Challenge
Improve product yields, lower scrap material costs and reduce operating costs by maintaining strict process control of critical parameters such as product temperature, optical energy delivery, spectral content and ensuring optimal, repeatable optical maintenance.

Solution
The OmniCure® AC7150 and AC7300 high irradiance, focused UV LED area curing systems and the OmniCure® LX Series UV LED spot curing systems fitted with its unique cylindrical lens provide innovative UV curing solutions at 365 nm and 400 nm for a high degree of adhesive compatibility.

Benefits
Provide manufacturers of syringes with increased production yields through consistent, repeatable, high irradiance optical delivery and low-temperature curing.

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Author: Roy Kayser, Senior Applications Manager, Lumen Dynamics
Application Overview

Bonding cannula to hubs in needle assemblies is a high speed, low temperature UV curing application. The cannula to hub joint has a unique small and cylindrical geometry, requiring innovative UV curing solutions. It is critical that this joint is well sealed to prevent fluids from leaking and that the position of the cannula is secured in the proper alignment.

**FIGURE 1:** Typical syringe bonding assembly.

Needle assembly typically consists of joining a stainless steel cannula to a plastic hub. Common plastic hub materials are: acrylonitrile butadiene styrene (ABS), acrylic, polycarbonate (PC), polyethylene (PE), polypropylene (PP), polysulfone (PS), polyurethane (PU) and cyclo olefin polymer (COP). Classic glass hub material is silica based (SiO2). The cannula is invariably made from stainless steel or equivalent medical grade metals available in a variety of gauge sizes.

**FIGURE 2:** UV exposure of hub to cannula joint.

The assembly process can be accomplished in either a continuous or indexed curing set-up. In a continuously moving conveyor application, the parts are continuously exposed to a linear UV source, typically at a speed of 6 to 10 cm/second. Successful curing requires a high output UV LED source such the OmniCure® AC7150 or AC7300 UV LED Area Curing systems, with front-end optics to focus the light energy onto the adhesive joint. This provides a sufficient dose for fully curing the adhesive, while the narrow spectrum of the LED maintains a low temperature of the plastic parts.

An indexed conveyor production line would utilize the OmniCure® LX400+ UV LED spot curing solution with the innovative cylindrical lens to match the geometry of the adhesive joint. This set-up will typically provide a 1 to 1.5 second static UV exposure simultaneously to a row of 4 to 8 syringes. This is followed by a step index occurring over the course of 0.5 seconds, resulting in a step speed of 2 cm/second.

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**Introduction**

There are over 380 FDA approved syringe manufacturers globally. Market forecasts estimate that the global market will likely grow at a CAGR of 10.4% over the period 2012 – 2018, with sales increasing to 22.6 Billion USD in 2018.

The global syringe market includes a wide variety of syringe types addressing a multitude of market segments utilizing refillable, prefilled and single-use syringes. Of the many precision assembly process steps to be considered, this document will focus on cannula to hub bonding. As the hub material can be comprised of various plastic and glass materials, the adhesive selection process and appropriate UV light source must factor this in when defining the process and equipment.
Benefits of the OmniCure® AC7150, AC7300 and LX Series in the Manufacturing of Syringes

- Specialty optics ensures precise delivery of optical energy and higher utilization of available optical power.
- Maximum flexibility via adjustable intensity control for desired optical output to meet specific application requirements.
- Higher optical efficiency resulting in lower operating costs.
- Zero IR content and selective narrow band optical emissions ensuring low heat generation with zero ozone emissions.
- Reduced operating and integration costs by eliminating the need for external venting.
- Lessened frequency of lamp replacements resulting in low maintenance and operating costs.
- Minimized downtime with remote temperature monitoring (applicable to AC Series only) of output and preventative control (via intensity control).

Specifications Overview

- The OmniCure® AC7150 includes a 150 mm x 15 mm optical window and is available in 365 nm and 395 nm versions.
- The OmniCure® AC7300 includes a 300 mm x 15 mm optical window and is available in 365 nm and 395 nm versions.
- The typical output irradiance for the AC7150 and AC7300 is as follows:

<table>
<thead>
<tr>
<th>Working Distance</th>
<th>AC7150 Irradiance (W/cm²)</th>
<th>AC7300 Irradiance (W/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm</td>
<td>3.3</td>
<td>5.0</td>
</tr>
<tr>
<td>20 mm</td>
<td>2.6</td>
<td>4.0</td>
</tr>
<tr>
<td>30 mm</td>
<td>1.9</td>
<td>3.0</td>
</tr>
</tbody>
</table>

- The LX Series include spot sizes of 2 mm, 3 mm, 6 mm, 8 mm, 10 mm, 12 mm and a light line (cylindrical) lens.
- Typical output irradiance for a LX400+ LED head with a cylindrical lens at 365 nm is 15 W/cm².
- Typical output irradiance for a LX400+ LED head with a cylindrical lens at 385 nm is 13 W/cm².

Typical Medical UV-Curable Adhesive:

A wide range of medical grade UV curable adhesives are available to accommodate the numerous materials and processes utilized in needle-to-hub assembly. The adhesive selection process must consider, as a minimum, the end-use application and standards requirements (USP Class VI and ISO 10993), hub material (optical transparency) and syringe temperature sensitivity. A selection of medical grade UV adhesives suitable for syringe manufacturing and known to be compatible with the OmniCure® AC7150, AC7300 and LX Series systems can be found here: www.ldgi.com/needle-assembly/medical-adhesives. Also, a large selection of adhesives have been successfully tested with the AC7150, AC7300 and LX Series systems which can be viewed here: www.ldgi.com/ac7150-ac7300/adhesives. For further assistance and adhesive compatibility inquiries, please contact Lumen Dynamics.
References