

HENKEL'S CLEAR PHOTOPOLYMER RESIN FOR DLP 3D PRINTERS CREATES NEW OPPORTUNITIES WITH PLASTIC CONTAINERS

Background

"Henkel has many customers in the packaging industry, and is itself a packaged goods company," says Aric Yackly, Business Development Manager for 3D Printing at Henkel. "We know first-hand where the inefficiencies lie. 3D printing has the potential to solve a lot of them and we're leveraging our Open Materials Network partnerships to help make it happen."

Plastic containers are used for many different purposes, including consumer packaged goods. Beverages, cosmetics, pharmaceuticals, and household chemicals are all sold in plastic bottles, tubs and boxes. The manufacturing and filling methods vary depending on the package's contents, but the workflow is typically the same:

- Package design is created
- Prototypes are tested
- Tooling is constructed
- Production lines are "made-ready"
- Samples are approved
- Production begins

Packaging companies are not new to 3D printing. Many have used it for years to help create early stage prototypes. In fact, back in 2015 Packaging Digest surveyed company executives and found that 33% of the respondents were already using the technology and of those, 100% were using it for prototyping. Perhaps more telling, over 60% of the execs said they would be using 3D printing within a year or two.

Packaging companies that adopted early experienced mixed results. While filament and powder technologies like fused deposition modeling (FDM) and selective laser sintering (SLS) were capable of yielding tangible prototypes, they weren't functional. Companies have also experimented with stereolithography (SLA) but often had challenges finding translucent photopolymer materials that were resistant to UV light. After just a few days in sunlight, the prints would degrade and discolor.

ProtoCAM is a Pennsylvania-based service provider that offers rapid prototyping additive manufacturing and other services for many different markets, including packaging. Like others in the industry, they've worked with many different 3D printing technologies. Recently, the firm installed a new Carbon 3D Printer and collaborated with Henkel to see if they could finally solve the challenges packaging companies face with low volume production.

APPLICATION:

Plastic bottles and containers

MATERIAL:

LOCTITE 3D IND405 Clear

TECHNOLOGY:

Carbon M2 3D printer

The Challenge

"Like most manufacturing industries, the packaging market is dependent on volume," says ProtoCAM VP of Additive, Ed Graham. "At high quantities, fixed costs of things like molds and tooling can be easily absorbed. But with prototyping, line testing, and low quantity production, those costs are prohibitive. Packaging providers need a better way to support that necessary and growing part of the market."

Traditionally, packaging has been an analog industry. Products were manufactured using time-tested technologies like injection molding and thermo-forming. The problem though, is that those technologies all work based on a make-ready and run pricing model. The high costs of items like molds and tooling have to be accounted for, and typically a significant volume is needed to minimize their impact on the price of each piece. In many cases, customers would have to order tens of thousands of pieces just to spread the cost far enough.

There are many times however, where buying in bulk isn't feasible. Early in the product development process, models and prototypes are critical engineering tools. Later, as production lines are being configured, small batches are required. Beyond that, there is significant demand for a more affordable, low volume solution.



Packaging prototype 3D printed with FDM
(photo courtesy Get3DSmart)

The status quo in packaging is stifling innovation. Many great ideas are simply discarded because they don't have the volume to offset the upfront packaging costs. Digital technology has already changed how packaged goods are labeled and decorated. If the industry can leverage similar technology to manufacture plastic packaging, it can unleash many of the same benefits including on demand and just-in-time production, in addition to customization and personalization.



The Solution

“Our wish list was pretty long,” says Mr. Graham. “We needed a 3D printing technology that could print enclosed shapes with the same features as if they were injection or blow molded. Wall thickness was of particular concern. Mass produced plastic bottles can be extremely thin and flexible. To be useful in setup or for low run applications, we needed to add to our portfolio a clear UV-resistant 3DP material that also withstands the production line conditions that our end-users have.”

Carbon’s continuous liquid interface technology (CLIP) offers several advantages over SLA. SLA operates by projecting ultraviolet light on the top of a vat of liquid photopolymer, causing it to harden. CLIP produces parts by projecting ultraviolet light through the bottom of a vat of liquid photopolymer. This allows parts to be made more quickly, but also changes how they are grown in the vat.

To optimize their parts for Carbon’s machine, ProtoCAM made several design improvements. By incorporating Design for Additive Manufacturing (DfAM) principles they were able to closely replicate the geometry of mass-produced plastic containers.

ProtoCAM also realized the importance of finding the right material. It had to be durable and offer good elongation, but it also needed to be clear.

“For many applications, transparency is key,” says “Mr. Graham. “Not only does it help the consumer see what’s inside the bottle or container, it also helps with monitoring fluid travel on the production line. To appeal to our target market, we needed a material with exceptional clarity.”

ProtoCAM collaborated with Henkel to find the solution. LOCTITE 3D IND405 Clear was chosen because of its strength and durability, but also for its dimensional stability, which is critical for post processing. In addition to supplying the material, Henkel validated it for use on Carbon machines and provided other services, including printer specifications and workflow.

ProtoCAM also applied its own 3D printing know-how. In addition to the front-end engineering work, they also optimized their post-processing procedures to maximize the clarity of the final product. The result was startling. Straight off the machine, prints appeared dull and cloudy. With the application of ProtoCAM’s post-processing methods, they became crystal clear.

To advance the solution even further, ProtoCAM investigated tinting the resulting product and found that they could accurately replicate mass-produced tinted bottles like those used in pharmaceuticals.



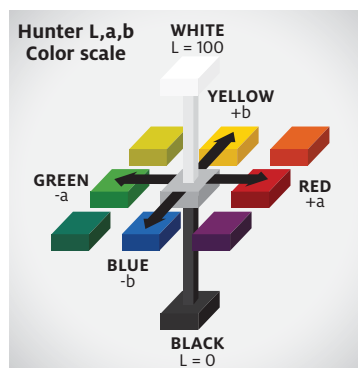
Bottle prototypes printed with IND405 Clear and tinted for enhanced color options while maintaining clarity

BENEFITS

“In the past when we tried this with SLA, the results were not optimal,” says Mr. Graham. “Print speed was too slow and the samples we made were easily discolored in sunlight. Our new solution, with the Carbon printer and Henkel’s material, not only prints faster, but the end result actually looks and performs like a mass-produced plastic container.”

| Method: ASTM G-154 - Cycle 1 ASTM E308 Total Transmittance | After Print 0 hours exposure | After QUV 240 hours exposure |
|------------------------------------------------------------------|------------------------------|------------------------------|
| L* | 98.86 | 91.06 |
| a* | -0.65 | -0.47 |
| b* | 1.03 | 1.42 |
| C* | 1.22 | 1.49 |
| h | 122.49 | 108.47 |
| Delta E - dE | NA | 0.47 |

QUV Exterior Weathering Data for LOCTITE IND405 Clear



CASE STUDY: PACKAGING COMPANIES SEEK CLARITY WITH 3D PRINTING



LOCTITE IND405 Clear (right) compared to traditional SLA parts (left) before and after significant UV exposure

For packaging brands, speed is critical, especially in the design phase. When ProtoCAM experimented with SLA, they found it took 32 hours to print a sample. With their new solution, they were able to print the samples in 6 hours, a savings of 75%. While that is impressive and helpful when rapid prototyping, the benefit compounds with small batch production. With their speed advantage, ProtoCAM can easily support the larger quantities required for line testing and small batch production.

The quality and clarity of the finished product is another big advantage. As part of the line testing process, fluids and other materials are tested to make sure they are filling properly. Transparent packaging helps engineers see inside the bottle.

"We run many different bottle filling lines in our own manufacturing facilities," says Mr. Yackly. "Often the set-up process requires 50 to 200 clear samples that are used to optimize filling. It was an expensive, time consuming process. With ProtoCAM's solution, packaged goods providers can cut precious time and money out of the setup, saving their clients' money and helping them get into full production more quickly."

With ProtoCAM's solution, plastic containers can be produced in small batches, much less expensively. Not only does this make line testing more affordable, but it also opens up opportunities with short-run production. In some cases, this can allow brands to manufacture their packaging just-in-time, or even "on demand." For companies in markets such as cosmetics, having the ability to produce in small batches can allow them to improve consumer testing and even offer limited editions.

For example, one retailer asked ProtoCAM to produce prescription jars in their signature red color. The jars were manufactured and used by the client to test the market and justify mass production.

Beyond packaged goods, ProtoCAM sees other opportunities for its new process.

"We think there's a lot of potential in automotive," says Mr. Graham. "As OEM's and their suppliers work through the product development process, they need functional prototypes. With the aggressive clips used by manufacturers nowadays, interior and exterior lighting components need the kind of strength and clarity Henkel's material provides. We're also excited to pursue opportunities with medical devices and other fluid filling applications. It's a very versatile solution."

Want to learn more about Henkel's unique material solutions for the additive manufacturing industry?
Visit Henkel's LOCTITE 3D Printing at LoctiteAM.com or reach out to us via loctite3dp@henkel.com

About **LOCTITE**

LOCTITE Additive Manufacturing delivers unique photopolymers with production capability, customize resins and deliver engineering services to identify the best application to address your needs. With a constantly growing portfolio of high-performance materials, specialized equipment and post-processing solutions, LOCTITE overcomes the limitations of conventional 3D printing to enable additive manufacturing for the production of durable, functional parts. Through its strategic partnership with technology leaders for specialized equipment, LOCTITE is driving the adoption of 3D printing beyond prototyping and toward the production of final parts. (www.LoctiteAM.com)

About **ProtoCAM**

Here at ProtoCAM does additive manufacturing differently. Experienced engineers work with customers on their unique projects to understand exactly what their goals are and what they would like their end-product to be. ProtoCAM provides support throughout the entire additive manufacturing process, from initial idea to end-product. ProtoCAM's second-generation additive manufacturing facility, opened in 2013, is in Pennsylvania's Lehigh Valley, just a short drive from New York and Philadelphia, and within a day of most major East Coast population centers. (www.protocam.com)

About **Carbon**

Carbon® is a 3D printing technology company helping businesses to develop better products and bring them to market in less time. The Carbon DLS™ process combines versatile printers, advanced software, and best-in-class materials to deliver functional parts with end-use performance and aesthetics, helping engineers and designers to create products that outperform. Carbon is a venture-backed company headquartered in Redwood City, CA. Currently, Carbon has customers in 17 countries and is continuing to expand globally. (www.carbon3d.com)