EDITION OCTOBER 2026

# Material selection guide for functional 3D printed parts

FDM and SLA resin. Thirteen materials, one decision table, and the design rules that decide whether a part works.

## From one of the largest 3D printing factories in Eastern Europe

ISO 9001:2015 certified factory · 200+ printers · Romania, EU

# How to choose

Start from what the part has to survive, not from the material list. A printed part fails in a working environment for a small number of reasons, and each one points at a different material.

1

### Name the enemy

Heat, sunlight, impact, repeated flexing, water or chemicals. Most parts have one dominant one. That decides the shortlist.

2

### Decide: stiff or tough

Stiffness (holds position) and toughness (survives a knock) pull in opposite directions. Fibre filled grades buy the first and cost the second.

3

### Check size and detail

Small, intricate or show-quality parts suit resin up to 218 x 122 x 220 mm. Everything larger, and almost every functional part, is FDM.

4

### Set orientation and walls

A printed part is weakest between layers, and the walls carry the load, not the infill. Say where the load comes from.

5

### Only then compare cost

Where two materials both survive the job, the cheaper and faster one to print is the right answer.

### What the ratings mean

The Low / Medium / High ratings in this guide are working classifications used when advising on a part. They are not measured figures. Tolerances, minimum feature sizes and printed-part strength or heat deflection values are not published here, because they have not been measured on parts from these machines. Where a part depends on one, it can be measured on a printed sample.

# Decision table

Find the row that describes what the part must survive. Start with the first choice; move to the alternatives when size, cost or a second requirement rules it out.

| The part must survive | First choice | Also consider | Avoid | Why |
|---|---|---|---|---|
| Sunlight and weather for more than a season | PETG | PETG CF, ASA if the part must withstand roughly 80 °C or more | PLA, ABS, ABS CF, PC-ABS, Wood filled PLA, Standard resin | PETG copes with sun, rain and most chemicals, is strong and costs less, so it is the default outdoors. Its practical limit is about 70-75 °C; above roughly 80 °C, choose ASA. |
| Heat: near a motor, a heat source or warm electronics | Polycarbonate | ABS, ASA, PC-ABS, ABS CF, Nylon PA12, Carbon fibre filled | PLA, Wood filled PLA, Standard resin | Polycarbonate is rated Very high; PLA softens at the temperature of a closed car in summer. |
| Knocks and impact | Polycarbonate, PC-ABS | ABS, ASA, Nylon PA12, TPU flexible | PLA, Carbon fibre filled, PETG CF, Standard resin | Fibre buys stiffness and costs toughness, so filled grades are not impact parts. |
| Must not flex or creep: fixtures, stiff brackets | Carbon fibre filled, ABS CF | PETG CF, Polycarbonate, PC-ABS | TPU flexible | Carbon fibre filled grades are rated Very high for stiffness. |
| Repeated flexing, sliding or wear: gears, hinges, snap fits | Nylon PA12 | PETG | Standard resin, Carbon fibre filled, PLA | Nylon is the answer when a PETG part keeps failing at the same point. |
| Must deform and return: gaskets, seals, grips, bumpers | TPU flexible | - | Standard resin, Carbon fibre filled, PLA | TPU is the only filament in this set that bends and returns to shape. |
| Water or cleaning agents | PETG | PETG CF | Nylon PA12 | PETG CF keeps the chemical resistance of PETG. Nylon takes up moisture and moves dimensionally in humid air. |
| Drilled, tapped, glued or smoothed after printing | ABS | ABS CF | - | ABS accepts acetone smoothing; ABS CF does not. |
| Large and flat without warping | PLA, PETG CF | ABS CF | ABS, ASA, Polycarbonate, PC-ABS | Shrinking materials need ribs or a designed split on long flat sections. |
| Fine detail, small size, moulded look | Standard resin | PLA | Carbon fibre filled, PETG CF, Wood filled PLA | Resin build volume is 218 x 122 x 220 mm; bigger parts go to FDM. |
| Appearance only: models, display, props | PLA, Wood filled PLA | Standard resin | - | Wood filled PLA sands and takes wood stain. |

# How the materials compare

Working classifications, not measured figures. Read across a row to see the trade-off each material makes.

| Material | Process | Heat | Stiffness | Impact | Outdoors |
|---|---|---|---|---|---|
| **PLA** | FDM | Low | High | Low | Not suitable |
| **PETG** | FDM | Medium | Medium | Medium | Suitable |
| **ABS** | FDM | High | Medium | High | Not suitable |
| **ASA** | FDM | High | Medium | High | Suitable |
| **TPU flexible** | FDM | Medium | Flexible by design | High | Short term only |
| **Nylon PA12** | FDM | High | Medium | High | Short term only |
| **Polycarbonate** | FDM | Very high | High | Very high | Short term only |
| **PC-ABS** | FDM | High | High | Very high | Not suitable |
| **Carbon fibre filled** | FDM | High | Very high | Low | Short term only |
| **PETG CF** | FDM | Medium | High | Low | Suitable |
| **ABS CF** | FDM | High | Very high | Medium | Not suitable |
| **Wood filled PLA** | FDM | Low | High | Low | Not suitable |
| **Standard resin** | SLA | Low | High | Low | Not suitable |

### Materials outside this list

The thirteen materials here are quoted instantly online. Other grades, such as PA12-CF or an ESD-safe filament, are reviewed by an engineer and quoted by hand. Material data sheets and a dimensional report can be supplied on request.

# Material profiles

## PLA

FDM

PLA is a rigid, plant-derived thermoplastic and the default choice for parts that need to look right rather than survive a working environment.

**Good for:** Concept and fit models; Display and presentation parts; Jigs used once; Large parts where warping would ruin the geometry.

**Wrong choice for:** Anything left in a car or in direct sun; Load-bearing parts under sustained stress; Parts near a heat source or motor.

### Design notes

PLA holds fine detail better than ABS or ASA and needs no enclosure, so a tall thin feature that would curl in another material usually survives.

It is brittle rather than tough: it fails by snapping, not bending, so avoid thin unsupported cantilevers on a part that will be handled.

## PETG

FDM

PETG is the general-purpose engineering filament: tougher than PLA, easier to print than ABS, and resistant to water and most household chemicals.

**Good for:** Functional prototypes; Enclosures and housings; Brackets and mounts, indoors and outdoors; Parts in contact with water or cleaning agents.

**Wrong choice for:** Parts needing a crisp cosmetic surface straight off the machine; Parts that must withstand roughly 80 °C or more; Long unsupported bridges.

### Design notes

It is the material to pick when the question is "will this snap" rather than "will this look right".

PETG is the default for outdoor parts: it copes with sun, rain and most chemicals, it is strong and it is one of the lower-priced filaments. Its practical limit is about 70-75 °C, so a part that must withstand roughly 80 °C or more goes in ASA.

## ABS

FDM

ABS is the traditional engineering thermoplastic: heat resistant, impact resistant, and machinable after printing.

**Good for:** Engineering and automotive parts; Parts that will be drilled or tapped; Housings near warm electronics; Parts to be glued or solvent bonded.

**Wrong choice for:** Very large flat panels in one piece; Outdoor parts in direct sun over months; Parts where dimensional accuracy matters more than toughness.

### Design notes

Shrinkage is the constraint, not strength. A long thin part will bow; adding ribs or splitting it at a joint costs less than reprinting it.

ABS accepts acetone smoothing, which turns a layered surface into a gloss one. Ask for it in the notes rather than assuming it.

## ASA

FDM

ASA is ABS reformulated to survive sunlight: the same heat and impact resistance, without the yellowing and surface chalking that ends an ABS part left outdoors.

**Good for:** Parts that must withstand roughly 80 °C or more; Housings near engines, heaters or warm electronics; Automotive exterior trim and prototypes; Outdoor parts that get hotter than roughly 80 °C.

**Wrong choice for:** Very large flat panels in one piece; Outdoor parts below roughly 80 °C, where PETG does the job for less; Fine cosmetic detail straight off the machine.

### Design notes

Choose ASA when the part must withstand roughly 80 °C or more. For outdoor parts below that, PETG is the default: it copes with sun and rain and costs less.

# Material profiles, continued

## TPU flexible

FDM

TPU is a rubber-like thermoplastic that bends and returns to shape instead of breaking, and it is the only filament here that does.

**Good for:** Gaskets and seals; Grips, handles and pads; Protective bumpers and feet; Wearable and contact parts.

**Wrong choice for:** Anything that must hold a dimension under load; Threaded features; Very thin walls, which come out floppy rather than flexible.

### Design notes

Wall thickness is what sets stiffness in TPU, more than infill. A thicker wall makes a firmer part; more infill mostly adds print time.

Overhangs in TPU need supports as much as any other material, and support removal on a flexible part is slower.

## Nylon PA12

FDM

PA12 nylon is the filament for parts that slide, wear or flex repeatedly without failing: gears, hinges, cable guides, snap fits.

**Good for:** Gears, cams and bushings; Living hinges and snap fits; Cable guides and wear parts; Parts that flex many thousands of times.

**Wrong choice for:** Parts that must not move dimensionally in humid air; Cosmetic surfaces; The cheapest possible functional part.

### Design notes

Nylon is the answer when a PETG part keeps failing at the same point after repeated use. It is a fatigue problem, not a strength problem.

Design clearances slightly looser than for PLA. Nylon parts that are a press fit off the machine tend to be too tight after they take up moisture.

## Polycarbonate

FDM

Polycarbonate is the strongest and most heat resistant filament quoted here, and it is what a part is printed in when it has already failed in something else.

**Good for:** High temperature fixtures and jigs; Structural parts under load; Impact-facing guards and shields; Replacements for parts that failed in ABS.

**Wrong choice for:** Cost-sensitive work; Very large flat parts; Parts where a cosmetic finish is the point.

### Design notes

Specify PC when the part has a stated service temperature or a stated load. Otherwise ABS or PETG will do the job for less.

Like ABS it shrinks; large flat geometry wants ribs or a split line.

## PC-ABS

FDM

PC-ABS is a blend that keeps most of polycarbonate's toughness and heat resistance while printing more like ABS.

**Good for:** Automotive interior parts; Housings that take knocks; Engineering parts near warm equipment; Larger parts where PC would be too slow.

**Wrong choice for:** Outdoor use over months; Cost-sensitive work; Cosmetic surfaces straight off the machine.

### Design notes

If the choice is between ABS and PC and the part is large, PC-ABS is usually the one that ships.

It shares ABS shrinkage behaviour, so the same rules about long flat sections apply.

# Material profiles, continued

## Carbon fibre filled

FDM

Carbon fibre filled filament is a base polymer loaded with chopped carbon fibre, which makes the part markedly stiffer and more dimensionally stable than the same part unfilled.

**Good for:** Jigs and fixtures that must hold position; Stiff structural brackets; Drone and robotics frames; Parts that would otherwise be machined aluminium.

**Wrong choice for:** Parts that need to flex; Impact-facing parts, since stiffness costs toughness; Fine cosmetic detail.

### Design notes

Choose carbon fill for stiffness and dimensional stability, not for raw strength. A carbon-filled part resists bending; it does not resist a hard knock better than its base polymer.

The matte surface hides layer lines better than any unfilled filament, so it often needs no finishing.

## PETG CF

FDM

PETG CF is PETG loaded with chopped carbon fibre: the same chemical resistance and the same easy printing as PETG, with much less flex and far less warping on long flat geometry.

**Good for:** Structural brackets and mounts, indoors and outdoors; Drone and RC parts; Jigs that must not flex; Long flat parts that warp in plain PETG.

**Wrong choice for:** Parts that need to bend rather than break; Fine cosmetic detail; Transparent or glossy finishes.

### Design notes

Pick it over plain PETG when the failure you are designing against is deflection rather than fracture. Fibre buys stiffness and costs toughness, in that order.

Outdoors it behaves like PETG: it copes with sun and rain, so it is the stiff choice for an outdoor bracket or mount. Only a part that must withstand roughly 80 °C or more needs ASA instead.

## ABS CF

FDM

ABS CF is ABS with chopped carbon fibre added, and the fibre solves the one thing that makes large ABS parts difficult: shrinkage.

**Good for:** Parts that live near heat; Large flat panels that bow in plain ABS; Tooling and production jigs; Housings that will be drilled or tapped.

**Wrong choice for:** Parts that need to flex; Outdoor parts in direct sun over months; Fine cosmetic detail straight off the machine.

### Design notes

Choose it over plain ABS when the constraint is holding a dimension rather than surviving an impact - the fibre trades some toughness for stability.

It does not take acetone smoothing the way unfilled ABS does; the fibre stays proud of the softened surface.

## Wood filled PLA

FDM

Wood filled PLA is PLA loaded with real wood particles, which gives the finished part a matte grain-like surface that can be sanded and stained like timber.

**Good for:** Architectural and scale models; Retail and display pieces; Props and set dressing; Parts that will be sanded and stained.

**Wrong choice for:** Any load-bearing role; Outdoor use; Fine mechanical detail.

### Design notes

It sands and takes wood stain, which is the whole reason to choose it. Plan on finishing rather than expecting it off the machine.

Mechanically treat it as PLA with a little less strength, and design accordingly.

# FDM or SLA

Both processes build a part layer by layer. They solve different problems.

| | FDM (filament) | SLA (resin) |
|---|---|---|
| **How it works** | FDM builds a part by laying molten plastic filament down in layers through a moving nozzle. | Resin printing cures liquid photopolymer with light, one thin layer at a time, against a build plate that rises out of a vat. |
| **Largest part** | 320 x 320 x 320 mm standard, up to 500 x 500 x 500 mm large-format; larger parts are split and bonded | 218 x 122 x 220 mm; larger parts are split or printed in filament |
| **Layer height** | 0.12 mm to 0.28 mm, 0.20 mm default | 0.02 mm |
| **Materials** | 12 engineering and appearance filaments in this guide | Standard resin |
| **Wins on** | Strength, real engineering plastics, size, quantity, cost | Fine detail, smooth moulded-looking surface |
| **Limited by** | Surface finish and the weak axis across layers | Build volume and the brittleness of cured photopolymer; degrades in sunlight |
| **Use it for** | Functional parts, fixtures, housings, spares, short-run production | Detailed models, masters, castable patterns, small parts with fine texture |

## Standard resin

SLA

Resin printing cures liquid photopolymer layer by layer and produces parts with far finer detail and a smoother surface than any filament process.

**Good for:** Miniatures and highly detailed models; Jewellery masters and castable patterns; Dental and medical models; Small parts with fine surface texture.

**Wrong choice for:** Large parts, which the build volume limits; Load-bearing or impact parts; Anything left in daylight.

**Design notes**

The build volume is the constraint. If the part is larger than the resin machines take, it is either split or printed in filament.

Resin captures detail a 0.42 mm filament nozzle physically cannot lay down, so a part that looks soft in FDM is usually a resin part.

The resin bench beside part of the filament fleet.

# Design rules summary

Derived from the settings these machines run: 0.42 mm extrusion width, 2-wall default, 0.12 mm to 0.28 mm layers and the build volumes on the floor. None is a tolerance.

## FDM (filament)

- **Draw walls in multiples of 0.42 mm.** One pass of the nozzle lays a bead 0.42 mm wide. A wall drawn at 0.84 mm is exactly two passes and comes out solid.
- **The default shell is 0.8 mm, which is 2 passes.** That is right for most parts. A part that carries load wants four or five passes instead, because the load-bearing shell is the walls and not the infill, and a fourth wall adds a third to it.
- **Overhangs past about 45 degrees from vertical need support, and support leaves a mark.** Molten plastic laid on air sags. Below 45 degrees each layer still rests mostly on the one under it, so it holds.
- **Orientation decides strength, and the weak axis is across the layers.** A printed part is strongest along a layer and weakest between two of them. A hook printed flat and a hook printed upright are the same file and different parts.
- **Use heat-set inserts rather than printed threads on anything that will be opened twice.** A printed thread in a soft filament strips. A brass insert pressed in with a soldering iron takes seconds and gives a machine thread.
- **Anything over 500 x 500 x 500 mm has to be split and joined.** That is the biggest machine on the floor. A part past it is not refused, it is printed in pieces and bonded, but a split designed into the model at a joint that was going to exist anyway is always better than a split chosen by whoever prepares the file.

## SLA (resin)

- **Every enclosed cavity needs a drain hole.** The part comes out of a vat of liquid. A sealed hollow fills with uncured resin that cannot be washed out, so the part stays heavy, keeps curing, and eventually cracks.
- **Cured photopolymer is stiff and brittle, so design it as a detail part, not a hinge.** Resin resolves detail no nozzle can lay down, and that is what it is for. A snap fit or a living hinge in cured resin snaps.
- **Anything over 218 x 122 x 220 mm is an FDM part.** That is the resin build volume. There is no large-format resin machine here, so a part past this size is either split or printed in filament, and for most parts filament is the right answer anyway.
- **Supports touch the part, so choose which face they touch.** A resin part is grown hanging off supports and every contact point leaves a small witness mark that is sanded off. Saying which face is the show face means the marks go somewhere that does not matter.

### Deliberately not published

- Dimensional tolerance actually held, per process, as a plus/minus figure or a percentage of nominal.
- Minimum feature size that survives on a real part, per process.
- Minimum wall thickness that comes out solid rather than gappy, per material.
- Tensile strength and heat deflection on printed test coupons, per material, per print orientation.

### Files

Accepted: STL, OBJ, 3MF, STEP, STP, up to 50 MB per file. Send STEP when it exists: it keeps true curved surfaces. STL stores no units, so check the export units.

# About 3Descu

3Descu is one of the largest 3D printing factories in Eastern Europe: an ISO 9001:2015 certified factory in Romania with 200+ printers running FDM and SLA resin, printing functional parts for manufacturers across the EU, the UK, Switzerland and Norway.

| 200+ | ISO 9001:2015 | 200+ m² | FDM + SLA |
|---|---|---|---|
| printers | certified factory | factory floor | filament and resin |

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