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PLA-CF

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PLA-CF is a toughened PLA reinforced with short carbon fibres. The fibres do two visible things: they give the print a deep matte, almost soot-black surface on which layer lines nearly vanish, and they make it distinctly stiffer — the highest bending modulus of any PLA in the range. What they do not do, despite the name, is make it stronger in a pull or more heat-resistant: tensile strength is a little above PLA Basic, heat deflection is the same 55 °C, and layer bonding is worse. It is a material for parts that must not flex and must look engineered: brackets, frames, jigs, drone arms, and anything that would otherwise be sanded and painted matte black. Carbon fibre is severely abrasive, so a hardened steel nozzle of 0.4 mm or larger is mandatory, and the manufacturer advises gloves and eye protection when handling filament ends and sanding prints.

FEELS LIKE

Dry, matte, rigid

Like a carbon-fibre composite part; slightly rough where fibres break the surface

THE EFFECT

Layer lines almost disappear

The matte finish hides what glossy PLA shows

STIFFNESS

Highest in the range

Bending modulus 3950 MPa — 44 % above PLA Basic

STRENGTH

Not the point

Tensile 38 MPa flat; heat resistance unchanged; layers weaker

NOZZLE

Hardened steel, 0.4 mm minimum

0.2 mm not compatible; stainless not recommended

HANDLING

Gloves and goggles

Fibre fragments can irritate skin and eyes

Where it sits in the range

Each bar shows this material against the strongest value found anywhere in this series of guides, PLA and PETG together (bar full = best in the series). The dark tick marks plain PLA Basic, the material most people know, so you can see at a glance where this one gives up or gains something. Values come from the manufacturer's own datasheets, measured on test bars printed flat (X-Y).



Good for

- Brackets, mounts, camera rigs and fixtures that must hold their shape

Not the right choice for

- Parts loaded across their layers — the fibres do not bridge layers, and Z toughness is low

- Drone and RC frames, arms and plates where stiffness per gram matters
- Jigs, gauges and workshop tools
- Enclosures, panels and consumer-product prototypes that should look finished off the printer
- Bicycle accessories and light-duty structural parts kept away from heat

- Anything hot: the heat limit is the same as PLA Basic
- Impact-facing parts; PLA-CF is stiff and comparatively brittle
- Unhardened nozzles, 0.2 mm nozzles, and third-party CF filaments in the material system
- Food contact; no certification. Children's items, because of fibre fragments

What short carbon fibre does inside a print

The fibres are chopped to fractions of a millimetre and align with the direction of extrusion as they pass through the nozzle. Along that direction they stiffen the line enormously; across it, and across layers, they contribute little and can even act as flaws. This is why the datasheet shows the highest bending modulus in the range (3950 MPa flat) alongside a Z-direction bending modulus of only 2260 MPa and Z impact toughness of 7.8 kJ/m². Tensile strength rises modestly, elongation drops, and heat resistance is untouched because the polymer, not the fibre, softens. The fibres also make the melt extremely thick (melt flow index 3.7, the lowest in the range) and abrasive; brass or stainless nozzles open up within a spool, and any orifice under 0.4 mm clogs. Broken fibre ends at cut filament and sanded surfaces are stiff enough to penetrate skin, which is why gloves are advised. The published mechanical values were measured on annealed specimens; un-annealed parts will be somewhat less stiff.

2 · Living with a PLA-CF print

A PLA-CF print is a rigid, handsome, slightly fragile object with a heat limit it does not look like it has.

Heat	Softens from about 55 °C — the carbon-fibre look fools people into treating it as engineering plastic. No car interiors, no near-motor mounts, no hot enclosures.
Sunlight	Carbon fibre is UV-opaque and protects the polymer somewhat; the surface remains PLA and embrittles over years outdoors.
Water and damp	Insoluble; moderate moisture uptake (0.42 %).
Chemicals	As PLA. Isopropyl alcohol is safe.
Food	Not certified for food contact, and loose fibres make it unsuitable in principle.
Skin contact	Smooth printed surfaces are fine. Rough edges, broken surfaces and cut filament can release fibre fragments that irritate skin or eyes — handle with gloves, do not rub broken surfaces.
Load over time	Stiffer than any other PLA, so it creeps less visibly, but it still creeps when warm.
End of life	General waste or 3D-print recycling; the fibre prevents composting.

Looks and feel

A deep matte finish with a fine texture where fibres meet the surface. Black is the classic, but the range includes muted colours such as burgundy, matcha green and jeans blue, all with the same low sheen.

Care

- Wipe clean; wear gloves if handling rough or broken edges
- Keep away from heat
- Sanding releases fibre dust: wet-sand, wear a mask and goggles, and wash hands afterwards

Layer lines are nearly invisible; the material looks like a moulded composite part.

- No finishing is normally needed; the matte look is the point
- Superglue and epoxy bond well to the matte surface

Gloves and goggles

The manufacturer's usage guide advises puncture- and cut-resistant gloves and safety goggles when handling PLA-CF filament, removing supports and sanding prints, because of hard microscopic fibre fragments at cut ends and rough surfaces. Its datasheet, oddly, lists no skin hazard — follow the guide.

What PLA actually is

PLA stands for polylactic acid. It is a polyester made by fermenting plant sugars — usually corn starch or sugarcane — into lactic acid and then linking those molecules into long chains. That plant origin is why PLA is often described as a bioplastic: the carbon in it was recently in a field, not in an oil well. It is the most widely used material in desktop 3D printing for a practical reason: it melts at a low temperature, barely shrinks as it cools, and therefore prints reliably on almost any machine without an enclosure.

Its two well-known limits follow from the same chemistry. PLA is a semi-crystalline polymer with a glass transition around 55–60 °C, so it starts to soften at temperatures a car dashboard or a sunny windowsill can reach. And although it is compostable in principle, that only happens in an industrial composting plant at around 60 °C with the right microbes; in a garden heap, in soil or in the sea it behaves like any other plastic for many years. Printed PLA should go into general waste or a dedicated 3D-print recycling stream, not the organic bin. Every variant in this series is a PLA base with something changed — a filler, a pigment system, an additive package or a foaming agent — and each guide explains what that change does to the material's behaviour.

3 · How it is printed

PLA-CF prints on standard machines with three firm requirements — a hardened steel nozzle of 0.4 mm or more, a lower speed limit, and the manufacturer's own PLA-CF if it is to go through the material system — and one strong recommendation: anneal the finished part to reach the published stiffness.

Manufacturer print window

Nozzle temperature	210–240 °C (specimens 230 °C)
Bed temperature	35–45 °C on Cool Plate; 45–65 °C on PEI
Build plates	Cool Plate, High-Temperature Plate, Textured PEI; Engineering Plate not recommended
Bed adhesive	Glue stick or liquid glue
Chamber	25–45 °C, no enclosure
Print speed	Up to 200 mm/s (specimens 180 mm/s)
Part cooling fan	On, 50–100 %
Retraction	0.6–1.0 mm at 20–40 mm/s
Max overhang without support	About 55°
Max unsupported bridge	About 30 mm

Support material	Support for PLA
Annealing	55–60 °C for 6–12 hours, recommended — the datasheet values were measured on annealed parts

Hardware and compatibility

Nozzle sizes	0.4, 0.6 and 0.8 mm; 0.2 mm not compatible
Nozzle material	Hardened steel required; stainless steel 0.2 and 0.4 mm not recommended; brass unsuitable
Abrasive	Yes, strongly; wear rate not published
Automatic material systems	AMS-compatible for the manufacturer's own PLA-CF, which is designed for it; third-party CF filaments are not covered
Spool identification	RFID tag
Maintenance	Regular cold pulls with PLA Basic or Matte are advised during long-term use to clear fibre residue

Moisture, drying and storage

Moisture uptake is moderate, but the manufacturer lists PLA-CF among the PLA variants that should be dried before printing; wet CF filament prints rough and weak.

Forced-air oven or filament dryer	55 °C for 8 hours (datasheet); 50–60 °C on the drying-recommendations page
Heated print bed method	65–75 °C for 12 hours, covered (usage guide: 70 °C, 12 h)
AMS 2 Pro / AMS HT	55 °C for 8 hours (usage guide)
Storage	Sealed with desiccant, below 20 % relative humidity

Tips that make a visible difference

- Design for flat loading: fibres stiffen along the layers, not across them; put ribs and bosses in the X-Y plane
- Anneal at 55–60 °C on a flat surface to reach the published stiffness; expect slight shrinkage
- A 0.6 mm hardened nozzle prints faster, clogs less and spreads wear over a larger orifice
- Cold-pull with PLA Basic every few spools; fibre residue accumulates in the melt zone
- Cut filament ends with side cutters and dispose of the offcuts — do not snap them by hand

Known problems and their fixes

Clogs and under-extrusion

Fibre build-up or a too-small nozzle. Use 0.4 mm hardened or larger, do a cold pull, and keep speed under 200 mm/s. Very thick melt (MFI 3.7) means small nozzles struggle.

Nozzle wears out quickly

Brass or stainless. Hardened steel only; even hardened wears faster than with plain PLA.

Part is not as stiff as the datasheet suggests

Not annealed. Anneal at 55–60 °C for 6–12 hours.

Part snaps along a layer

Low Z toughness (7.8 kJ/m²). Reorient, add walls, or accept that CF stiffens rather than toughens.

Ringling and surface artefacts

Reported on some machines; reduce speed and acceleration for outer walls.

Skin irritation after handling

Fibre fragments. Gloves, and avoid rubbing rough surfaces.

4 · The numbers — technical datasheet

Figures are from the PLA-CF Technical Data Sheet V2.0 as served from the manufacturer's own CDN (specimens printed at 230 °C / 35 °C bed / 180 mm/s, 100 % infill, annealed at 55 °C for 8 hours). A second document also labelled V2.0 circulates with slightly different values; see data notes.

Physical and thermal properties

Property	Test method	Value
Density	ISO 1183	1.22 g/cm ³
Melt flow index (210 °C, 2.16 kg)	ISO 1133	3.7 ± 0.6 g/10 min
Melting temperature	DSC, 10 °C/min	165 °C
Glass transition temperature	DSC, 10 °C/min	63 °C
Vicat softening temperature	ISO 306	69 °C
Heat deflection temperature, 0.45 MPa	ISO 75	55 °C
Heat deflection temperature, 1.8 MPa	ISO 75	54 °C
Saturated water absorption (25 °C, 55 % RH)	—	0.42 %

Mechanical properties

Property	Test method	X-Y (flat)	Z (across layers)
Young's modulus	ISO 527	2790 ± 120 MPa	2160 ± 90 MPa
Tensile strength	ISO 527	38 ± 4 MPa	26 ± 2 MPa
Elongation at break	ISO 527	8.4 ± 3.2 %	3.6 ± 0.7 %
Bending modulus	ISO 178	3950 ± 190 MPa	2260 ± 180 MPa
Bending strength	ISO 178	89 ± 4 MPa	49 ± 3 MPa
Charpy impact, unnotched	ISO 179	23.2 ± 3.7 kJ/m ²	7.8 ± 0.7 kJ/m ²
Charpy impact, notched	ISO 179	7.6 ± 2.6 kJ/m ²	not published

The two HDT values differ by only 1 °C, which is atypical; both revisions of the sheet print it this way.

What the mechanical numbers mean in practice

The bending row is where carbon fibre earns its keep: 3950 MPa modulus and 89 MPa strength flat are the highest in the range, 44 % and 17 % above PLA Basic. Tensile strength rises only to 38 MPa and stiffness in a pull to 2790 MPa. The cost is everywhere else — elongation of 8.4 % flat and 3.6 % across layers, unnotched impact of 23.2 kJ/m² (below Basic), and a Z bending modulus barely half of the flat figure, which is the fibre alignment showing through. Glass transition and Vicat are the highest in the range (63 °C, 69 °C) but HDT is not — 55 °C — because a small stiffness increase does not move the

point at which the polymer yields under load. Read PLA-CF as "rigid PLA Basic that looks better", not as an engineering upgrade.

Product format

Diameter	1.75 mm $\pm$ 0.03 mm
Net weight	1 kg
Spool	ABS, 200 × 67 mm, rated to 70 °C; ships with desiccant
Colours	7 (EU): Black, Burgundy Red, Matcha Green, Jeans Blue, Royal Blue, Iris Purple, Lava Gray
Identification	RFID tag
Datasheet version	V2.0

Safety, certifications and chemical resistance

- Declared composition polylactic acid and carbon fibre; odourless; the datasheet lists no skin hazard but the usage guide warns of fibre fragments and advises gloves and goggles for handling, support removal and sanding
- Flammable; combustion products water and carbon oxides
- RoHS and REACH compliance stated across the filament line; no safety data sheet was located for this product
- No food-contact or toy certification; no emissions data published
- Sanding dust contains carbon fibre fragments: wet-sand, mask, goggles
- Resistant to oils and greases; not to acids, alkalis or some organic solvents

5 · Compared with Polymaker and SUNLU

Carbon-fibre PLA is where published figures diverge most between brands, and where the Z-direction data that only Polymaker and Bambu publish matters most, because that is where CF parts fail.

Polymaker

PolyLite PLA-CF

Polymaker's CF grade is denser (1.29 g/cm³) and reports a somewhat lower flat stiffness and much lower bending strength than Bambu's, but a higher permitted speed (300 mm/s). Its most useful number is the one Bambu also publishes and SUNLU does not: Z tensile strength of 15 MPa, less than half of flat — the worst layer retention in Polymaker's PLA range, and a fair warning about CF parts generally. Notched Charpy 5.5 kJ/m² is in the same brittle class as Bambu's 7.6. Cardboard spool.

Density	1.29 g/cm ³
Tensile X-Y / Z	31.2 / 15.1 MPa
Young's modulus X-Y	3281 MPa
Bending strength X-Y	51.7 MPa
Charpy notched X-Y	5.5 ± 0.2 kJ/m ²
HDT 0.45 / 1.8 MPa	54 / 50 °C
Nozzle / bed	190–230 °C / 25–60 °C
Max speed	50–300 mm/s

SUNLU

SUNLU PLA-CF

SUNLU quotes higher tensile and bending strength than either rival (44 and 79 MPa) with a notched Izod of 3.5 kJ/m² — brittle — and no Z data. Its listed density of 0.9 g/cm³ is almost certainly a publishing error: carbon fibre raises density, and every unfilled SUNLU PLA is above 1.2. No hardened-nozzle guidance is published. The least expensive of the three.

Density (as published)	0.9 g/cm ³ — implausible
Tensile	44 ± 5 MPa
Bending strength	79 ± 5 MPa
Izod notched	3.5 ± 1.5 kJ/m ²
HDT	55.5 ± 3 °C
Nozzle / bed	215–245 °C / 50–60 °C
Spool	cardboard, 1 kg

Reading cross-brand numbers fairly

Manufacturer datasheets are produced by different labs on different printers, and two numbers are comparable only when the test standard, specimen orientation and impact method match. Charpy and Izod impact results are not interchangeable; notched and unnotched results differ by a factor of three or more; and Polymaker publishes Z-direction data where SUNLU publishes none. Treat cross-brand figures as an indication of class, not a ranking. Where a brand's marketing claim is not backed by its own datasheet, this guide says so.

Bottom line. Bambu's PLA-CF has the highest published bending stiffness and strength of the three and is the only CF filament its material system is validated for. Polymaker's is the most honest about the layer weakness that defines the category; SUNLU's numbers are the highest and the least complete. All three need a hardened 0.4 mm nozzle, gloves, and a design that keeps loads in the plane of the layers.

How to read the datasheet

X-Y vs Z

A 3D print is a stack of layers. X-Y describes a test bar printed lying flat, where the load runs along the extruded lines. Z describes a bar printed standing up, where the load tries to pull the layers apart. Z values are always lower, and the ratio between them tells you how well the layers have fused. Real parts fail along layer lines far more often than through them.

Tensile strength (MPa)

The stress at which a bar pulled from both ends breaks. Megapascals are newtons per square millimetre: a 10 mm × 10 mm cross-section of a 35 MPa material holds roughly 3.5 kN, about 350 kg, before it snaps in a slow pull.

Young's modulus (MPa)	Stiffness — how much force it takes to stretch the material by a given amount. Higher means more rigid. It says nothing about strength: a stiff material can still be brittle.
Elongation at break (%)	How far the bar stretched before it broke, as a percentage of its original length. Low values (under 5 %) mean the material snaps with little warning; higher values mean it yields and bends first.
Bending (flexural) strength and modulus	The same two ideas measured by pressing down on the middle of a bar supported at both ends — closer to how brackets, clips and shelves are actually loaded.
Charpy impact (kJ/m²)	A pendulum hammer strikes the bar; the energy it absorbs before breaking is divided by the fracture area. This is the best single indicator of toughness — resistance to drops and knocks. Unnotched bars measure the bulk material; notched bars have a small cut that concentrates stress and give much lower numbers. Never compare a notched figure with an unnotched one, or a Charpy figure with an Izod one (a different test geometry).
Glass transition, T_g (°C)	The temperature at which the polymer's chains gain enough mobility for it to change from glassy and rigid to leathery and soft. Above T _g a loaded part will slowly creep and deform. For PLA and PETG this is the single most important thermal number.
Heat deflection temperature, HDT (°C)	The temperature at which a bar under a fixed bending load sags by a set amount. Quoted at 0.45 MPa (light load) and 1.8 MPa (heavy load); the light-load figure is always the higher of the two. Practical rule: keep loaded parts well below the 0.45 MPa figure.
Vicat softening point (°C)	The temperature at which a needle under load penetrates 1 mm into the material. Another measure of when the surface stops being hard.
Melting temperature, T_m (°C)	Where the crystalline regions melt, measured by DSC (a calorimeter). Printing happens well above T _m so the polymer flows freely.
Melt flow index, MFI (g/10 min)	How much molten material flows through a standard die in ten minutes under a fixed weight (210 °C for PLA; PETG sheets use 210–250 °C, so compare only at equal temperature). Higher means runnier and easier to push at speed; lower means more viscous, which is why some variants have lower speed limits.
Water absorption (%)	How much moisture the filament takes up from air at 55 % relative humidity. Absorbed water boils in the nozzle, causing pops, bubbles, stringing and rough surfaces — hence the drying recommendations.
Density (g/cm³)	Mass per volume. A 1 kg spool of a 1.31 g/cm ³ material contains about 5 % less printable length than a 1 kg spool at 1.24 g/cm ³ — heavier fillers cost you metres.
Annealing	Baking a finished print at a temperature just above T _g to let it crystallise further. It can raise heat resistance and stiffness but usually shrinks and sometimes warps the part.

Data notes and sources

Where sources disagree

- Two documents both labelled PLA-CF TDS V2.0 exist. The manufacturer's CDN copy (used here) gives flat elongation 8.4 %, bending modulus 3950 MPa and bending strength 89 MPa; reseller-hosted copies give 12.7 %, 3700 MPa and 96 MPa. All other values agree.

- The manufacturer's US store summary quotes 53 MPa tensile and 114 MPa bending strength — far above either datasheet revision. Those figures are not used.
- Speed: datasheet and store pages say up to 200 mm/s; a third-party guide says 250 mm/s. 200 is used.
- A commonly repeated claim that the 0.4 mm high-flow nozzle is unsuitable for PLA-CF (poor overhangs) appears in the manufacturer's PLA usage guide; the store page instead excludes stainless 0.2 and 0.4 mm. Both are reported.
- The datasheet's "no skin hazard" conflicts with the usage guide's glove-and-goggle advice; this guide follows the more cautious source.

Sources

- Bambu Lab, PLA-CF Technical Data Sheet V2.0 (CDN copy) — https://store.bblcdn.eu/s8/default/aefa8303ad8d40248b0d86dfd46518/Bambu_PLA-CF_Technical_Data_Sheet_V3.pdf
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- Bambu Lab Community Forum, PLA-CF printing issues — <https://forum.bambulab.com/t/pla-cf-printing-issues-clogged-nozzles-and-ringing-artifacts-on-x1c/61045>
- Polymaker Wiki, PolyLite PLA-CF TDS — <https://wiki.polymaker.com/polymaker-products/more-about-our-products/documents/technical-data-sheets/pla/pla-cf>
- SUNLU, filament parameter table — <https://www.sunlu.com/wiki/43>

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