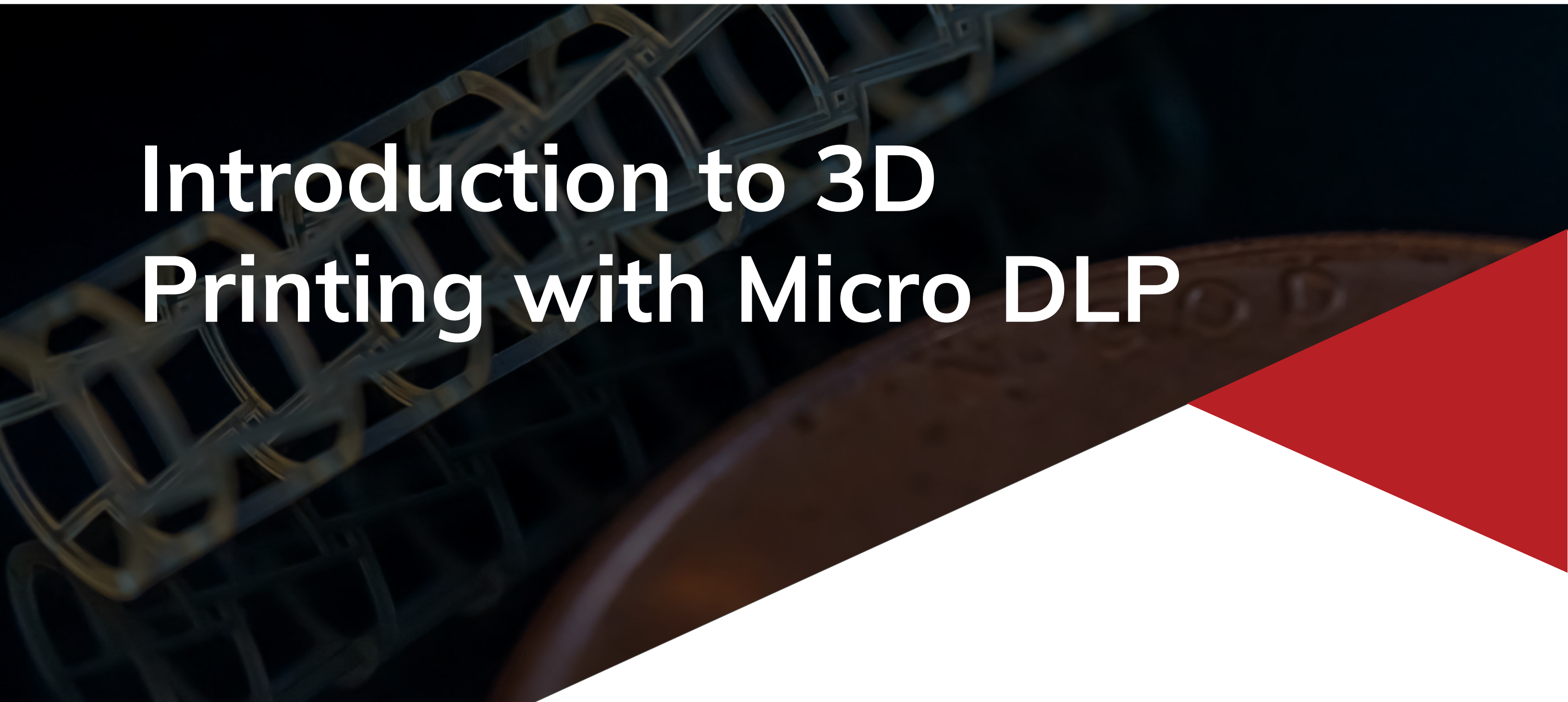
EMPIRE GROUP

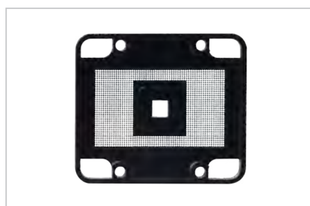
WHITEPAPER



Introduction to 3D Printing with Micro DLP

Small devices that require high precision, high resolution, and high accuracy are all around us. From the electronic connectors in cellphones to the tiny valves in medical pumps, these devices aren't just small in size; many have small features with significant complexity. Historically, micro CNC machining and micro injection molding were the only way to make precise parts like this. Both methods require paying for and waiting for tooling, which adds project costs and lengthens time-to-market.

Additive manufacturing, or 3D printing, doesn't require molds or tools. Moreover, it can reduce the time from concept to prototyping to low-volume production. Yet most 3D printers aren't able to make small parts with high precision, resolution, and accuracy. Now that's all changing. Thanks to Micro DLP technology, you can 3D-print small parts with 2 μm resolution and +/- 10 μm accuracy at scale.





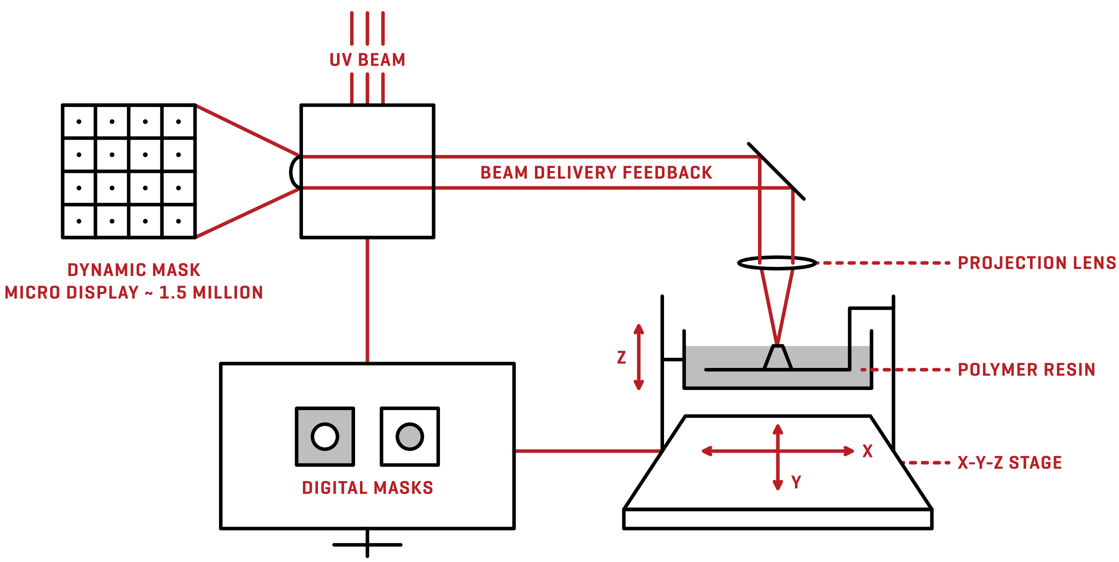


Parts printed by a Micro SLA-based 3D printing system

What is Micro DLP 3D Printing?

Micro DLP is a form of stereolithography (SLA) that incorporates a DLP® light engine, precision optics, motion control, and advanced software. SLA produces parts in layers using a photochemical process. A photosensitive liquid resin is exposed to light so that polymeric cross-linking and solidification occurs. With Micro DLP technology, a flash of ultraviolet (UV) light causes the rapid photopolymerization of an entire layer of resin. Micro DLP technology supports continuous exposure for faster processing.

HOW MICRO DLP WORKS



Like other 3D printing processes, Micro DLP begins with a CAD file. This file is then sliced into a series of 2D images called digital masks that show or hide specific areas of a layer. Each layer has a mask, and each layer is added until the entire 3DP structure is complete. To fabricate individual layers, slicing data is sent to the Micro DLP 3D printing system. The platform features a digital light processing chip (DLP), a projection lens, motion control stages, and a reservoir for the UV-curable resin.

Within a Micro DLP 3D printing system, UV light is projected onto a DLP chip according to the layer's mask pattern. By controlling the projection lens, Micro DLP technology can achieve resolutions of several micrometers or hundreds of nanometers. UV-curable materials include plastic resins that are rigid, tough, high-temperature resistant, biocompatible, flexible, or transparent. In addition to engineering and biomedical plastics, Micro DLP technology supports the use of hydrogels and composite resins that contain ceramic or metal particles.

Micro DLP vs. Competing Technologies

Micro DLP technology represents the nexus of two major technology trends: 3D printing and miniaturization. Part of what's limiting miniaturization, however, is the difficulty in prototyping and eventually cost effectively manufacturing small parts. Historically, the requirements for producing these parts have been beyond the capabilities of 3D printers. Today, Micro DLP is the only process to provide a 3D printing solution that matches precision injection molding in terms of resolution, size and tolerance.

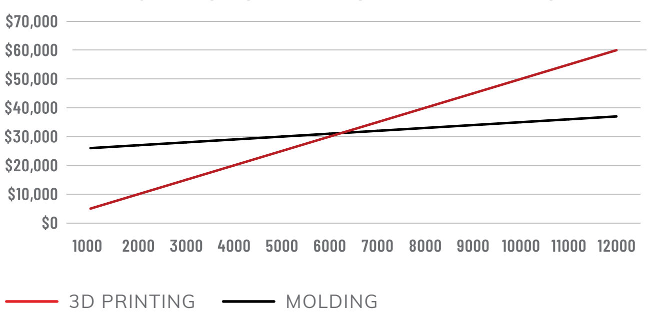
COMPARISON OF **MICRO DLP** AND OTHER 3D PRINTING TECHNOLOGIES

TECHNOLOGY	HIGHEST XY RESOLUTION	PRODUCTION SPEED	FEATURE
Micro DLP	2 μm	Fast	High precision, fast in speed
SLA	~50 μm	Slow	Medium precision, slow
TPP-DLW	<50 nm	Extremely slow	Ultra-high precision, small overall size, slow in speed
FDM	~200μm	Slow	Rough surface, low precision
PolyJet	600 DPI (42.μm)	Fast	Low precision, fast speed, large size

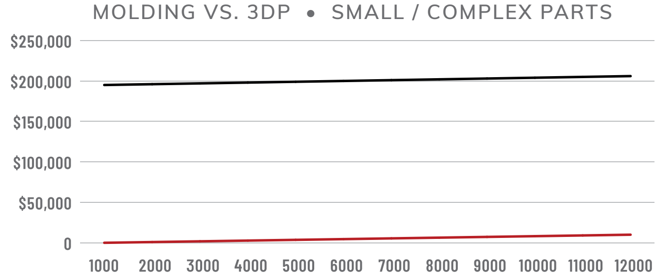
Micro DLP is superior to other 3D printing technologies for small parts that require high precision, resolution, and accuracy at faster speeds. Traditional SLA systems are only capable of medium-precision parts at slower speeds. Fused deposition modeling (FDM), another common 3D printing technology, is limited to low-precision parts with rough surfaces. Inkjet technology offers fast speeds, but with limited materials. Two-photon polymerization based direct laser writing (TPP-DLW) can produce small parts in ultra-high precision, but it's a slow process with greater precision than many applications need.

Micro injection molding and micro CNC machining are still options, of course, but require expensive and time consuming tooling and set up. They are not cost-efficient for prototyping and low-volume production. Cross-over volume, the point at which these processes become economical, is in the low thousands for most types of parts. For small, high-precision parts, the cross-over volume is significantly greater because the tooling costs are so high. Typically, parts that are micro injection molded or micro CNC machined have tooling that costs hundreds of thousands of dollars. The lead times for this tooling are measured in months or many weeks.

MOLDING VS. 3DP • STANDARD PARTS



MOLDING VS. 3DP • SMALL / COMPLEX PARTS



Micro DLP Applications

Micro DLP technology is ideal for electronics, medical devices, microfluidics, filtration, and micro-electro-mechanical systems (MEMS). In the electronics industry, applications include connector bases and chip sockets. Medical applications include cardiovascular stents and blood heat exchangers. Micro DLP technology has been used to 3D print a spiral syringe needle for minimally invasive surgery. With microfluidics, the Micro DLP process printed a valve for a gene sequencer. Related applications include lab-on-a-chip (LOC) devices that integrate multiple lab functions and can filter extremely small fluid volume.

MEMS applications for Micro DLP span multiple industries and can include micro switches, gears, latches, sensors, motors, valves, and actuators. In consumer electronics, MEMS microphones are used in smartphones, headsets, and laptops. In cars, MEMS devices are used in accelerometers for airbag deployment and electronic stability control. Biomedical MEMS, or Bio-MEMS, include stents, microneedles, and LOC devices. Micro DLP technology also has optical applications such as optical sensors, optocouplers, and fiberglass conductors.

At leading universities, Micro DLP technology is now supporting research and development efforts that will revolutionize product design, drug discovery, and microfiltration. In addition, Micro DLP can produce anisotropic structures where a 3D printed model can have different mechanical properties in different directions. In one direction, a structure can be compressible and provide energy absorbing and dampening. In other direction, the structure can provide stiffness for load bearing.

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