

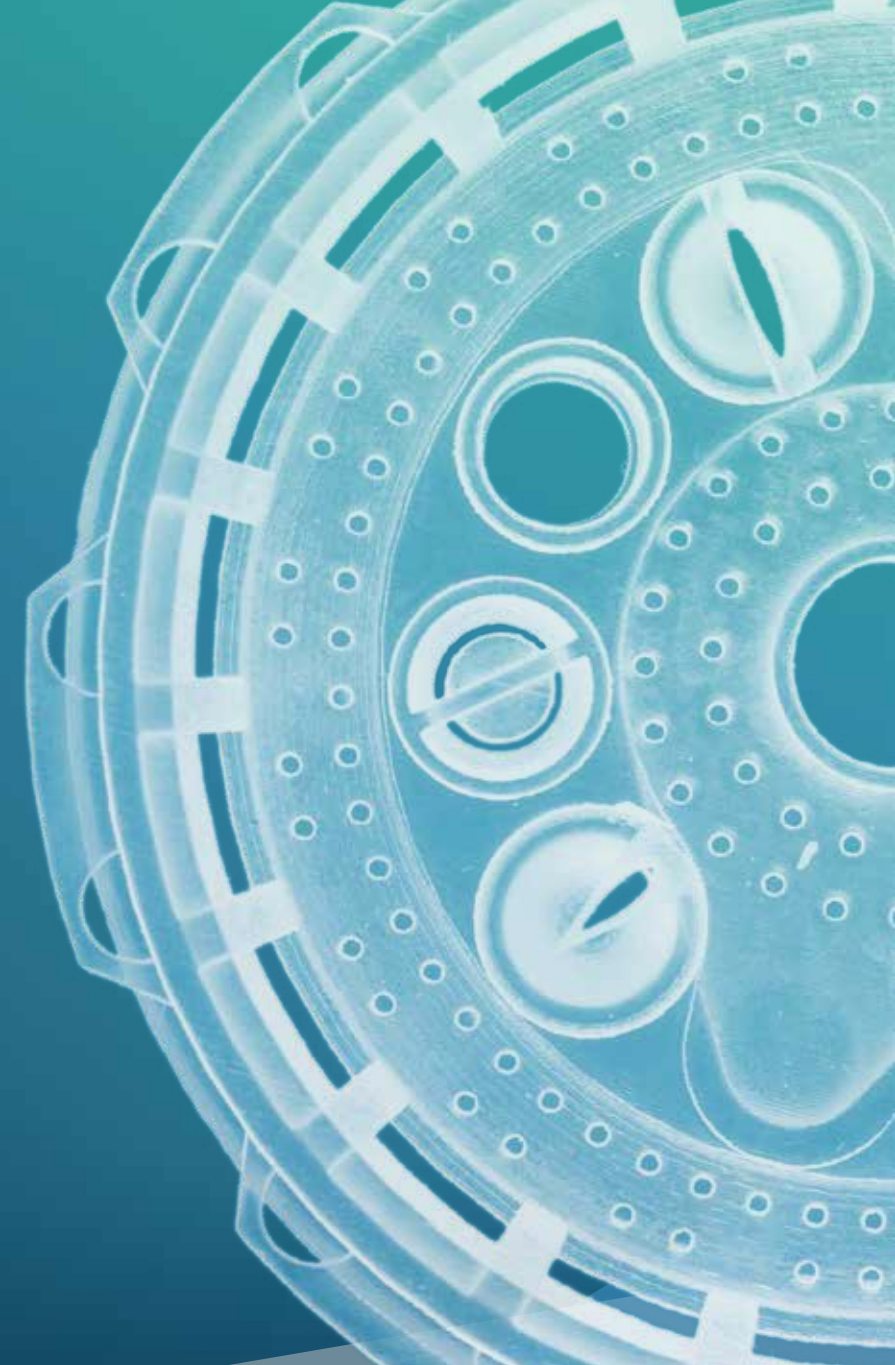
EBOOK

Fast and Economical Production of Clear Parts with 3D Printing



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What's Clear About Clear

To get the clearest parts, you need the clearest materials.

Achieving transparent 3D printed parts can be challenging if you don't have the right materials and technology, but the value and versatility of clear parts makes finding the right materials a hurdle worth vaulting to address your advanced applications.

This ebook provides examples of applications where the combination of clear materials and 3D printing can bring new insights and innovation, as well as significant savings in time and cost.



Advantages of Clear 3D Printed Parts

**COST-EFFECTIVELY PRODUCE
CLEAR PARTS IN HOURS**

SPEED UP DEVELOPMENT TIMES

**TEST, VERIFY AND DELIVER BETTER
PERFORMING PRODUCTS**

**SIMULATE APPEARANCE OF GLASS, ACRYLIC
AND OTHER TRANSPARENT MATERIALS**



Advantages of Clear 3D Printed Parts

No other manufacturing process produces clear components for product development more cost-effectively than 3D printing.

In addition to the key product development advantages outlined in the sidebar, 3D printing enables increased design complexity due to the way parts are created one layer at a time.

The additive process allows intricate, highly complex geometries and features to be produced that would otherwise be unattainable due to the constraints of traditional manufacturing methods.

The value of a clear material is the ability it gives you to see through or into a component that mimics a final product.

Combining 3D printing with clear materials merges the advantages of visibility with geometric freedom, enabling designers and engineers to more thoroughly test, verify and deliver better performing products and speed development timelines.

For some applications, design evaluation necessitates additional material properties such as thermal resistance, moisture resistance, or a certain strength threshold. Knowledge of, and access to, a wide range of materials can help you choose the best one for your specific applications.

3D printed prototypes lower costs by allowing you to:



Get visibility into the workings of a complex assembly



Functionally test fluid and gas flows through a system



Significantly reduce length of total product design cycles

Post-Processing Translucent and Tinted Parts

With a few simple steps, high quality clear materials can be transformed with incredible results. Typically, this involves a combination of wet and dry sanding, bead or vapor blasting, applying a surface tint or dye as desired, and a final clear coat for enhanced surface smoothness.

[Watch the video here >](#)



Where Clear Materials Matter

With the right materials and post-processing techniques, 3D printing can produce clear parts that simulate the appearance of glass, polycarbonate, acrylic and other transparent materials, which is helpful for design verification where transparency is needed.

The practicality of clear printing extends beyond one-to-one representations and can be used for a broad range of advanced design verification and functional prototyping. The ability to see into a part or system during testing is tremendously beneficial and expands the applications and value of clear printing accordingly.



PACKAGED CONSUMER GOODS

- Bottles, cosmetics, cleaning products, personal care, etc.
- Lenses and light covers
- Housings and enclosures
- Complex assembly prototypes and verification
- Demonstration models and executive reviews



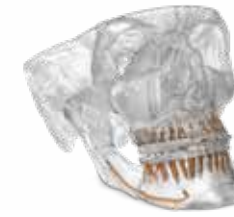
AUTOMOTIVE & AEROSPACE

- Lenses and light covers
- Fluid flow visualizations in sub-systems or components
- Moving vehicle turbulence and drag (ship, auto, train, bus)
- Computational Fluid Dynamics (CFD) verification
- Complex assembly prototypes and verification



INDUSTRIAL & ELECTRONICS

- Engine, turbine and transmission covers, housings, components
- Valves, pipes, pumps, pressure and flow devices
- Computational Fluid Dynamics (CFD) verification
- Light pipes and LED covers



HEALTHCARE & DENTAL

- Anatomical models
- Fluid flow in biological vessels and medical devices
- Medical models and devices
- Microfluidic devices

It's Clear Because... You Need a Visual on Interferences within Your Assembly

Being able to see into an assembly helps designers find out what is and isn't working in their design, and problem-solve to improve space claims and how various mechanisms interact.

VAULT is a leading manufacturer of tablet enclosures for the point-of-sale industry, and offers highly configurable and customizable solutions. The company uses 3D Systems' stereolithography (SLA) 3D printing solution with Accura® ClearVue™ material within its development workflow to accelerate and improve communication, both between departments at VAULT, as well as with the end-customer.

"Customers don't always understand how things will ultimately integrate and fit, so there's a real utility and cool factor to being able to print in clear," says Quentin Forbes, VP Engineering at VAULT. "When you can see through a part, there's really no discussion, there's just solutions and resolved questions."

[Read the full story here >](#)



It's Clear Because...

You Want the Most Aesthetically Clear Part for Automotive Lenses and Headlamps

Clear 3D printing provides a quick and cost-effective way to prototype clear parts.

TecNiq is a leading provider of LED lighting solutions based in Michigan that uses 3D Systems' SLA 3D printing in almost every part of its business. According to company president Jeff Condon, clear 3D printing is serving both the engineering and business side of his organization. In terms of engineering, his team is able to use Accura® Clearview™ prints to check snap-fit functionality and address potential tooling problems in assemblies before they become larger issues.

From a business perspective, Condon says: "Customer decisions made since we've introduced clear 3D printing are delivering a measurable ROI." TecNiq has even had two lamps meet U.S. Department of Transportation output specifications "right out of the printer," according to Condon.

[Read the full story here >](#)



It's Clear Because... You Need Visibility into a System or for Visual Evaluation of Fluid Flow

When testing fit, function, serviceability, and assembly, see-through parts replace guesswork with observation and insights.

Engineers in the filtration department at Parker Hannifin, the global leader in motion and control technologies, have reported great success using 3D Systems' clear SLA materials to observe oil flow within a separator system, among other applications.

The speed and easy integration of 3D printing into Parker Hannifin's workflow helped the company develop and prove an optimized prototype within three weeks according to its R&D Manager.



It's Clear Because... You Need Visibility Through an Anatomical Model or Drill Guide

The ability to selectively color clear 3D prints is of great benefit in the field of anatomical modelling and surgical planning.

Selective coloring is particularly useful for obtaining a better visualization of specific anatomical features. Features such as veins, nerves and tooth roots, as well as masses such as tumors can be selectively colored in certain clear materials and used to help plan surgeries and for reference within the operating room.

Clear 3D printing is also popular for producing drill guides used in dental applications due to the ability to visually confirm that they are sitting properly.



Selectively coloring clear materials helps give a better view of specific anatomical features.

3D Systems' Range of Clear Materials

3D Systems offers 11 different clear materials that can be 3D printed using a choice of the industry's leading 3D printing technologies: stereolithography (SLA), Multijet Printing (MJP) and Figure 4 projector-based printing. Each of these technologies offers a unique set of clear or translucent materials, and each technology comes with its own range of features and benefits for you to match to your specific applications and industry requirements.

If you need large-size, ultra-clear parts with high accuracy and surface finish for industries such as automotive, aerospace, or white goods, then **stereolithography** may be your technology of choice.

MJP technology, with its highly efficient melt-away support process is suitable for delivering clear parts as complex assemblies, straight out of the printer, or for when you need multi-material capability that mixes clear and opaque

components within the same printed part. MJP technology delivers medium-sized prototype parts with the ability to simulate properties such as polypropylene or ABS, as well as parts with high heat deflection temperatures ranging from 90°C to over 250°C for tooling in indirect manufacturing applications.

If your need is for real production-grade clear parts that will remain stable for years without the rapid onset of brittleness or yellowing from additional UV exposure, then **Figure 4** technology may be the choice for you.

Figure 4 is ideal for when you need to deliver long-term clear parts at high speed in high volumes, or batch-runs of relatively small clear parts with the ability to easily and quickly scale to larger quantities. Or for when extremely high heat deflection temperatures of 300°C or more are required—as long as an amber tint to the parts is acceptable.

Choosing Your Clear 3D Printing Technology

	PART SIZE	PRODUCTION-GRADE PARTS (LONG-TERM UV & HUMIDITY PERFORMANCE)	PRINTING SPEED	HEAT DEFLECTION TEMPERATURE	RANGE OF MECHANICAL PERFORMANCE	OPTICAL CLARITY	INITIAL ACQUISITION COST	SUPPORT PROCESS STRUCTURE
SLA	*****	***	***	***	***	*****	*****	Break-away resin
MJP	****	***	****	****	*****	***	****	Melt-away support
Figure 4	***	*****	*****	****	*****	*****	***	Break-away resin

How to Get Clear Parts

STEREOLITHOGRAPHY

If your customers need the clearest of the clear, 3D Systems Accura® ClearVue™ is the industry's clearest 3D printing material available, outperforming the closest competitors by as much as 7% in clarity, with up to 500% less green tint and up to 400% less yellowing.

For certain applications, however, additional material properties are of equal or greater importance to clarity, such as strength or temperature resistance. When selecting a clear material for an application, consider your application needs holistically to find the solution best suited to the specifics of your project.



POPULAR CLEAR MATERIALS FOR 3D SYSTEMS' STEREOLITHOGRAPHY INCLUDE:

MATERIAL	DISTINGUISHING PROPERTIES	APPLICATIONS	COMPATIBLE PRINTERS
Accura® ClearVue™ ¹	Unbeatable clarity; rigid and tough; excellent humidity and moisture resistance	<ul style="list-style-type: none"> Lenses Headlamps Consumer packaging Applications that require transparency or clarity to match glass, polycarbonate, acrylic, etc. 	<ul style="list-style-type: none"> ProX® 800 ProX® 950 ProJet® 6000 ProJet® 7000 SLA 750
Accura® ClearVue™ Free	Clear material with a bit of flex; tough; excellent humidity and moisture resistance	<ul style="list-style-type: none"> Snap fits Functional prototypes 	<ul style="list-style-type: none"> ProX® 800 ProX® 950
Accura® 60	High rigidity clear material; high accuracy with rapid build times; reasonably high heat deflection (48 °C at 0.455 MPa/66 PSI; 41 °C at 1.82 MPa/264 PSI)	<ul style="list-style-type: none"> Thermoforming Light pipes Applications where extremely high accuracy is required 	<ul style="list-style-type: none"> ProX® 800 ProX® 950 SLA 750
Accura® Phoenix	Clear material with the potential for high thermal resistance ² over 120 °C	<ul style="list-style-type: none"> Engine oil flow visualizations High heat applications that require clarity 	<ul style="list-style-type: none"> ProX® 800 ProX® 950 ProJet® 6000 ProJet® 7000

¹ Indicates Class VI capable.

² Additional high temperature materials with various secondary properties and levels of clarity are also available. Thermal post-cure slightly alters color.

How to Get Clear Parts

MULTIJET PRINTING

The clear materials available for 3D Systems' Multijet Printing (MJP) technology cover a range of material properties from high strength and rigid to flexible with extreme toughness. This range allows you to select the mechanical properties your customer's application demands, rather than compromise between performance and clarity.

3D Systems' MJP printers use a system that leaves no surface support artifacts and allows for support removal from fine channels. This support wax can be capitalized to mark or decorate the part internally by applying volume demarcations to containers; company branding or logos to covers; or internal barcodes and QR codes for lot control, just to name a few creative applications.

POPULAR CLEAR MATERIALS FOR 3D SYSTEMS' MULTIJET PRINTING INCLUDE:

MATERIAL	DISTINGUISHING PROPERTIES	APPLICATIONS	COMPATIBLE PRINTERS
VisiJet® Armor (M2G-CL)	Engineering ABS-like material; mid-modulus, tough	<ul style="list-style-type: none"> • General purpose prototyping • Consumer packaging • Jigs and fixtures • Housings that need to withstand handling/ abuse • Snap fits 	<ul style="list-style-type: none"> • ProJet® MJP 2500 Plus
VisiJet® ProFlex (M2G-DUR)	Engineering polypropylenelike-material; flexible, high impact strength	<ul style="list-style-type: none"> • Semi-rigid consumer goods and packaging • Living hinges • Protective covers/housings 	<ul style="list-style-type: none"> • ProJet® MJP 2500 Series
VisiJet® M2R-CL¹	Rigid; moderate flex	<ul style="list-style-type: none"> • General purpose prototyping • Select medical applications such as drill guides 	<ul style="list-style-type: none"> • ProJet® MJP 2500 Plus
VisiJet® CR-CL 200¹	Rigid; moderate flex	<ul style="list-style-type: none"> • General purpose prototyping • Select medical applications such as drill guides 	<ul style="list-style-type: none"> • ProJet® MJP 5600 Series
VisiJet® M2S-HT90¹	Rigid; up to 90°C high temperature resistance	<ul style="list-style-type: none"> • Functional testing in warm environments • Mold and dies for rapid tooling applications • Select medical device applications 	<ul style="list-style-type: none"> • ProJet® MJP 2500 Plus
VisiJet® M2S-HT250¹	Rigid; up to 250°C heat resistance	<ul style="list-style-type: none"> • Functional testing in warm environments • Mold and dies for rapid tooling applications • Select medical device applications 	<ul style="list-style-type: none"> • ProJet® MJP 2500 Plus

¹ Indicates Class VI capable.

How to Get Clear Parts

FIGURE 4® PRINTING

Figure 4 3D printing is ideal for when you require high-speed, high-volume 3D printing of smaller-sized production-grade clear parts. In addition to print speed, Figure 4 maximizes productivity with a short post-cure step that does not require thermal curing. You can also densely pack or nest parts into the build chamber in the most convenient orientation without sacrificing part isotropic properties.



MATERIAL	DISTINGUISHING PROPERTIES	APPLICATIONS	COMPATIBLE PRINTERS
Figure 4® Tough Clear	Tough, clear material with good combination of impact strength, elongation, and tensile strength; production-grade chemistry engineered for long-term environmental UV, humidity stability, and long-lasting clarity	<ul style="list-style-type: none"> • Transparent enclosures • Lenses • Light pipes • Backlit panels • See-through structural components 	<ul style="list-style-type: none"> • Figure 4® Standalone • Figure 4® Modular • Figure 4® Production
Figure 4® MED-AMB 10	Rigid amber-clear material capable of meeting ISO 10993-5 & -10 standards for biocompatibility (cytotoxicity, sensitization, and irritation); sterilizable with thermal resistance over 100 °C	<ul style="list-style-type: none"> • Medical device components • Surgical drill guides • Splints 	<ul style="list-style-type: none"> • Figure 4® Standalone • Figure 4® Modular • Figure 4® Production
Figure 4® EGGSHELL-AMB 10	Rigid amber-clear plastic that can withstand silicone injection at high temperature and pressure; process-optimized for easy, break-away removal	<ul style="list-style-type: none"> • Sacrificial tooling • Silicone parts 	<ul style="list-style-type: none"> • Figure 4® Standalone • Figure 4® Modular • Figure 4® Production
Figure 4® HI TEMP 300-AMB	Rigid amber-clear plastic with HDT over 300°C at both low and high stress (HDT at 0.455 and 1.82 MPa); high tensile modulus for use in molds (4000 MPa)	<ul style="list-style-type: none"> • Hot liquid or gas flow visualization • Low pressure molding/tooling • HVAC, motor enclosures, stators 	<ul style="list-style-type: none"> • Figure 4® Standalone • Figure 4® Modular • Figure 4® Production

Whats Next?

Interested in learning more about clear materials and solutions for 3D printing? Our application engineers are ready to help you find the solution that's right for your application.

[GET IN TOUCH](#)



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