Can you 3D print an oil seal?

Asked 3D Content Team
Published October 28, 2026 · Last verified October 28, 2026

Abstract. Only as a stopgap on a slow shaft. A molded nitrile oil seal is rated to 80 °C and 10 m/s; NinjaFlex TPU deflects at 60 °C. Never print a hydraulic seal.

Keywords: tpu, replacement-parts

1 Can you 3D print an oil seal?

Only as a stopgap. A printed TPU (thermoplastic polyurethane) lip can keep dust or splash off a slow, hand-turned shaft until the replacement arrives. It cannot match a molded nitrile oil seal, which Freudenberg Sealing Technologies rates to 80 °C (176 °F) and 10 m/s. Never use one in hydraulics, where cylinders run at 1,000 to 3,000 psi.

1.1 Molded nitrile oil seal against a printed TPU lip

An oil seal, also sold as a radial shaft seal or lip seal, is a rubber lip on a stiff case with a spring wrapped around the lip. A standard molded one against a printed lip:

Table 1. Molded nitrile oil seal against a printed TPU lip

	Molded nitrile (NBR) oil seal	Printed TPU lip
Hardness	72 Shore A	85A (NinjaTek NinjaFlex) to 95A (Polymaker PolyFlex TPU95-HF)
Heat	−40 to 80 °C (−40 to 176 °F), 100 °C (212 °F) for short periods	Deflects under load at 60 °C (140 °F) at 0.07 MPa and 44 °C (111 °F) at 0.45 MPa (NinjaFlex)
Shaft surface speed	Up to 10 m/s	Not rated on any of the three filament data sheets
Pressure	Up to 0.05 MPa (about 7 psi)	Not rated; printed TPU walls tore apart between layers at 0.4 to 0.5 MPa (58 to 73 psi)
Lip	Overlaps the shaft and touches it along a band 0.1 to 0.2 mm wide	Stacked layers with a seam at every layer change; Prusa Research's regular layer is 0.15 mm
Spring	Spring-steel tension (garter) spring holds the lip on	None
Oil and grease	Good resistance to mineral oils and greases	"Good" (Polymaker), "resistant to most kinds" (Bambu Lab TPU 95A HF), high resistance to ASTM test oils (NinjaFlex)
Rated for	Rotating shafts, hubs and axles	No filament data sheet here rates it for a moving seal

The seal column comes from Freudenberg Sealing Technologies: the data sheet for its DIN 3760 standard WA seal and the material sheet for 72 NBR 902, the nitrile in its Simmerring BA seals. The lip band comes from Nomikos and colleagues (Proc IMechE Part D, 2023). The TPU column comes from the NinjaTek, Polymaker and Bambu Lab data sheets, Prusa Research's watertight tests and a 2023 pressure test in Acta Mechanica Slovaca.

1.2 Why a printed lip leaks

A printed lip lacks what makes a molded one work. Nomikos and colleagues describe the molded design: the lip overlaps the shaft, which creates contact pressure, and the spring adds a set force. A thin oil film sits between lip and shaft, and as the shaft turns the lip pumps escaping oil back into the housing.

Where a printed lip falls short:

- **The edge.** The molded contact band is 0.1 to 0.2 mm wide, about one layer at Prusa Research's regular 0.15 mm layer height. Prusa found the main source of leaks in prints is the seam made at each layer change, and on a printed lip that seam runs straight across the band.
- **The spring.** Without one, the lip holds on by its own stretch alone.
- **Hardness.** The Parker O-Ring Handbook calls 70 to 80 Shore A the most suitable compromise for most seals, moving ones above all. It says 90 durometer or harder "often allow a few drops of fluid to pass with each cycle". A 95A filament sits above that range; 85A NinjaFlex is closer.
- **Heat.** Friction heats the contact: the 2023 lip-seal study found it can run several degrees Celsius hotter than readings taken just beside the seal. NinjaFlex deflects under load at 60 °C, where the nitrile seal is rated to 80 °C.

Oil is the smaller problem. BASF found its Elastollan TPU lost no strength in the standard IRM reference oils (mineral test oils), even after 3 weeks at 100 °C. It warns that oil additives can do irreversible damage and advises testing each lubricant. Brake fluid and many hydraulic oils attack TPU, BASF adds.

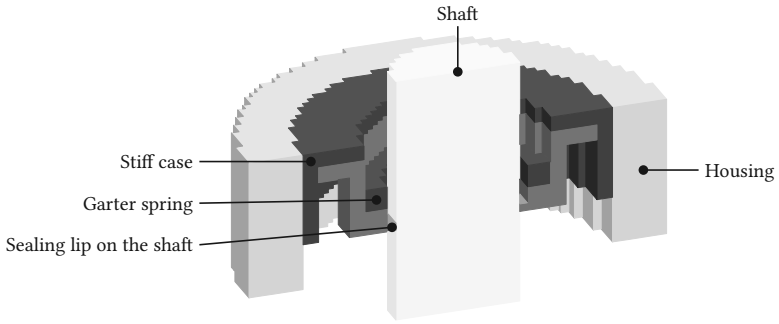


Figure 1. The rubber lip touches the shaft along a narrow band, and the spring wrapped around it keeps that lip pressed on as the shaft turns.

1.3 Can you 3D print a hydraulic seal?

No. Parker Hannifin rates its 3L medium-duty hydraulic cylinders at 1,000 psi and its 2H heavy-duty ones at 3,000 psi. Hallite molds its 605 rod seal from polyurethane, the family TPU belongs to, and rates it to 400 bar (6,000 psi). That rating assumes an extrusion gap of no more than 0.40 mm and a rod finish of 0.1 to 0.4 µm Ra (average roughness).

Printed layers are the weak point. In the 2023 Acta Mechanica Slovaca test, printed TPU walls 0.8 and 1.2 mm thick tore apart between layers at 0.4 and 0.5 MPa (58 and 73 psi). Results for other printed parts under pressure are on can 3D printed parts hold water pressure.

A failed hydraulic seal is also dangerous. Tigercat, a heavy-equipment maker, warns that fluid injected under the skin at as little as 7 bar (100 psi) can cause crippling injuries. A pinhole leak, it adds, can release an almost invisible stream at over 200 bar (3,000 psi). Never feel for a hydraulic leak with your hand, even gloved. Tigercat says to probe with the far end of a long piece of cardboard or wood.

1.4 When a printed shaft seal is reasonable

Only where a few drops do not matter and the shaft barely turns:

- A dust or splash wiper that keeps grit off a slow shaft, with the oil sealed elsewhere.
- A grease cap over the end of a bearing.
- A stopgap on a hand-turned or low-speed shaft while the molded seal is on order.

For the stopgap, print the softest TPU your printer feeds, 85A over 95A for the hardness reason above. Use 100 percent infill and the gap-closing settings on is TPU waterproof. Make the lip's inner diameter slightly smaller than the shaft, since a molded lip seals by overlapping it.

1.5 How to order the molded replacement

Garlock, a seal maker, sizes a replacement from the machine rather than the old seal. Measure the shaft diameter, the housing bore diameter and the bore depth. Skip the old seal's inner diameter: Garlock says it is hard to measure and doing so can stretch the lip. Seals are listed as shaft by bore by width, as in Freudenberg's Simmerring BA 30 x 52 x 8 mm.

If the housing itself is printed, choose a seal with a rubber-covered outside. Freudenberg says the rubberized jacket on its WA design copes with rougher bores and split housings, both likely in a printed part.

1.6 How to check a printed seal on your machine

1. Lay a sheet of paper or a drip tray under the shaft before the first run.
2. Turn the shaft by hand, or run it at its slowest speed, for a short session.
3. Check the paper and the shaft just outside the seal for weeping. Oil there means the lip is not holding, so stop.
4. Pull the seal and look at the lip. A worn flat band, a split along the layer seam or a swollen, soft lip means it is finished.
5. Repeat after every session, and fit the molded seal as soon as it arrives.

References

[1] Radial shaft seal WA, product data sheet (Dichtomatik, Freudenberg Sealing Technologies). https://products.fst.com/medialibrary/assets/productdatasheet_en_wa_ee3e2488a0.pdf. Accessed October 28, 2026.

[2] Material 72 NBR 902, material data sheet (Freudenberg Sealing Technologies). https://products.fst.com/medialibrary/materialdatasheets/72%20NBR%20902_en.pdf. Accessed October 28, 2026.

[3] Simmerring BA, 30 x 52 x 8 mm, 72 NBR 902 (Freudenberg Sealing Technologies). https://products.fst.com/eu/en/categories/ba/products/40412069. Accessed October 28, 2026.

[4] Measurement and prediction of thermal performance of automotive transmission radial lip seals (Proc IMechE Part D, 2023). https://doi.org/10.1177/09544070231213903. Accessed October 28, 2026.

[5] NinjaFlex 3D Printing Filament Technical Specifications (NinjaTek). https://ninjatek.com/wp-content/uploads/NinjaFlex-TDS.pdf. Accessed October 28, 2026.

[6] NinjaFlex Chemical Resistance Guide (NinjaTek). https://ninjatek.com/wp-content/uploads/NinjaFlex_CR.pdf. Accessed October 28, 2026.

[7] PolyFlex TPU95-HF Technical Data Sheet V5.5 (Polymaker). https://polymaker.com/wp-content/uploads/TDS_Polymaker_PolyFlex-TPU95-HF_V5.5_2025-12-29_EN.pdf. Accessed October 28, 2026.

[8] Bambu Filament Technical Data Sheet V1.0, TPU 95A HF. https://store.bblcdn.com/58df32731eab4c90a7dac9b12e13ba88.pdf. Accessed October 28, 2026.
[9] Elastollan Material Properties, Thermoplastic Polyurethane Elastomers (BASF). https://basf.com/dam/jcr:b36f0d83-b60b-35d8-8dab-35f7f0795b37/basf/www/kr/documents/ko/product/Elastollan_Material%20Properties.pdf. Accessed October 28, 2026.
[10] Parker O-Ring Handbook ORD 5700 (Parker Hannifin). https://mfc.arizona.edu/sites/default/files/2022-02/parker_o-ring_handbook.pdf. Accessed October 28, 2026.
[11] Watertight 3D printing PT1: Vases, cups and other open models (Prusa Research blog). https://blog.prusa3d.com/watertight-3d-printing-pt1-vases-cups-and-other-open-models_48949/. Accessed October 28, 2026.
[12] Design of Printing Parameter Settings Methodology for FFF Printing of Waterproof Samples from a Flexible Material (Acta Mechanica Slovaca, 2023). https://actavia.sjf.tuke.sk/artkey/ams-202301-0007_design-of-printing-parameter-settings-methodology-for-fff-printing-of-waterproof-samples-from-a-flexible-materi.php. Accessed October 28, 2026.
[13] Parker Cylinder Military Actuation Products (Parker Hannifin). https://discover.parker.com/cylinder-military. Accessed October 28, 2026.
[14] 605 Rod Seal, Twin Lip Polyurethane, data sheet (Hallite). https://hallite.com/global/digital_collateral/datasheets/metric/fluid_power_metric_catalogue_2018_605_web.pdf. Accessed October 28, 2026.
[15] High pressure fluid injuries, heavy equipment (Tigercat). https://www.tigercat.com/safety/a-dangerous-bite/. Accessed October 28, 2026.
[16] How Do You Measure Oil Seals? (Garlock). https://www.garlock.com/faqs/measuring-oil-seals. Accessed October 28, 2026.

Cite as: Asked 3D. “Can you 3D print an oil seal?.” October 28, 2026. https://asked3d.com/answers/3d-printed-oil-seal. Last verified October 28, 2026.