



## Technical guide

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### A Technical Guide – Part Four

#### Material Selection for Functional 3D Printed Parts

One of the most common reasons a 3D printed part fails is not poor print quality, bad settings, or even weak design. It is simply the wrong material being used for the job. Material choice sits at the heart of functional 3D printing, and yet it is often treated as an afterthought. To design parts that work reliably, material selection must be intentional and informed.

When people are new to 3D printing, they often choose materials based on convenience. They pick whatever prints easily, looks good, or happens to be loaded in the printer. While this approach may work for visual models or short-term prototypes, it quickly breaks down when parts are expected to carry load, withstand heat, or survive long-term use.

To understand why material choice matters so much, we need to remember what 3D printed parts are made of. Unlike metals or machined plastics, most desktop 3D prints are built from thermoplastics. These materials soften when heated and harden when cooled, and their behaviour is strongly influenced by temperature, stress, and time.

Each thermoplastic has a unique combination of stiffness, toughness, flexibility, and heat resistance. No single material excels at everything. Choosing the right one is about matching those properties to the way the part will be used, not about finding a “best” filament overall.

PLA is a good place to start because it is so widely used. PLA prints easily, holds fine detail, and produces dimensionally accurate parts. It is stiff, which means it resists bending under light loads. These characteristics make PLA excellent for visual models, alignment tools, and prototypes where appearance and accuracy matter more than durability.

However, PLA has significant limitations. It is brittle, meaning it tends to crack rather than deform when overloaded. It also has poor heat resistance. Even moderate warmth can cause PLA to soften, leading to warping or permanent deformation. Over time, PLA also suffers from creep, slowly changing shape under constant load. For functional parts expected to last, these weaknesses are critical.

PETG is often chosen as the next step up, and for good reason. PETG is tougher than PLA and far more forgiving under stress. Instead of cracking, it tends to flex slightly and recover. This makes PETG suitable for clips, enclosures, brackets, and parts that experience occasional impact or vibration.

PETG also handles moisture well and does not become brittle with age. However, its flexibility can be a disadvantage in applications where rigidity is essential. PETG parts may slowly deform under sustained load if not designed carefully, especially in warm environments. This means geometry and wall thickness become particularly important when using PETG.

ABS represents a shift toward true engineering plastics. ABS is tougher, more impact-resistant, and far more heat tolerant than PLA or PETG. It has been used in manufactured products for decades, which is why it appears in automotive interiors and consumer electronics housings.

The challenge with ABS is not performance, but process control. ABS shrinks significantly as it cools, which can lead to warping and cracking if the printing environment is not controlled. Enclosures, stable temperatures, and careful cooling are essential. When printed correctly, ABS produces parts suitable for demanding functional roles.

ASA is closely related to ABS but adds an important advantage: resistance to ultraviolet light. Where ABS can degrade and become brittle outdoors, ASA maintains its properties under sunlight. This makes ASA an excellent choice for external components, outdoor enclosures, and parts exposed to weather.

Like ABS, ASA requires controlled printing conditions. The payoff is long-term durability in environments that would quickly destroy less robust materials. For outdoor functional parts, ASA is often the correct choice even if it is more challenging to print.

Nylon takes functional performance even further. Nylon is exceptionally tough, fatigue-resistant, and capable of absorbing repeated stress without cracking. Where PLA snaps and PETG bends, nylon often flexes and returns to shape. This makes it ideal for hinges, gears, clips, and mechanical components.

However, nylon introduces a new challenge: moisture sensitivity. Nylon absorbs water from the air, and this dramatically affects both printing behaviour and final part strength. Printing nylon successfully requires dry storage, controlled environments, and careful preparation. When handled correctly, nylon produces some of the strongest plastic parts available on desktop machines.

Composite materials, such as carbon fibre-filled filaments, are often misunderstood. These materials add stiffness and dimensional stability but usually reduce layer adhesion and impact resistance. They are excellent for rigid parts that must not flex, but poor choices for components that experience shock or repeated loading.

It is also important to understand that material behaviour is closely linked to print orientation. A material that performs well along the layer lines may perform poorly across them. Material choice and orientation must be considered together, not in isolation.

Environmental conditions further complicate material selection. Exposure to heat, sunlight, chemicals, and moisture all influence how plastics age. A part that performs perfectly indoors may fail quickly outdoors if the material is not suited to that environment.

Time is another factor. Some materials maintain their properties for years, while others slowly degrade. Creep, embrittlement, and UV damage are long-term processes that must be considered for permanent installations.

Professional designers approach material selection by asking how the part will live its life. Will it be loaded constantly or occasionally? Will it experience heat? Will it be indoors or outdoors? Will it be assembled once or many times? These questions guide material choice far more effectively than print convenience.

At BritForge3D, material selection is never an afterthought. Each project begins by understanding the application and choosing a material that supports it. This approach prevents failure, reduces reprints, and ensures parts perform as intended.

Material choice is not about finding the strongest filament. It is about finding the *right* filament. When material properties align with design intent, 3D printed parts stop being fragile prototypes and become reliable functional components.

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## Closing Thoughts

Understanding materials is a turning point in learning 3D printing. Once you stop asking “what prints easiest?” and start asking “what will this part experience?”, your results improve dramatically. Material selection transforms 3D printing from a hobby into a manufacturing tool.

In the next technical guide, we will explore **print speed, acceleration, and motion control**, and how these hidden settings influence strength, accuracy, and reliability.

## Guide 4 Summary – Material Selection for Functional Parts

This guide focused on the critical role material choice plays in determining whether a part succeeds or fails. By examining how different plastics respond to heat, load, moisture, and time, you learned why selecting material based on real-world use is essential.

The key lesson is that there is no “best” filament — only the right material for a specific application. Understanding material behaviour allows you to design parts that last rather than merely print successfully.

In the next guide, we explore how print speed, acceleration, and motion control quietly influence strength, accuracy, and consistency.

