Are 3D prints waterproof? How to make a print watertight

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Abstract. Prints leak by default. Prusa Research's fix: 4 to 6 perimeters, 105 to 110 percent flow, 0.15 mm layers, one vase-mode wall, and epoxy for parts that must stay sealed.

Keywords: watertight, waterproofing, slicer-settings

1 Are 3D prints waterproof?

Not by default, but the right settings will seal them. Prusa Research's test models held water once they had enough perimeters, and PLA (polylactic acid) and carbon-fiber polycarbonate (PC) boxes stayed dry 20 meters underwater with no coating. Whether a print is waterproof depends on wall count, flow, layer height and material. Only a test settles the question.

1.1 What the tests showed

Prusa Research printed several dozen open models (vases and cups) and found thin-walled prints leaked while thick-walled ones held. Every material it tried became watertight at some perimeter count, from 2 for ABS (acrylonitrile butadiene styrene) and ASA (acrylonitrile styrene acrylate) up to 5 for HIPS (high-impact polystyrene) and PVB (polyvinyl butyral).

A second round used closed boxes. PLA, carbon-fiber PC and SLA (stereolithography) resin parts stayed dry at 20 meters with no post-processing. PETG (glycol-modified PET) leaked through its seams. Settings and material decide, and a leak test confirms the result.

2 What is the difference between watertight and waterproof in 3D printing?

Watertight means the print holds liquid without leaking out: a vase or a cup. Waterproof means it keeps water out under submersion or pressure: a sealed housing. Prusa Research split its testing the same way: open models first, then closed models sunk in a bucket overnight and taken to 20 and 30 meters.

2.1 Why the distinction matters

The two words get used interchangeably, but the jobs differ. An open vessel fails when water gets out through the wall, and the fix lives in the slicer. A closed part fails when water gets in, which adds a lid, a thread or a gasket to the problem.

Prusa found no printed gasket that held; O-rings did, and a threaded flashlight housing with an O-ring worked at 30 meters. The wall settings below apply to both; a closed part also needs a seal.

3 Why do 3D prints leak?

Mainly through the seam where each layer starts and ends, and through the transitions between perimeters and solid infill. Prusa Research traced most leaks to those two places, not to the bond between layers. Under-extrusion leaves channels between lines, and thick walls with sparse infill leave voids that collect water.

3.1 Where water gets through

The seam is the point on each layer where the nozzle begins and finishes an outline. Stacked layer on layer, those points form a vertical line of tiny gaps, and Prusa named it the main source of leakage.

The perimeter-to-infill transition is where the perimeters, the outline lines that make the wall, meet the solid top and bottom layers. PrusaSlicer overlaps them by 10 percent of the nozzle diameter by default, 0.04 mm on a 0.4 mm nozzle. Prusa's Knowledge Base says raising that to 25 to 35 percent closes persistent leaks.

Under-extrusion opens the third path. Bambu Lab's guide notes that filament changes volume between melting and solidifying, so a flow set too low leaves holes in the lines. Damp filament adds bubbles and more holes.

The layer bond is the fourth path, and Prusa found it was rarely the culprit. Layer height still mattered: 0.05 mm layers leaked least and 0.3 mm layers leaked most.

Infill voids add a fifth path in walls thick enough to need infill. Water crosses the outer perimeters into the voids and weeps out anywhere, which is why Prusa's Knowledge Base favors even wall thickness.

4 How do you make a 3D print watertight?

Print more perimeters, push more plastic and use thinner layers. Prusa Research recommends 4 to 6 perimeters, 105 to 110 percent extrusion multiplier, a nozzle 5 to 10 °C hotter and 0.15 mm layers. For open shapes, one vase-mode wall held water in every material Prusa tried. Outdoor or pressurised parts can be sealed with epoxy or lacquer.

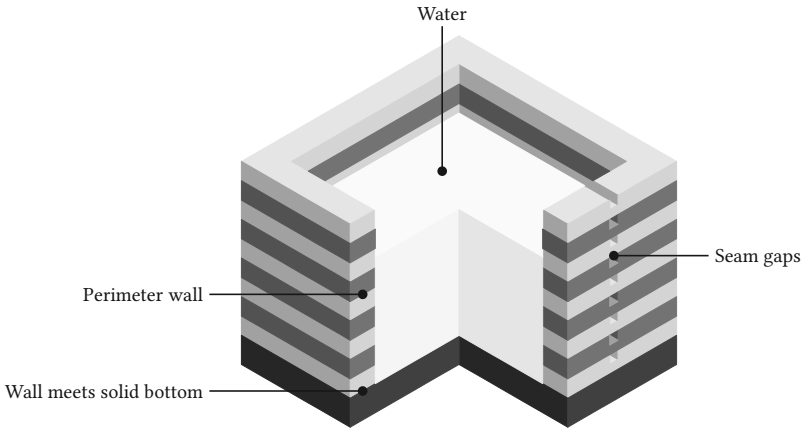


Figure 1. The seam stacks a small gap on every layer into a vertical line, and the corner where the wall meets the solid bottom is the other path Prusa found.

4.1 Perimeters

Wall count is the setting that moved the result most. Prusa's blog puts most parts at 4 to 6 perimeters, about 2 to 3 mm of wall. Its Knowledge Base says start at 3 to 4 and go to 5 to 6 if the geometry allows.

Bambu Lab's guide gives 2 to 4 wall loops and 0 to 40 percent infill for vases. The material-by-material minimums from Prusa's tests live on how many walls make a print watertight.

Bottom layers matter less: every Prusa test object with 2 to 7 solid bottom layers held, though the post suggests 5 or more to be safe.

4.2 Flow and temperature

Prusa's blog raises the extrusion multiplier to 105 to 110 percent where dimensional accuracy is not critical. The Knowledge Base offers an alternative: a line 5 to 10 percent wider, 0.44 mm instead of 0.40 mm, plus a nozzle 5 to 10 °C above the preset. Bambu Lab's guide raises the flow ratio by 0.02 to 0.05, for example from 0.98 to between 1.00 and 1.03 for its PLA Basic. It warns that going further brings rough surfaces and stringing.

4.3 Layer height and vase mode

Prusa's tests favor 0.15 mm layers, with 0.2 mm acceptable and 0.05 mm best. Vase mode, which PrusaSlicer calls spiralize outer contour, prints the wall as one continuous spiral with no seam. Prusa found a single vase-mode wall watertight in every material tested. Extra flow is, in Prusa's words, probably the only way to seal a vase-mode wall.

4.4 Sealing for outdoor and pressurised use

When settings are not enough, Prusa lists four coatings: acrylic lacquer from a spray can, epoxy resin, chemical smoothing, and nail polish. Epoxy gave Prusa perfect watertightness on a box that had leaked and improved its mechanical properties, at the cost of messy work and fumes. Chemical smoothing only applies to ABS, ASA, HIPS and PVB; Prusa's Knowledge Base notes that acetone-smoothed ASA may need none of the slicer changes above. Food-safe epoxies exist, but food contact is a separate topic not covered here.

4.5 Water absorption and outdoor limits

Water also gets into the plastic itself. Bambu Lab's data sheets give saturated water absorption at 25 °C and 55 percent humidity as 0.43 percent for PLA Basic, 0.45 percent for PETG Basic and 2.35 percent for its carbon-fiber nylon PA6-CF. Prusa's Knowledge Base says polyamide can take up water equal to 10 percent of its weight. Prusa Polymers measured 0.10 percent uptake in Prusament PETG after 7 days.

For parts that live outside, Prusa's material pages give these limits:

Table 1. Water absorption and outdoor limits

Material	Weathering (Prusa Knowledge Base)	Heat limit
PLA	degrades under UV	softens above 60 °C
PETG	water and humidity resistant, for exterior use	below 80 °C
ASA	UV resistant	up to 93 °C

Questions answered in this guide

- Can you 3D print a garden hose adapter?
  https://asked3d.com/answers/3d-printed-garden-hose-adapter
- Can you 3D print an oil seal?
  https://asked3d.com/answers/3d-printed-oil-seal
- Do 3D prints dissolve in water?
  https://asked3d.com/answers/do-3d-prints-dissolve-in-water
- Do 3D prints float in water?
  https://asked3d.com/answers/do-3d-prints-float
- Is PLA safe for water containers?
  https://asked3d.com/answers/pla-water-containers
- How to seal 3D prints for a reptile enclosure
  https://asked3d.com/answers/seal-3d-prints-for-reptiles
- Can you seal a 3D print with resin?
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- Can you seal 3D prints with silicone?
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- How to waterproof a 3D printed boat
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- How to seal 3D prints for an aquarium
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- How long does PLA last in water?
  https://asked3d.com/answers/how-long-does-pla-last-in-water
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  https://asked3d.com/answers/is-abs-waterproof
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- Is PETG waterproof?
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- Is PLA waterproof?
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- Is 3D printed TPU waterproof?
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- How to seal 3D prints with epoxy or a coating
  https://asked3d.com/answers/seal-3d-prints-with-epoxy
- How to 3D print a waterproof box
  https://asked3d.com/answers/waterproof-3d-printed-box
- Can you waterproof a 3D print with spray?
  https://asked3d.com/answers/waterproof-spray-for-3d-prints
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- Which filament is waterproof? Materials for parts that hold water
  https://asked3d.com/answers/waterproof-filament-for-3d-printing
- How to test a 3D print for leaks before you trust it
  https://asked3d.com/answers/test-3d-print-for-leaks
- How many walls make a 3D print watertight?
  https://asked3d.com/answers/how-many-walls-for-watertight-prints

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