post-processed.

Detailed results: Process test

The assessment of how easy it is to process a given filament depends on one-off issues and is therefore harder to characterize than quality or performance. However, we wanted to point out obvious or recurrent process-related characteristics we observed when using the filaments.

In particular, we gave a better grade if the filament was sold with a spool, if it was easy to feed into the printer, if the filament was not getting tangled, and if there was no or limited post-processing needed.

		Country	Price (€/kg)	Assessment	Spool included?	Comments
Regular PLA	ReprapWorld.com	NL	20	B	✓	No particular issue with the filament. Doesn't age very well
	eSUN易生	CN	22	B	✓	Usually works fine but spool gets tangled occasionally
	Dutch Filaments	NL	22	B	✓	Feeds into the printer very well but prone to jamming the extruder
	RepRapper	CN	22	B	✓	No major issue
	colorFabb	NL	48	A	✓	Good spool format and feeds very nicely into the printer
	filo3D	FR	58	B		The filament is very well conditioned but the manufacturer charges for its spool system
	MakerBot	US	59	A	✓	Very nice spool and the filament is very even, leading to very few issues
	Faberdashery	UK	86	B		Similar to filo 3D, the filament feeds very nicely but there is no spool available
Modified PLA	CONSO-3D *Wood blend*	FR	60	B	✓	No issue with the filament
	Proto-pasta *Carbon fiber blend*	US	65	B		No issue with the filament, but no spool provided. It can break easily due to increased rigidity
	colorFabb *copperFill* *Copper blend*	NL	67	C	✓	The filament is actually quite easy to feed into the printer but the print requires a lot of post-processing to reach the beautiful copper finish

Disclaimer

We do not pretend to have an exhaustive and perfect test. In particular, the test does not account for the following parameters:

- Printer specificities: we used only one 3D printer to do the tests and we believe there may be some differences depending on the machine used
- Ease of procurement: depending on your location or the volume required, it may be cheaper and/or simpler to get filament from a given supplier and affect your choice
- Toxicity: we didn't measure the toxicity of each filament. While we assume that PLA filaments are comparable in terms of toxicity, it may be a limitation if we extend the study to more material types
- Color variety: if you are looking for a specific color or a wide range of options, it may influence the supplier you choose.
- Customer service: Some suppliers will provide assistance if you are struggling with the filament, and this could compensate some of its apparent shortcomings