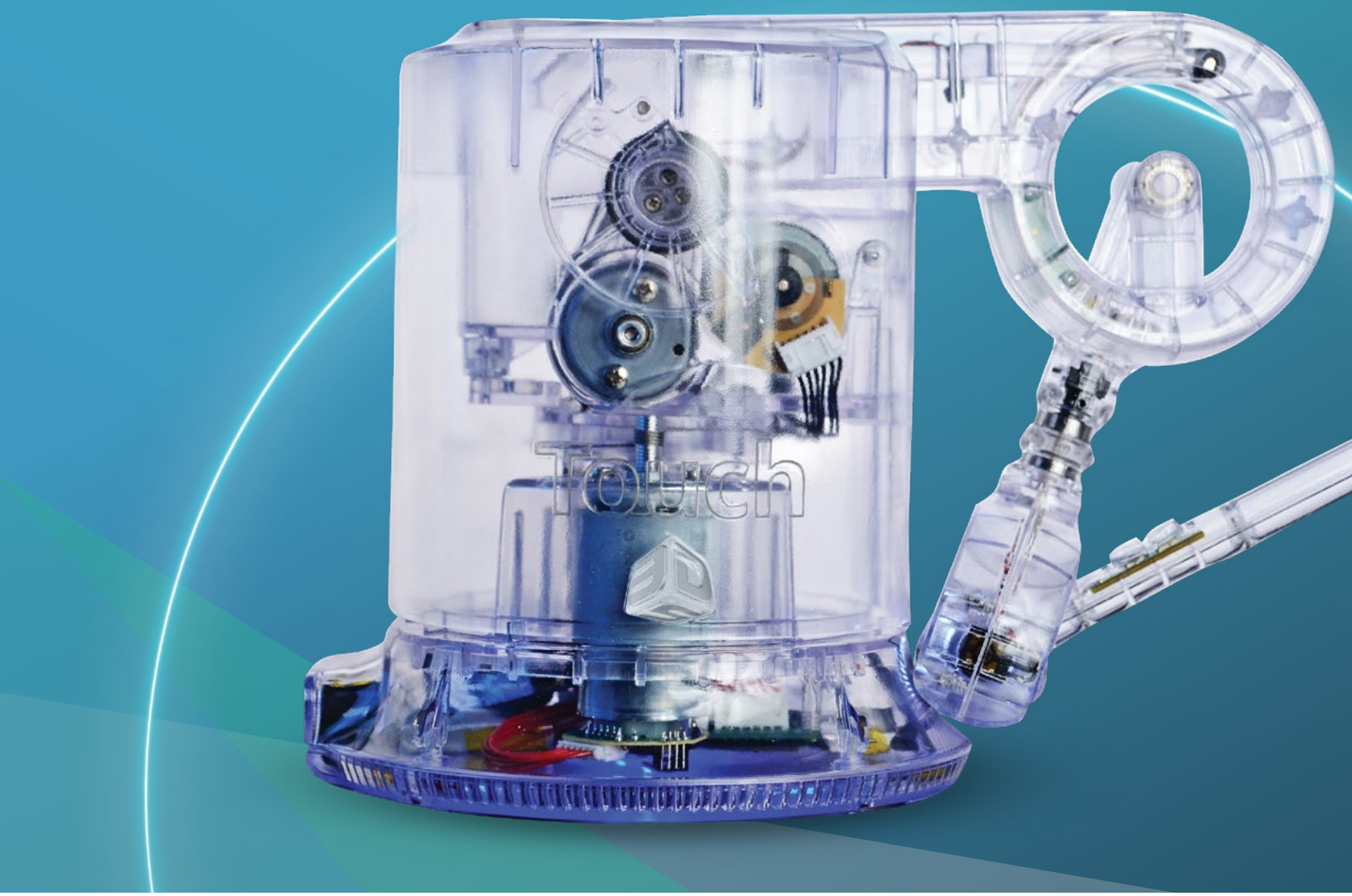
White Paper

Accura® ClearVue™: Redefining Finished Component Transparency for SLA Additive Manufacturing



3D SYSTEMS
Additive Manufacturing Solutions

When a part requires transparency it needs to be, well, transparent. The combination of 3D printing and transparent-like materials has encouraged designers to think even further outside of the box and motivated engineers to expand the boundaries of functional testing for fluid handling and wind tunnels.

However, until recently, available materials for stereolithography (SLA), the most accurate 3D printing technology, were 'almost' transparent. This means that designers weren't able to fully appreciate the effects of a fully-clear component when the prototype is tinted or less-than-transparent. This also means that engineers may have to make the trade-off between strength and clarity to achieve desired accuracy between prototype model and the final component or system. Ultimately, like a pair of glasses improves vision to 20-20, a more transparent material improves our ability to see the consequences of design variations on our final product's performance.

3D Systems material scientists have developed the best solution yet for transparent 3D printing.

Verified by rigorous testing and utilized in a variety of demanding applications, 3D Systems Accura ClearVue for SLA printing is the most clear and most colorless 3D printing material on the market.

While the material was developed to excel in clarity and color metrics, it was formulated also for ease-of-processing, exceptional detail and smooth surface finish, strength and durability, and moisture resistance.

This unique combination of material properties and processing speed make the material a high-performing and cost-effective choice for functional prototypes used in fluid flow evaluation for automotive, aerospace and medical components, lighting and optical light transmission, clear packaging, lenses and eyewear. This is ideal for aesthetic prototypes where transparency is important. When form and fit testing for see-through parts aid the review process or for fine detail clear model building — particularly for components that will be produced from polycarbonate, acrylic, crystal polystyrene or glass — Accura ClearVue is the right choice of material. For tool building, conformal-cooling mold designs can be visually inspected and functionally tested for fluid throughput when a prototype is printed in ClearVue.

Any prototyping or end-use situation which can be improved with transparency is an excellent candidate for ClearVue.

Defining clear and colorless

Materials scientists and engineers use two terms to describe transparency; being clear (clarity) and being colorless. CIE L*a*b* color measurement results can precisely quantify the clarity and color characteristics of a material, allowing engineers to accurately compare one material option to another.

Water is the standard for evaluating clarity and color. It rates as 100% for its ability to provide clarity — meaning it transmits all light and has zero color.

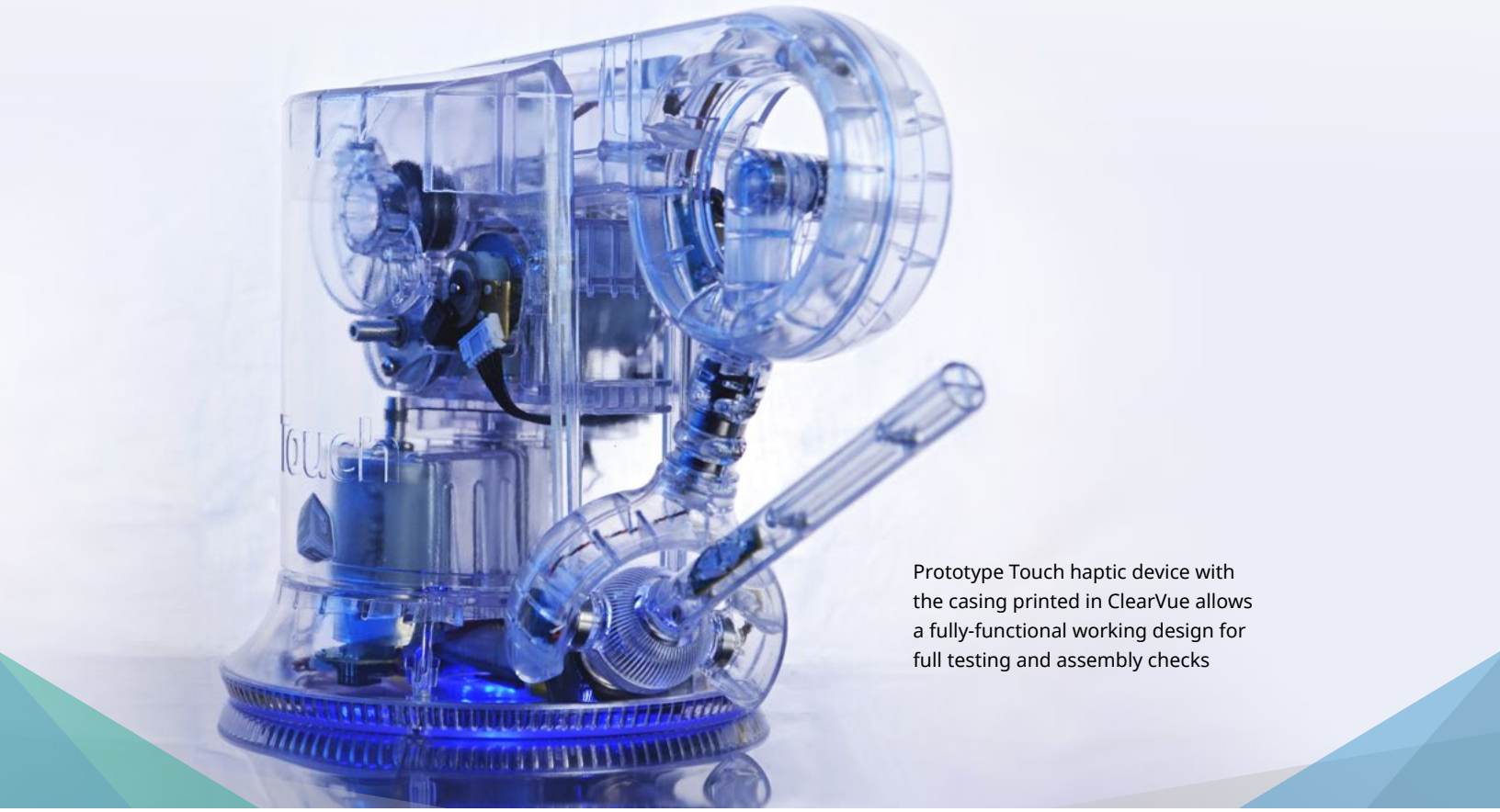
Any material tested for clarity will be rated as an 'L' value on a 100-point scale, where 100 is as clear as water, and 0 is completely opaque. When a material cannot transmit all light, it scores less than 100% in clarity. There is always a color tint involved, even if that color is grey or black. The extent to which the color is visible is measured on a color scale indicating any yellowness or other tint. These degrees of coloration are quantified by the b* and a* values.

100%

AS CLEAR AS WATER TRANSMITTING ALL LIGHT

0%

COMPLETELY OPAQUE CANNOT TRANSMIT LIGHT

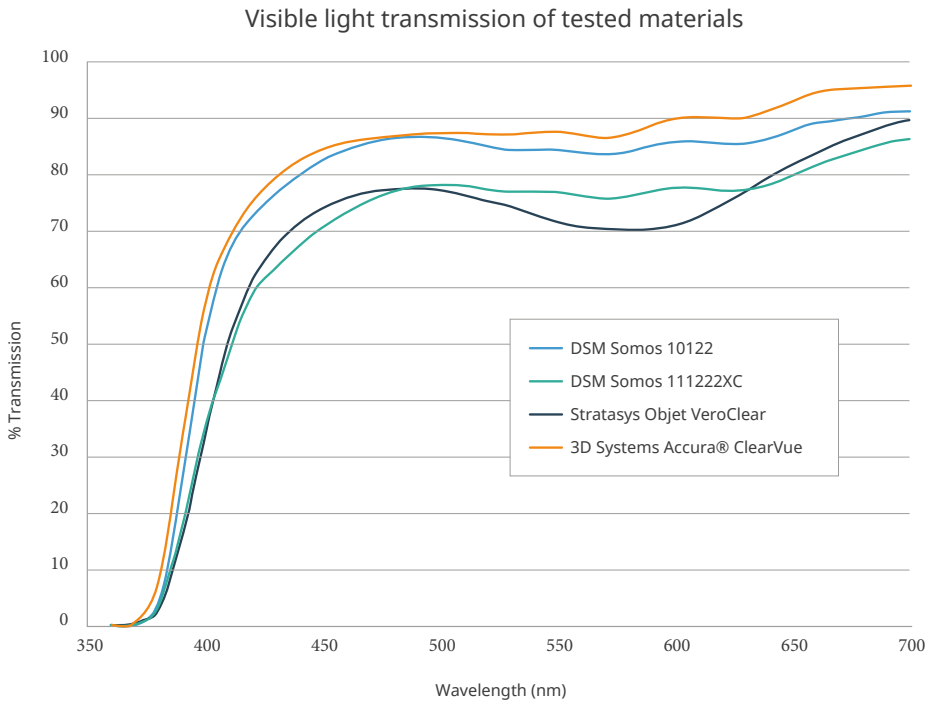


Prototype Touch haptic device with the casing printed in ClearVue allows a fully-functional working design for full testing and assembly checks

Testing ClearVue and its competition

3D Systems ClearVue material was compared to three print materials from competing vendors; VeroClear from Stratasys and Somos WaterClear XC 10122 and WaterShed XC 11122 from DSM. The lab test was conducted using a Konica-Minolta CM-5 spectrocolorimeter.

Identically-shaped objects were 3D printed with the specified printer. They were manually polished to ensure maximum transparency (a requirement for all four materials tested). For the clarity and color tests, they were measured in the same position in the test apparatus.



THREE STATED VALUES WERE MEASURED:

- L* is a measure of light transmission, which can be correlated to clarity (water=100)
- a* is a measure of color intensity along the red/green axis of color space. Low values indicate shades close to neutral/gray (water=0)
- b* is a measure of color intensity along the yellow/blue axis of color space. Low values indicate shades close to neutral/gray (water=0)

3D SYSTEMS CLEARVUE	STRATASYS VEROCLEAR	DSM 10122	DSM 11122
L* = 95.45 a* = -0.54 b* = 1.36	L* = 88.24 a* = -1.71 b* = 2.50	L* = 93.80 a* = -1.30 b* = 2.26	L* = 90.15 a* = -2.77 b*= 5.94

The L* result shows 3D Systems' ClearVue material is notably better (closer to 100). The same is true for a* and b* (closer to zero).

As the results above show, 3D Systems' Accura ClearVue scores closer to water on all three metrics.

As such the material is deemed to be the most clear and the most colorless of all the print materials.

In addition to colorimeter data, 3D Systems has also looked at the light transmission of these materials across the entire visual spectrum. These spectra show that Accura ClearVue has the highest percentage of transmission in the visible light region (from 400-700nm). Additionally both Stratasys' VeroClear and DSM's 11122 show significant absorption in the blue and violet areas of the visible spectrum (below 450nm). This results in these latter materials appearing significantly more yellow. This is also shown by their significantly higher b* colorimetry data — nearly 200% and 400% worse than Accura ClearVue respectively.

Why more clarity is important

On the key score of clarity (L* values), 3D Systems ClearVue scores higher than all other materials tested — by as much as 7%.

According to 3D Systems materials chief scientist Don Titterington, that extra 7% makes a significant visual difference. In addition the b* and a* number shows that ClearVue has the least yellowing, (up to 400% lower) and less of a green tint by up to 500%.

ClearVue material properties

This section is an introduction to the ClearVue's specific material properties. For a more detailed explanation, 3D Systems also offers a **technical data sheet.**

ClearVue is a high-clarity plastic with excellent humidity and moisture resistance. ClearVue is capable of meeting USP Class VI, making it suitable for a wide range of medical and pharmaceutical applications.

3D Systems rates its materials for a variety of properties, as good/better/best. In addition to its optical performance, these material characteristics are superior to other clear 3D print materials.

CLEARVUE - KEY BENEFITS

- Accuracy: Good
- Moisture Resistance: Best
- Optical Clarity: Best
- Durability: Better
- Use in RTV/Master Patterns: Good
- Use in Snap Fit Assemblies: Good
- Use in General Purpose Models: Best

The advantages of SLA

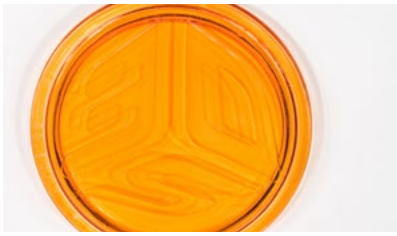
3D Systems' ClearVue material can be used effectively on any industrial-level SLA 3D printer.

Stereolithography (SLA) is the most common commercial 3D printing process, invented by 3D Systems founder Chuck Hull and is a technology on which 3D Systems continues to lead and innovate. SLA creates parts layer-by-layer in a photopolymerization process which links chains of molecules to build up the part.

SLA is ideal for models requiring high precision and fine feature detail, at wide variations in scale. The wide variety of resin materials available from 3D Systems gives engineers wide latitude in selecting the SLA process for prototypes and end-use parts. Smooth finish is another hallmark of SLA parts.

Only 3D Systems SLA printers meet or exceed standard tolerances for injection-molded plastics with the broadest range of applications with industry-leading accuracy and most advanced technologies incorporated into the platforms.

3D Systems offers a selection of SLA printers, each offering the highest precision and accuracy and varying in capacity and footprint.



On Demand Manufacturing from 3D Systems

3D Systems On Demand Manufacturing service offers a broad range of part production processes and technologies to fit all your needs using both industrial-grade 3D printing technologies as well as traditional production methods.

This service has a core expertise in the rapid production of clear prototypes and parts using Accura ClearVue and SLA with numerous SLA platforms on hand at facilities worldwide.

"Clear parts production is a key part of our facility's work,' said Tracy Beard, GM, On Demand Manufacturing at Lawrenceburg TN. "We will produce thousands of parts a week, and the material is versatile enough to be quickly finished and tinted to make perfect prototypes."

Typical clear prototype parts requested by customers to On Demand Manufacturing include realistic automotive headlights, turn signals and brake lights both to scale and full-size. Larger prototypes for functional fluid testing include cylinder heads for engines to be tested on-track to show oil coverage, air filters for heavy equipment and more.

One such customer, Orora, a glass bottle supplier, engaged On Demand Manufacturing to assist with rapid, clear prototypes of a beer bottle design for a key brewing company. With four alternative designs created and finished within two days using SLA and Accura ClearVue, Orora and its customer could immediately determine exactly the right design to work with.

3D Systems SLA 3D printers on-hand include everything from the smaller-build ProJet SLA 6000 and 7000 systems, through to the large ProX 800 with a 25.6 x 29.5 x 21.65 in (650 x 750 x 550 mm) build envelope. This is supported by the very wide-format ProX SLA 950 platform delivering SLA parts up to 59 x 30 x 22 in (1500 x 750 x 550 mm).

"Given our history and expertise, we know that On Demand Manufacturing delivers truly world-class results in SLA, especially clear parts," stated Beard. "Our latest QuickParts e-commerce service also enables you to get prototypes in even faster time."

3D Systems' On Demand Manufacturing has facilities and technology that enable a designer to get rapid prototypes significantly faster without investing in a 3D printer. With a rapid turn-around of SLA Clear parts, innovators can have perfect, functional prototypes within a couple of days.

Find out more about On Demand Manufacturing ›

ClearVue at 3D printing service bureau CIDEAS

CIDEAS is a 3D printing service bureau in suburban Chicago with an international following.

The company has been using 3D Systems ClearVue for four years. "ClearVue has neutral coloring," says company president and CEO Mike Littrell. "It is the best we've ever seen." The company regularly recommends ClearVue to customers, and has printed a wide range of parts and models.

An early use of ClearVue was for patient-specific models of the heart and connecting aortic branches, which surgeons use to prepare for surgery. CT scan data was moved into CAD and prepared for 3D printing on the 3D Systems stereolithography (SLA) printer. Other common projects include lenses, light pipes, IR sensor packing, and packaging displays. One client creates prototypes of conformal cooling molds, while another creates point-of-sale displays for retail products or executive review. A current project is a pre-production transparent model of a new medical device, to be used at trade shows and private demonstrations. "We are building halves of the device clamshell in ClearVue," says Littrell. "Then we use other technologies to create clip parts for the full model."

CIDEAS says demand for clear parts took a big jump when they started using ClearVue. "Anybody who has seen our clear parts has been blown away," says Tom Schulte, CIDEAS customer development director.

"It became obvious we needed a bigger build envelope than our initial small frame system," so the company added the 3D Systems ProX 800 with its 25.6 x 29.5 x 21.65 in (650 x 750 x 550 mm) build envelope.

Using in-house processes, CIDEAS can start with ClearVue and then match to a specific tint such as red or amber typically used in automotive tail lights as required, or supply the part as frosted. This team's post-processing skill with ClearVue has gained CIDEAS clients in the lighting industry, who create prototypes of frosted diffused lighting products that rival the final production glass.

Littrell says the majority of their work in ClearVue is in design verification, for demonstration models, and for focus groups and executive review.

What's Next?

Interested in learning more about Accura® ClearVue™?

Get in touch today - we will be right with you.

Get in Touch

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