Is 3D printed nylon waterproof?

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Published October 10, 2026 · Last verified October 10, 2026

Abstract. A nylon print holds water with 4 perimeters, but the plastic absorbs it: 2.35% for Bambu Lab PA6-CF vs 0.43% for PLA, and soaked PA6-CF can lose half its strength.

Keywords: nylon, watertight, part-strength

Table 1. How much water nylon filaments absorb

Filament	Nylon type	In humid air	After 48 h in 60 °C water
Bambu Lab PA6-GF	PA6, glass fiber	2.56% (25 °C, 55% RH)	not given
Bambu Lab PA6-CF	PA6, carbon fiber	2.35% (25 °C, 55% RH)	not given
Bambu Lab PAHT-CF	PA12 and other long-chain PA, carbon fiber	0.88% (25 °C, 55% RH)	not given
Polymaker Fiberon PA6-CF20	PA6, carbon fiber	3.3% at equilibrium (conditions not stated)	5.30%
Polymaker PolyMide CoPA	PA6/PA66 copolymer	2.82% at equilibrium (conditions not stated)	6.16%
Polymaker Fiberon PA12-CF10	Long-chain nylon, carbon fiber	1.5% at equilibrium (23 °C, 70% RH)	2.92%
Prusament PA11 Carbon Fiber	PA11, carbon fiber	0.50% after 7 days (24 °C, 22% RH)	not given
Bambu Lab PLA Basic, for comparison	none	0.43% (25 °C, 55% RH)	not given
Bambu Lab PETG Basic, for comparison	none	0.45% (25 °C, 55% RH)	not given

1 Is 3D printed nylon waterproof?

A nylon print can hold water, but the plastic does not stay dry. Prusa Research needed 4 perimeters to stop a nylon print leaking. Bambu Lab lists 2.35 percent water uptake for PA6-CF in humid air, against 0.43 percent for PLA (polylactic acid). After a hot soak, Polymaker's PA6-CF20 lost half its tensile strength; its PA12-CF10 lost 7 percent.

1.1 How much water nylon filaments absorb

Each figure comes from the maker's own technical data sheet. PA (polyamide) is the chemical name for nylon and RH is relative humidity. PETG is glycol-modified PET.

The humid-air column is the weight a part gains in damp air. The soak column is the water Polymaker measured in its test bars before the wet strength tests. The Prusa Knowledge Base gives the ceiling for badly stored polyamide filament: water up to 10 percent of its weight.

1.2 What the water does to strength and stiffness

Polymaker soaks its "wet" bars for 48 hours in 60 °C water. That is harsher than damp air: the soaked bars held more water than each grade's humid-air equilibrium in the first table.

The PA6-based grades lose the most. PolyMide CoPA kept a quarter of its stiffness and Fiberon PA6-CF20 about a third, so a wet bracket bends far more under the same load. Both got tougher: notched impact strength roughly tripled or quadrupled. UL Prospector's polyamide guide describes the same trade: moisture raises toughness and cuts strength and stiffness.

The long-chain PA12-CF10 kept over 90 percent of its tensile strength and stiffness, and its impact strength held steady.

Bambu Lab's own descriptions draw the same line. It pitches PA6-CF for parts used in dry environments and says PAHT-CF was optimized to keep its mechanical properties when wet.

1.3 Does nylon swell in water?

Yes. Arkema soaked its molded resins in 20 °C water for 25 weeks. PA6 gained 9.5 percent in weight and grew 2.2 to 2.7 percent in length. PA11 gained 1.9 percent and grew 0.2 to 0.5 percent.

Table 2. What the water does to strength and stiffness

Polymaker filament (X-Y direction)	Tensile strength, dry / wet	Bending modulus, dry / wet	Notched impact, dry / wet
PolyMide CoPA	78.0 / 34.3 MPa	2510 / 636 MPa	6.9 / 27.7 kJ/m²
Fiberon PA6-CF20	109.3 / 54.7 MPa	7037.6 / 2286.2 MPa	11.0 / 35.6 kJ/m²
Fiberon PA12-CF10	77.4 / 71.7 MPa	2886.5 / 2652.7 MPa	9.9 / 10.2 kJ/m²

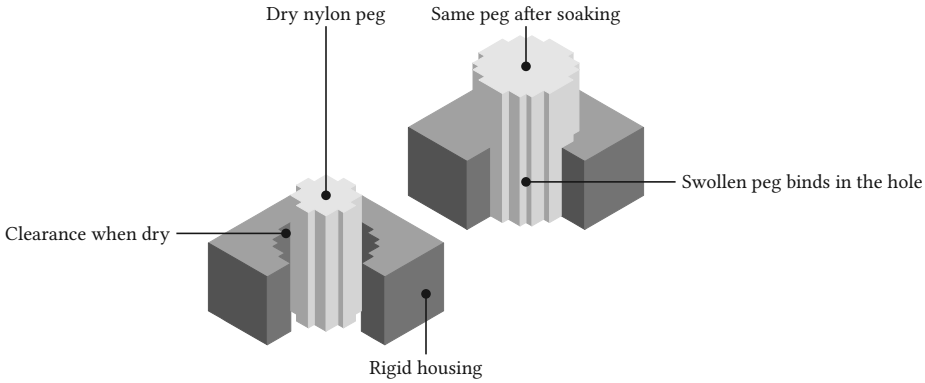


Figure 1. Nylon takes up water and grows, so a fit that was right when the part was dry can bind once it is wet.

Say you print a 100 mm PA6 part: at Arkema's PA6 figures it would end up 102.2 to 102.7 mm long. Those numbers are for unfilled molded resin, not filament. They still show why a tight press fit or bearing seat in nylon can bind once wet.

UL Prospector adds that glass-filled nylon swells unevenly: very little along the flow direction, much more across it.

1.4 Why PA12 and PA11 absorb less than PA6

All nylon is hygroscopic: it pulls water from the air. Prusa Research calls PA6 extremely so, and says PA12 and PA11 take up less. Polymaker credits PA12-CF10′s chemical structure for its lower moisture sensitivity compared with PA6 and PA6/66.

The first table bears it out. The PA12 and PA11 grades sit at 0.50 to 1.5 percent in air, the PA6 grades at 2.35 to 3.3.

1.5 When to print a wet part in nylon

- **Use nylon for a wet part only when you need its toughness.** A cup or planter gains nothing from it. PLA and PETG absorb about a fifth of what PA6 does; the waterproof filament table compares them.
- **For a load-bearing wet part, choose PA12 or PA11.** Polymaker's PA12-CF10 kept 93 percent of its tensile strength wet; its PA6-CF20 kept half.
- **Design for the wet state.** Size loads to the wet column above, and leave clearance on fits for growth.
- **Seal the walls for holding water.** Use 4 or more perimeters, as in how many walls make a print watertight.

Drying the spool before printing (Bambu Lab lists 80 °C for 8 to 12 hours for PA6-CF) improves print quality but does nothing to keep the finished part dry.

1.6 How to check it on your own print

1. Print a test piece with your production settings, then dry it.
2. Weigh it on a jewelry scale and measure one long dimension with calipers.
3. Put it where it will work: submerged, or in damp air, at its service temperature.
4. Weigh and measure it every few days until the weight stops rising. Weight gain divided by dry weight gives the uptake percentage.
5. Flex the wet piece against a dry one. If it is now too soft, or the size change ruins a fit, switch to a PA12 or PA11 grade.

For leaks through the wall rather than into it, use the leak test.

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Cite as: Asked 3D. "Is 3D printed nylon waterproof?." October 10, 2026. https://asked3d.com/answers/is-nylon-waterproof. Last verified October 10, 2026.