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Printing elastomeric applications on Origin® P3™ DLP

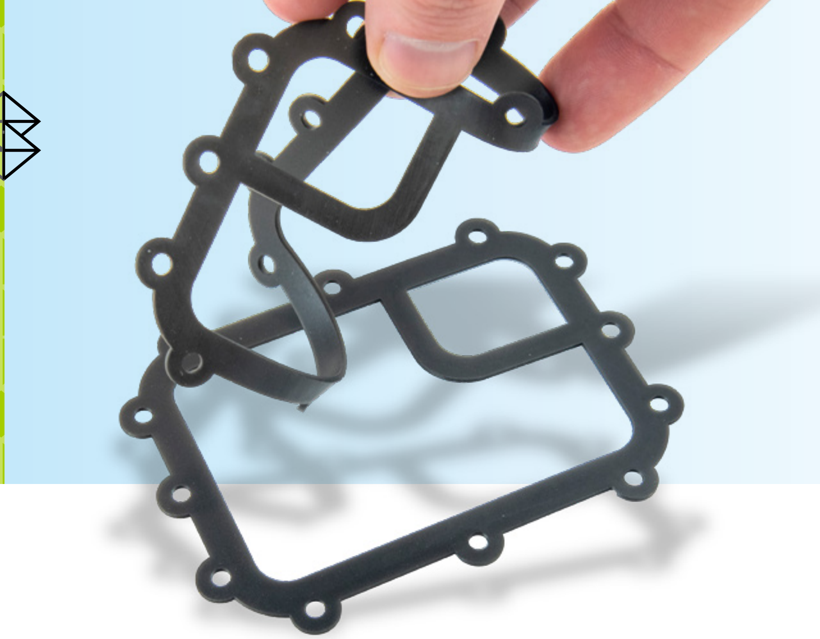
The Origin validated materials portfolio offers a family of high-performance elastomeric resins ideal for applications from functional prototypes to end-use parts.

Introduction

Printing high-performance elastomers on Origin is ideal when parts require flexibility or elasticity. Whether the parts are used for functional prototyping, pre-production or small series manufacturing of end-use parts, choosing the right material for the job is key to success.

What is an elastomer?

An elastomer is a type of polymer that exhibits unique mechanical properties, primarily high elongation with the ability to return to its original shape after being stretched or deformed. These materials are characterized by their elasticity and flexibility, making them highly valuable in various industries. Elastomers are sometimes referred to as rubber-like materials due to their rubbery texture and behavior.



Can elastomers be 3D printed?

Several 3D printing technologies are capable of printing elastomers, each with its own set of advantages and limitations. Here are some of the primary 3D printing technologies that can be used for elastomeric materials:

Fused Deposition Modeling (FDM): FDM 3D printers can print elastomeric materials in the form of flexible filaments. These machines use a heated nozzle to extrude and deposit layers of the material. TPU (Thermoplastic Polyurethane) is a common elastomeric filament used in FDM printing. FDM is suitable for creating flexible and soft parts – including big and bulky parts – but may have limitations in terms of surface finish, fine details and intricate geometries, as well as having anisotropic mechanical properties.

Selective Laser Sintering (SLS): SLS 3D printing involves using a high-power laser to sinter powdered materials layer by layer. TPU and TPE (Thermoplastic Elastomer) powders can be used in SLS machines to produce elastomeric parts with good mechanical properties. SLS offers the advantage of producing complex geometries and functional prototypes, but is lacking in accuracy and surface finish, as well as high initial cost.

PolyJet: PolyJet technology utilizes liquid photopolymer resins that are jetted onto a build platform and cured with UV light. Some PolyJet materials have elastomeric properties, allowing for the creation of multi-material, rubber-like parts with a high level of detail and a wide range of shore hardness values.

Stereolithography (SLA): SLA 3D printing uses a liquid photopolymer resin that is cured layer by layer using an ultraviolet (UV) laser. Flexible and rubber-like resins can be used in SLA printers to create elastomeric parts with high accuracy and fine details. SLA is excellent for producing parts that require accuracy, a smooth surface finish and a big build volume, but will have limitations in terms of printing time and initial machine and resin vat cost.

What have been the challenges with 3D printing elastomers until now?

Until recently, 3D printing with elastomers has faced several challenges that hindered its suitability for producing end-use parts. One significant issue was the low tear strength exhibited by photopolymer elastomers, which limited their ability to withstand mechanical stresses and resulted in fragile prints. Furthermore, these photopolymer elastomers suffered from low resilience, lacking the elasticity and rebound necessary for many practical applications. Additionally, there was a limited range of material property sets available for all types of elastomers, restricting designers and engineers in their material selection. To compound these challenges, thermoplastic elastomers used in 3D printing displayed substantial anisotropy, leading to inconsistent mechanical properties in different directions.

Collectively, these limitations have historically made 3D printed elastomers less suitable for end-use parts. Fortunately, ongoing research and advancements in materials and printing technologies are addressing these issues, opening up new possibilities for functional elastomeric components.

P3 standing up to the challenge: printing end-use elastomeric parts.

The Origin is a cutting-edge P3 3D printer, based on a DLP (Digital Light Processing) light engine. DLP 3D printers work by using a digital light projector to selectively cure a liquid photopolymer resin layer by layer to create a 3D object. Cross-sections are sequentially projected onto the surface of the resin, cures and solidifies the exposed areas, forming a single layer of the object. The build platform is then raised, and the process is repeated.

Printing elastomers on an Origin printer offers a multitude of significant advantages. Firstly, it leverages high-performance materials like Loctite® IND402, renowned for its impressive tear strength, and both Loctite® IND402 and P3™ Stretch™ IND475, characterized by their exceptional resilience. Secondly, a less viscous material such as P3 Stretch 80 open up elastomeric printing to users new to this type of material as it processes easily and prints fast on Origin, is simple to clean and UV post-cure.

The availability of multiple hardness properties further enhances the versatility of these materials, allowing for precise customization to meet specific project requirements. Moreover, the Origin ensures near-isotropic performance, guaranteeing consistent mechanical properties in all directions—an essential factor for engineering robust, reliable parts.

Beyond its exceptional material capabilities, the Origin – utilizing pneumatic mechanism controlling pull forces, a heated chamber for consistent temperature, best in class projector, UV wavelength and optics – stands out with its unrivaled surface finish quality among additive manufacturing technologies. It excels in terms of speed, significantly reducing printing times compared to alternative methods, making it a highly efficient choice for rapid prototyping and elastomeric component production. Its best-in-class accuracy and repeatability enhance the reliability of printed parts.

Notably, the Origin printer embraces an open AM license, providing the flexibility to explore a wide range of elastomeric possibilities, fostering innovation and customization in 3D printing endeavors.

The Origin is the right choice when you care about accuracy, repeatability, surface finish, printing time and quick material changeovers. Consider a different technology than DLP if you need extremely large build volumes or need other specific material properties, such as those of thermoplastics.

Benefits and trade-offs of additive manufacturing elastomeric parts vs. traditional manufacturing

Additive manufacturing (AM) of elastomeric parts offers several benefits compared to traditional manufacturing methods, but it also comes with some trade-offs. One key advantage of AM is the ability to create complex geometries and highly customized designs with ease, enabling rapid prototyping and the production of intricate elastomeric components that are challenging, costly or impossible to achieve through traditional means.

Another important advantage is the ability to easily create many design iterations, or the ability to produce a small series without the expensive initial costs of tooling. Additionally, AM reduces material waste and offers more sustainable production practices, as it only uses the necessary material, minimizing environmental impact.

However, there are trade-offs to consider, including potentially slower production speeds for larger quantities of parts compared to traditional mass production methods. AM may also have limitations in terms of material choices, as not all elastomeric materials are readily available for 3D printing. Surface finish and mechanical properties may differ between AM and traditional manufacturing, affecting the suitability of the part for certain applications.

The choice between additive manufacturing and traditional methods ultimately depends on the specific requirements of the project, such as customization needs, production volume, the cost of traditional tooling, lead times, and material properties.

Common applications

- Seals
- Gaskets
- Bumpers for vibration isolation
- Grips, knobs, switches and buttons
- Flexible ducts / housings
- Grommets
- Wearables

Validated elastomers

P3 Stretch™ 80

P3 Stretch 80 by Forward AM, is the latest addition to our flexible and elastomeric resins. With its high hardness of Shore 87 A, it is at the high end of our portfolio, which now covers the whole spectrum from Shore 40 A to 87 A. This addition to the Origin® elastomers materials comes at an affordable price point, making it an interesting entry-level material for users starting elastomer printing. Less viscous than typical elastomers, P3™ Stretch™ 80 processes easily and prints fast on Origin®, is simple to clean and UV post-cure. It's relatively low tear resistance is a point of attention when selecting an elastomer. The material makes an excellent replacement for traditional polyurethane or TPU.

Ideal for:

- Functional prototyping of elastomeric end-use parts
- Fit & form testing for consumer products, including footwear, watch bands, accessories
- Applications in aerospace, automotive, industrial applications where aesthetics, grip and interaction with Class A surfaces is required.

Loctite 3D IND402

High rebound elastomer. Single component elastomer material with high elongation and high resilience, that maintains excellent tensile strength and high energy return. Does not require thermal post processing. Ideal for lattice structures e.g. mid soles and soft inserts.

Ideal for:

- Knobs, switches and buttons
- Wearables needing only basic biocompatibility (i.e., passes ISO 10993-23:2021)
- Seals
- Flexible ducts / housings

P3 Stretch 475

Resilient, low shore hardness elastomer with good tear strength. Single component industrial strength UV resin that cures to a soft, elastomeric material. P3 Stretch IND475 is suitable for applications where resilience is desired, such as lattice structures and functional prototyping. Easy to print of a variety of platforms, making it a superior material for elastomeric

Ideal for:

- Seals and flexible ducts that need a softer material
- Soft grips

Mechanical properties comparison

Material	Ultimate tensile strength	Tear strength	Elongation at break	Tensile modulus	Hardness
P3 Stretch 80	11 MPa	21 N/mm	117%	54MPa	87 A
Loctite IND402	5.5 MPa	28 N/mm	230%	42 MPa	75-90 A
P3 Stretch 475	2.4 MPa	8 N/mm	122%	2.5 MPa	49A, 45 A

Case studies

Gaskets for vehicle lighting

JW Speaker, one of the most respected brands in specialized LED vehicle lighting, uses additive manufacturing to provide their customers with customized parts quickly at low cost. Gaskets remained a challenge for a long time, as no technology could produce elastomeric parts with the high definition and superior surface finish needed. P3 Stretch IND475 on Origin P3 DLP proved to be – as they called it – a game-changer, allowing them to save a lot of money by 3D printing their gaskets, avoiding the need for an expensive injection molding tool.

Automotive assembly tool

Valiant TMS, who designs, develops and delivers specialized manufacturing automation products for Fortune 500 companies, uses P3 Stretch 80 to produce a tool for an automotive customer. Compared to the traditional molded polyurethane solution, Valiant TMS achieved a 150% cost reduction and slashed the lead time from 4-6 weeks to 3 days for 24 components. And the accuracy of the new components was much higher than the molded-in equivalents.

Race car handles

Nissan Motorsports needed handles for their Super GT racing cars. Standard manufactured handles were uncomfortable with long lead times. 3D printed handles made with Henkel Loctite® IND 402 reduced lead time from multiple weeks to just 16 hours for two sets of handles, and allowed to save on mold cost and mold production.

End of arm tooling

Functional soft grippers are complex parts to mold and require high-rebound materials to function correctly. An industrial customer was looking for an alternative to molding as this technical process causes very long tooling lead times – machine downtime that the manufacturer could not afford. Using P3 Stretch 475 material and Origin One, the need for tooling and molding becomes non-existent, and parts can be 3D printed, processed and installed in just hours.

For the full stories, consult the Case Studies section on Stratasys.com

What's next for P3 elastomers?

The future trajectory for P3 elastomers should prioritize several key areas. First and foremost, continuous efforts to enhance printability are crucial, ensuring a seamless and efficient 3D printing experience. This includes refining material properties and compatibility, making it easier for users to achieve consistent, high-quality results.

It is clear that more functional elastomers are needed to address industry-specific applications, including improved chemical/water resistance, FR (Fire Retardant) and FST (Fire, Smoke, Toxicity) properties, ESD, and rebound and abrasion resistance. This multifaceted approach will position the P3 elastomers portfolio as versatile, reliable, and innovative, further diversifying the applications of these elastomers across industries and solidifying their place as a cutting-edge solution in 3D printing technology.

Summary

Elastomers are a category of materials known for their exceptional elasticity, flexibility, and resilience. They are indispensable in 3D printing for producing objects that require rubber-like properties, making them valuable for a broad spectrum of industries and applications.

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