

# Instant FIP Gaskets, Just Add Light

By Dr. John Arnold

Ultraviolet-curing elastomers have been developed for form-in-place (FIP) gasket applications. A 0.25-inch thick bead completely cures in seconds upon exposure to UV light. Unlike traditional FIP gaskets, the instant cure feature of these gaskets makes them a drop in replacement for preformed gaskets. Simply dispense, UV cure and compress. The UV gasket is immediately

## Introduction

Light-curing adhesives have been used in automotive, appliance, and electronic manufacturing for more than 20 years. Wherever light can reach the resin and the cured resin meets the performance requirements of the application, then the UV "cures in seconds" feature leads to their selection as the assembly or production method of choice. Using light to cure FIP gaskets is the latest utilization of UV productivity.

Cure time for the UV elastomers is shown in comparison to cure times of other form-in-place gaskets (Table 1).

As shown in Table 1, UV-acrylate gaskets are the fastest way to produce a form-in-place gasket. Due to material cost and performance, traditional silicones and urethanes have been the most commonly used gasketing materials. Unfortunately, urethanes and silicones cure very slowly. No assembly or quality control (QC) testing can be performed until the gasket is fully cured; otherwise, the gasket will remain permanently deformed. Besides their slow cure, silicones can release corrosive by-products during cure that can affect product durability of electrical circuits. Two-part urethane resins can be difficult to use because they are moisture sensitive, require exacting ratios and air-free mixing. UV silicones cure quickly on the surface (due to their cationic cure), but standard beads are too thick to completely cure with light; so additional heat or moisture cure mechanisms are needed to fully cure the silicone elastomer. Hot

ready for testing or assembly. Total automation becomes a reality, since the cure rate equals the dispensing rate. One-component chemistry makes automation even easier. Instant cure eliminates labor costs and plant space devoted to shuffling in-process inventory associated with other FIP technologies. Their low compression set and wide range of properties makes these UV-curing gaskets good candidates for many applications.

Additional benefits of the UV FIP elastomers that will be realized:

- Reduction or the elimination of fixtures and jigs.
- Elimination of complex and costly packaging designed to protect slower curing gaskets from being permanently compressed during shipping.
- Immediate inspection of gasket compression and placement (and removal or process corrections if incorrect.)
- Reduction of scrap.
- Reduction of plant space.
- Reduction of inventory.
- Shortening just-in-time (JIT) manufacturing and shipping cycles.

All of these features not only lead to smoother and faster manufacturing, but also lead to significant cost reductions. Figure 1 summarizes the cost benefits of complete UV cure versus other FIP methods.

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## Instant cure eliminates labor costs and plant space devoted to shuffling in-process inventory associated with other FIP technologies.

## TABLE 1

### Comparison of cure times of new UV elastomer and other FIP gasket materials

FIP Gasket	Time to Skin Over	Time to Full Cure under ambient conditions
UV Acrylate	Seconds	Seconds
Air-Dry Silicone	Minutes to hours	Hours to days
2-part Urethane	Minutes to hours	Hours to days
UV Silicone	Seconds	Hours to days
Hot Melts	Seconds	Minutes

melts are very quick, but require a substantial capital investment eliminating their consideration for small applications and most are not recommended for any thermal applications.

## UV FIP Costs

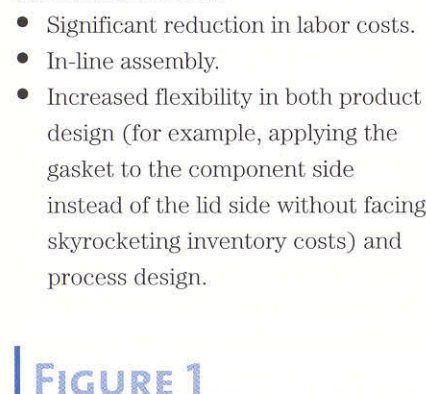
The new UV elastomers are one component and cure in seconds. The UV elastomers are made from several different acrylated chemistries, including urethanes and rubber elastomers. While slightly higher material cost compared to other liquid gaskets, instant UV elastomers offer dramatic reductions in processing costs.

Because the UV FIP gasket process can be completely automated, potential benefits include:

- Significant reduction in labor costs.
- In-line assembly.
- Increased flexibility in both product design (for example, applying the gasket to the component side instead of the lid side without facing skyrocketing inventory costs) and process design.

## FIGURE 1

### Relative costs of UV acrylate FIP gaskets to other FIP gaskets



than the cost of unproductive floor space or the cost of in-process part racks and certainly a fraction of the costs of automated racks.

## Testing Costs

The new FIP UV elastomers are dispensed as 100% reactive resins, which become a solid polymer or plastic upon exposure to the UV light. The possibility of instant QC allows manufacturers to avoid costly wastes due to unexpected variations in two-component mixing or deviations in the dispensing system or unexpected deviations in part tolerance. Instant QC means not having to scrap or rework a full day of production or having to retrieve in-process parts that were shipped to your customer and expected to cure in transit.

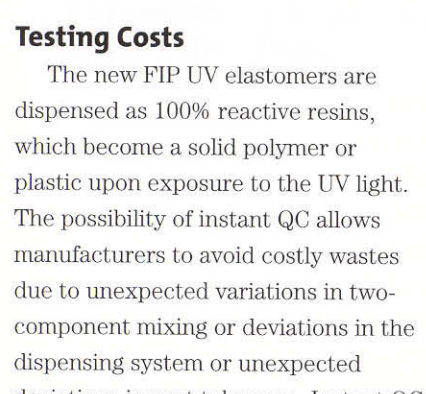
Because no cure occurs before exposure to the light, there is still the additional benefit that any mistake in the dispensing process can be detected and corrected by the removal of the uncured resin. Thus, costly and unnecessary scrap can be eliminated.

## Inventory Costs

Assuming no changes in a company's comfort zone with respect to shipping, receiving, and inventory procedures, the excess inventory cost is the sum of in-process components. With an instant cure UV process, only 2-5 parts are excess inventory. With a 1-2 day FIP process, this could mean hundreds to tens of thousand parts in the excess inventory. The cost of that inventory is the sum of the material value of every component in the device, the labor that has been applied to the component, and the energy consumed in manufacturing the assembly to the FIP stage. If you are gasketing small plastic cases, the inventory costs might be small. If you are gasketing durable goods and electronic assemblies, then inventory costs are taking a significant bite out of your profits.

## FIGURE 3

### Flanges and shallow grooves are recommended mating part interfaces for FIP applications.



Since the FIP gasket adheres to the substrate, the gasket does not need a narrow groove to hold it in place.

Figure 3 demonstrates the proper joint design for form-in-place gaskets. Applying the FIP directly to a flange with no groove provides an excellent seal with minimum resin use for most applications. Adding a shallow groove may improve the seal for applications involving pressure differentials or when sealing chemicals that are known to attack the gasket.

Flanges are adequate for most gaskets. Most gaskets only serve to compensate for deviations in part fit between the box and the lid. Most applications see neither a pressure differential nor an aggressive environment to seal. As with all form-in-place gaskets, UV FIP gaskets are best applied directly on a flange or as a tall thin bead in a shallow, wide channel.

## Range of Properties of New UV FIP Products

UV FIP elastomers are available in many product profiles. The viscosity of these products can range from thin wicking grades (500 cP) to nonflowing gels (30,000-150,000 cP at 20 rpm). Durometer hardness ranges from A10

## Labor Costs

Labor costs are inversely related to the degree of automation and directly related to number of parts in process. Historically, UV applications require less labor than other technologies. UV operations eliminate production steps; for example, the labor associated with part shuffling. UV FIP elastomers are easy to automate. UV processes also use a much smaller footprint than other operations. The smaller footprint often allows one person to comfortably load and unload parts while keeping the process running.

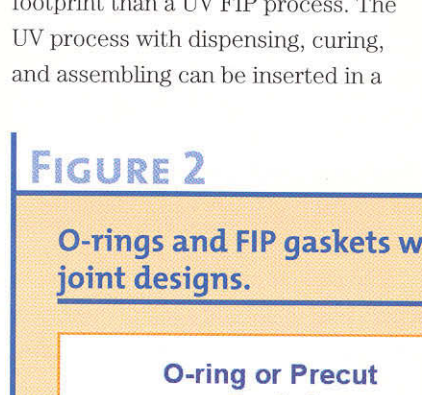
## Floor Space Costs

Floor space is costly. Ask anyone who has to build a new site to expand production. UV processes can expand production and fit into spaces that are too small for other FIP processes. Floor space contributes to the real costs of rent and mortgage. Floor space requires maintenance and cleaning and consumes energy (heating, cooling and lighting.)

No other FIP process has a smaller footprint than a UV FIP process. The UV process with dispensing, curing, and assembling can be inserted in a

## FIGURE 2

### O-rings and FIP gaskets work best with different joint designs.



production line in a space as little as 2 x 6 ft<sup>2</sup>. High volume applications may increase the curing distance (from 2-6 feet.) High volume applications may also need room for resin storage (which is the same for all FIP resins.)

The cure speed of these new UV acrylates allows conveyor speeds of 1-25 ft/min on conveyors fitted with moderate (200 mW/cm<sup>2</sup>) to high intensity (2,000 mW/cm<sup>2</sup>) UV lamps. Parts coming off a line at 1-25 ft/min are good assembly rates.

With its small footprint and high productivity, a UV process can multiply the equation of how many dollars of product can be produced per-square-foot of factory.

## Flange Designs Suitable for Using UV FIP Elastomer Gaskets

Figure 2 demonstrates why FIP gaskets should not be dispensed into grooves designed for o-rings. Groove walls limit the cross-sectional expansion of a FIP gasket when it is compressed. This is also a wasteful use of resin, since most of the resin is filling the channel instead of sealing the joint. Deep, narrow grooves have nothing to do with sealing. Deep, narrow grooves keep the o-ring from falling out of joint.

## Summary

In depth research and marketing trials over several years have resulted in the commercialization of many UV FIP elastomer gaskets. Successful applications exist within automotive, electronic and consumer products markets. UV technology enables manufacturers to replace labor with fully automated FIP gaskets. UV FIP gaskets offer many savings, process and design advantages over traditional FIP gaskets.

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LIT270 Rev. 5/15/03