

White Paper

Evaluating Transparency Measures for SLA Additive Manufacturing in Transportation



Seeing the Value of Clear Parts

There are a number of prototyping and end-use applications in the automotive sector that benefit from truly transparent materials. These extend beyond headlamps and lens covers which require clarity as final products, to include out-of-the-box use cases. Optimizing housings and enclosures with clear prototypes is an excellent example, as is verifying fluid flow with a direct view into a given assembly or system.

The combination of 3D printing and transparent materials offers designers and engineers an unprecedented opportunity to improve outcomes through the production of innovative and informative components. However until recently, 3D printing materials were tinted or less-than-transparent and the resulting

prototypes made clear visuals challenging, and other needed characteristics elusive. For example, deciding between strength and clarity has been a common trade-off that limits the utility of the resulting component.

Fortunately, 3D Systems' materials scientists have introduced a better option with the most clear and most colorless 3D printing material on the market: Accura® ClearVue™. As discussed within this paper, Accura ClearVue is not only the most transparent clear SLA material currently available, but it offers additional material properties that extend the range of addressable applications.

Beyond excelling in clarity and color metrics, this material was formulated for ease-of-processing, exceptional detail and smooth surface finish, strength and durability, and moisture resistance.

Accura ClearVue is a high-performing and cost-effective choice for functional prototypes for fluid flow evaluation in automotive and aerospace components, lighting and optical light transmission, clear housings and enclosures, lenses, and more. Beyond form and fit models, the aesthetics of Accura ClearVue make it an excellent choice for any components that will ultimately be produced in polycarbonate, acrylic, crystal polystyrene, or glass. If transparency is of value, consider Accura 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.

0%

COMPLETELY OPAQUE
Cannot transmit light



100%

AS CLEAR AS WATER
Transmitting all light

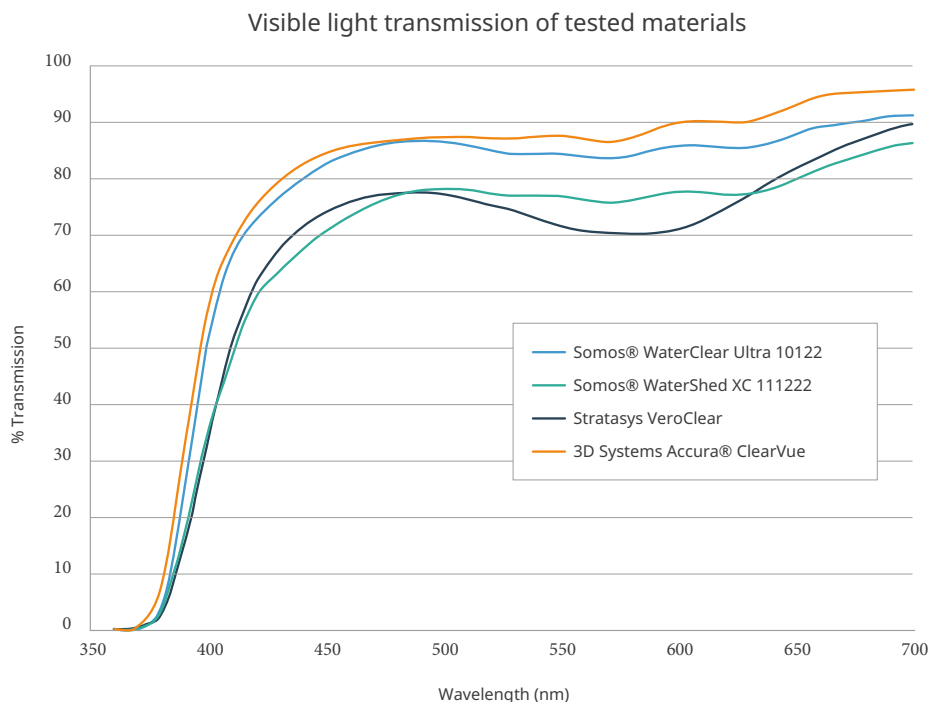


The aesthetics of Accura ClearVue make it an excellent choice for any components that will ultimately be produced in polycarbonate, acrylic, crystal polystyrene, or glass.

Testing Clear 3D Printing Materials

3D Systems Accura ClearVue material was compared to three 3D printing materials from competing vendors; VeroClear, Somos® WaterClear Ultra 10122 and WaterShed XC 11122 from Stratasys. The lab test was conducted using a Konica-Minolta CM-5 spectrophotometer.

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 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 | STRATASYS 10122 | STRATASYS 11122 |
|---------------------|---------------------|-----------------|-----------------|
| L* = 95.45 | L* = 88.24 | L* = 93.80 | L* = 90.15 |
| a* = -0.54 | a* = -1.71 | a* = -1.30 | a* = -2.77 |
| b* = 1.36 | b* = 2.50 | b* = 2.26 | b* = 5.94 |

The L* result shows 3D Systems’ ClearVue material is notably better than the competition (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, testing 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 — inferior to Accura ClearVue by nearly 200% and 400% respectively.

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

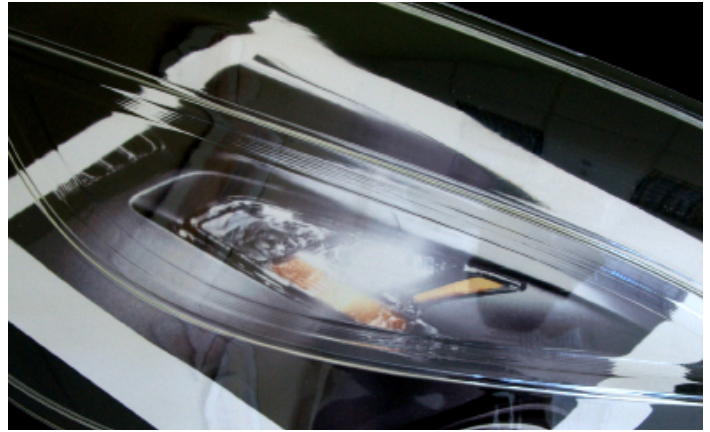
According to 3D Systems materials chief scientist Don Titterington, that extra 7% makes a significant visual difference. In addition, the b* and a* numbers show that ClearVue has the least yellowing (up to 400% lower), and less of a green tint by up to 500%.

Material Properties of Accura ClearVue

Accura ClearVue is a high-clarity plastic with excellent humidity and moisture resistance. It 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.

For a more detailed explanation, 3D Systems also offers a [technical data sheet](#).



The Advantages of SLA

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

SLA is the most common commercial 3D printing process, invented by 3D Systems' founder Chuck Hull. 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 with smooth surface finish, at wide variations in scale. The broad portfolio of resin materials available from 3D Systems gives engineers greater versatility for prototypes and end-use parts.

Only 3D Systems' SLA printers meet or exceed standard tolerances for

injection-molded plastics for the broadest range of applications with industry-leading accuracy and the 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.



What's Next?

Interested in Learning More About Clear 3D Printing?

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

[Get in Touch](#)

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