Guide to Selecting and Using

DYMAX UV LIGHT CURING SYSTEMS

DYMAX®

Discover a Better Solution

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BENEFITS of UV LIGHT CURING

Light curing technology has allowed manufacturers to lower processing costs, produce higher quality products and eliminate the use of harmful chemicals from the workplace for over 20 years. Although each manufacturer will perceive and realize a unique set of benefits from light curing, there are a few features/benefits that DYMAX customers consistently cite:

Light Curing Features	Light Curing Benefits
Fast Light Cures "On Demand"	➢ *Reduced labor costs*
	➢ *Simplified automation*
	➢ *Easier alignment of parts before cure*
	➢ *Improved in-line inspection*
	➢ *Reduced work-in-progress*
	➢ *Shorter cycle times*
	➢ *Shorter lead times to customers*
	➢ *Fewer assembly stations required*
	➢ *No racking during cure*
	➢ *No ovens/heat curing*
One-Component	➢ *No mixing*
	➢ *No pot life issues, less waste*
	➢ *Less expensive dispensing equipment*
	➢ *No hazardous waste due to purging/poor mixing*
	➢ *No static mixers*
	➢ *Easier to operate/maintain dispensing systems*
Environmentally and Worker Friendly	➢ *Better work acceptance*
	➢ *No explosion proof equipment*
	➢ *Reduced health issues*
	➢ *Reduced regulatory costs*
	➢ *Reduced disposal costs*

DISCOVER A BETTER SOLUTION

Realizing the tremendous opportunity for cost savings, expanded design capabilities, and environmentally "friendly" bonding and sealing solutions, DYMAX introduced UV adhesives and coatings to manufacturers in the early 1980's. Since that time the company has specialized in UV assembly solutions and now offers the broadest range of UV curing resins available and a complete line of UV curing equipment. Our resins and curing equipment are used in a wide range of Medical, Electronic, Industrial, Aerospace, Optical, Automotive, Packaging and Novelty applications. As the only major manufacturer of both UV curing resins and UV curing equipment, we are acutely aware of the need to match the curing system with the curing chemistry.

Free resin samples and a curing equipment rental program allow our customers to fully evaluate DYMAX products prior to purchase. In addition, our Technical Service Engineers are available to help recommend a resin, a curing system, and a curing process for your specific application. Whenever possible, DYMAX Technical Service Engineers will conduct testing on your specific parts. If testing indicates our current line of over 3,000 formulations or complete line of UV curing systems are not suitable, we will either customize a solution for you or help you search for a solution elsewhere.

This *"Guide to Selecting and Using DYMAX UV Light Curing Systems"* will assist you in selecting the best UV curing system for your application. It will also help you set up an efficient and controlled UV curing process. For more information on DYMAX UV curing equipment and resins, please contact our Technical Service Engineers by phone at +49 (0)69 7165 3568 or visit us on the web at www.dymax.com. Your complete and on-going satisfaction with your DYMAX UV curing process is our commitment and our mission.

Visit the DYMAX Web site at www.dymax.com to learn more about our UV light curing systems and compatible adhesives.

OVERVIEW OF UV LIGHT CURING SYSTEMS

SPOT LAMP SYSTEMS

DYMAX spot curing systems provide very high intensity (3,000 to 18,000 mW/cm^2 (320-395 nm)) over a small area (typically <12 mm diameter). These intensities typically result in a 0.5 to 5-second cure time. DYMAX spot curing systems utilize an integral timed/manual shutter and typically require little external shielding.

Spot lamp systems are ideal for curing small areas quickly and can be easily integrated into an automated assembly process or used as a turnkey bench-top system. Learn more about DYMAX UV spot curing lamps on pages 8-11.

BlueWave™ 200 Spot Curing System

FLOOD LIGHT CURING SYSTEMS

DYMAX UV flood curing systems offer moderate intensity (75 to 225 mW/cm^2) over a large area (12 cm x 12 cm or 20 cm x 20 cm). These lamps are ideal for curing areas larger than 12 mm in diameter or curing many small parts simultaneously.

DYMAX UV flood systems can be incorporated into conveyors, automated assembly systems, or used as turnkey bench-top units. Learn more about DYMAX UV flood curing systems on pages 12-13 of this guide.

5000-PC Flood Lamp with Lightshield and Shutter

CONVEYORS

DYMAX conveyors incorporate flood curing systems. The benefits of light curing conveyors include consistent cure times and the ability to cure larger parts. Another benefit of conveyors is that they completely shield operators from UV light. DYMAX conveyors have 12 cm (UVC-5) or 20 cm (UVC-8) wide belts. Conveyor speed is tightly controlled and typically ranges between 0.1-10 m/min (UVC-5) or 1-15 m/min (UVC-8) (although faster conveyors are available). DYMAX light curing conveyors can be outfitted with different types of lamps. Learn more about DYMAX UV curing conveyors on page 14.

UVC-8 20 cm Wide UV Curing Conveyor

RADIOMETERS

A radiometer is a device that measures the intensity and/or energy associated with light of specified wavelengths. UV light is, by definition, not visible and so a radiometer is required to determine UV intensity. The ACCU-CAL 20 (for spot curing lamps) and the ACCU-CAL™ 30 (for all curing systems) are the most popular DYMAX radiometers. These radiometers measure intensity and energy in the UVA (320 nm to 400 nm) range. The ability to measure light intensity is useful for three reasons: maintaining a controlled light curing process, providing a worker friendly light curing process, and measuring light transmission rates through substrates. Learn more about DYMAX radiometers on page 15 of this guide.

ACCU-CAL™ 30 Radiometer

ADDITIONAL EQUIPMENT

This guide contains the most popular DYMAX UV curing systems and radiometers. Additional equipment and accessories are available upon request.

FUNDAMENTALS of UV LIGHT CURING

Developing a successful light curing process requires knowledge of the following key concepts.

Higher Intensity = Faster Cures – Intensity is the light energy reaching a surface per time and it is often measured in mW/cm^2. Higher intensity light (of the proper wavelengths) will generally provide faster cure.

Shortwave and Longwave Bulbs – DYMAX UV curing systems can be outfitted with either shortwave bulbs (emphasizing UVB and UVC) or longwave bulbs (emphasizing UVA and visible light). Longwave bulbs are recommended for curing most DYMAX (and similar) light curing materials due to their superior depth of cure and substantial visible light intensity. The chart at the bottom of this page describes the portion of the electromagnetic spectrum emitted by standard DYMAX longwave bulbs.

Distance and Substrates Affect Intensity – Distance from a light curing lamp, always affects intensity. Intensity decreases with increasing distance from both spot lamps and flood curing systems, especially spot lamps. Intensity decreases with increasing distance from the focal point for focused-beam systems. Intensity is also reduced when curing through substrates that transmit less than 100% of the light used for curing. Advances in light curing adhesive technology now allow curing through most translucent substrates, even those that block UV completely.

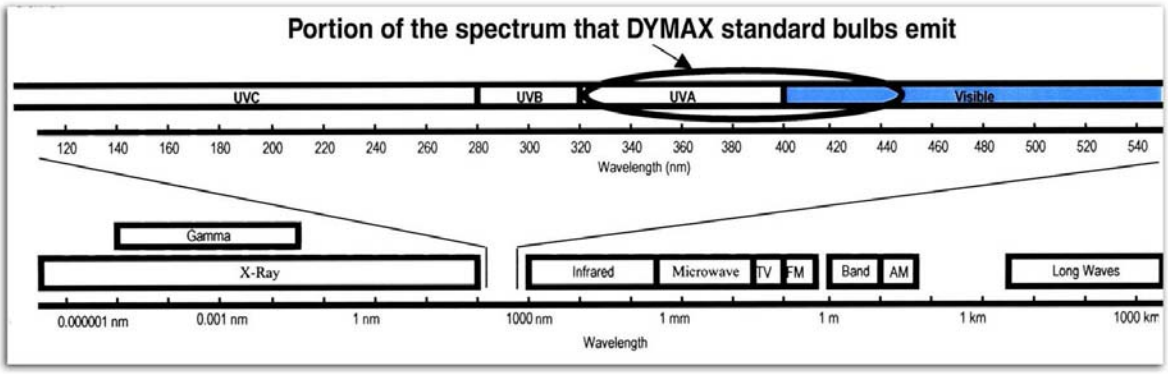
Limited Depth of Cure – Since light curing materials themselves absorb light, each has a maximum depth of cure. For most DYMAX products, this depth is between 6.3 mm and 12.7 mm.

Determining Complete Cure – Changing from a liquid to a solid is a simple definition of cure. A more complete definition is that curing is complete when further light exposure no longer improves product properties. Quantitative testing of cured specimens can be used to determine the minimum exposure time and/or minimum intensity required for complete cure. The graph on Page 17 shows how this method could be used in a bonding application.

Shadows – Light curing materials will not cure unless exposed to light of appropriate wavelength, intensity, and duration. Some DYMAX light curing materials can be cured with heat in "shadowed " areas.

Oxygen Inhibition - In some cases, UV adhesive surfaces exposed to oxygen during curing may remain tacky after cure. This is caused by oxygen inhibition. Oxygen in the air actually slows the cure at the top most layer of an air exposed coating surface. This tackiness does not necessarily indicate incomplete cure and can be observed with some materials, even after complete cure. In general, there are four ways to minimize or eliminate the tackiness associated with oxygen inhibition:

- *Longer and/or Higher Intensity Cure - In many cases, curing longer or with higher intensity will minimize or eliminate a tacky surface.*
- *Use of "Shortwave" Bulb - Use of a UVB (shortwave) bulb instead of a UVA (longwave) bulb may also help to eliminate surface tack. A UVB bulb may, however, result in a limited depth of cure.*
- *Choose an Alternate DYMAX Material – An alternate formulation may cure "tack-free" more readily.*
- *Blanket with Inert Gas - Blanketing exposed resin surfaces with inert gas (like nitrogen or argon) during cure can often eliminate the problem of oxygen inhibition completely.*



DESIGNING a UV LIGHT CURING PROCESS

There are several factors to consider when designing a UV curing process.

Intensity – A well designed UV light curing process incorporates a curing system with excess intensity. Excess intensity provides both a safety margin and long bulb life. See page 17 "*Setting-Up and Monitoring a Light Curing Process*" for specific intensity and safety margin guidelines.

Spectral Output – It is important to match the spectral output of the lamp to the material and application. DYMAX supplies both shortwave bulbs (also called Mercury or "H") and longwave bulbs (also called Metal Halide or "D" bulbs). In general, longwave bulbs emit primarily UVA providing superior depth of cure, while shortwave bulbs emit primarily UVB/UVC providing superior surface cure for coatings and inks. Longwave bulbs are recommended for most applications involving DYMAX materials.

Curing Area – The size of the area to be cured may dictate which type of lamp is appropriate. Spot lamps are typically used to cure areas less than 12 mm in diameter. Flood or focused-beam lamps are used when curing large areas (up to 20 cm x 20 cm). Multiple flood lamps or conveyors can be used to cure even larger areas.

Avoid Creating a "Bottleneck" – Ideally, the UV curing process is designed to be faster than the limiting or "bottleneck" step in the overall manufacturing process. Dispensing, assembling, testing, or packaging parts while other parts are curing, will maximize efficiency.

Curing Multiple Parts Simultaneously– In some cases, it is more efficient to cure many small parts simultaneously using a flood or conveyor than to cure each part individually. For example, a spot may cure one small part every 3 seconds (or 20 parts per minute) whereas a flood lamp may cure 20 small parts every 15 seconds (or 80 parts per minute).

Multiple Cure Stations – On an automated production line where the required cure time exceeds the index/cycle time, multiple cure stations can be used. For example, if a part requires 9 seconds to cure and the index/cycle time is only 3 seconds, each part can be cured for 3 seconds beneath 3 separate lamps. Brief interruptions during cure are acceptable.

Safety - Proper equipment set-up and operator training are the keys to developing a safe light curing process. Always follow the operation manual to ensure safe installation. Proper shielding, protective equipment and eye protection are required to ensure a safe UV curing process.

Power Supply **-** The DYMAX light curing systems are outfitted with either a transformer-based or auto-switching power supply. A transformer-based power supply is voltage sensitive, i.e. lower voltage produces lower intensity (or even failed ignition). An auto-switching power supply adjusts for variations in voltage, providing a more consistent intensity. The transformer-based units are only recommended where line voltages are as follows:

- *Consistently ≥230V (for 230V units) or ≥115V (for 115V units) for transformer-based spot lamps*
- *Consistently ≥110V (for 120V units) for transformer-based flood lamps*

Controls - Unless exposed to light of sufficient wavelength, intensity, and duration, most light curing materials will remain uncured. To insure a consistent exposure time, timed shutters are standard on spot lamps and available for most flood and focused-beam systems.

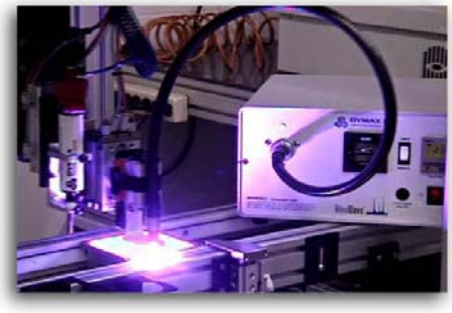
Lamp intensity should be regularly monitored with a radiometer. Bulb replacement and/or appropriate lamp maintenance should be conducted when intensity dips below a pre-determined minimum value.

Bulb Life – The cost of replacement parts can be an important consideration when selecting a light curing system. Generally, low bulb replacement costs are achieved by selecting a lamp with intensity to spare, thereby extending allowable bulb life.

price per bulb x frequency = bulb replacement cost

UV SPOT LAMP SYSTEMS

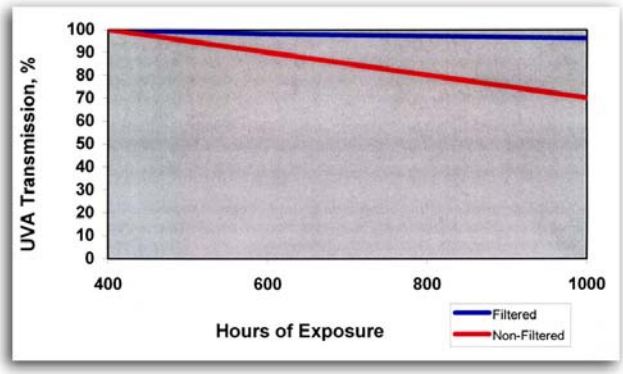
UV spot lamp systems offer higher intensities and therefore faster cures than any other type of UV curing lamp, but only over an area of 12 mm diameter or less. As shown in the diagram below, intensity and curing area vary dramatically with distance from the lightguide. All DYMAX UV spot units described in this guide offer integral shutters and proprietary "Cool Blue™ Filters" that virtually eliminate liquid lightguide degradation common in other UV spot lamps. DYMAX provides two standard UV curing spot lamps. These units vary in intensity, bulb life and PLC (Programmable Logic Controller) integration. All DYMAX UV spot lamps can be outfitted with a wide range of lightguides.

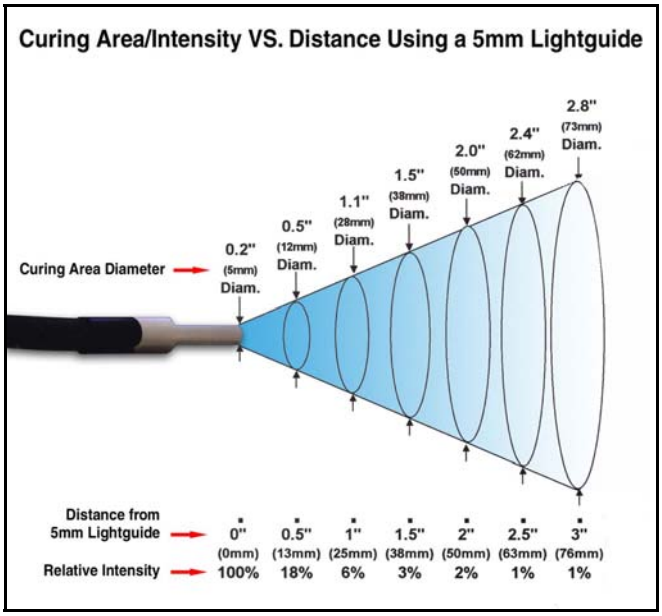


DYMAX UV Spot Lamps are Ideal for Automation!

COOL BLUE™ FILTER TECHNOLOGY

The unique and proprietary "Cool Blue™ Filter" technology virtually eliminates liquid lightguide degradation. This filter, located between the bulb and lightguide, filters out wavelengths below 320 nm and IR that would otherwise degrade the liquid-filled lightguides. The following diagram shows the benefit of the "Cool Blue™ Filter" technology, which is designed to last the lifetime of DYMAX UV spot lamp systems.



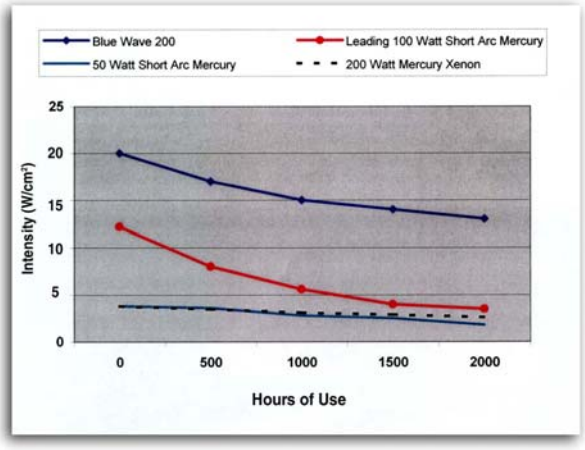


DYMAX BLUEWAVE™ 200

With over 18,000 mW/cm² of effective UVA curing power, the Blue Wave™ 200 is one of the most powerful UV spot curing systems in the industry. Cure times of 0.5 to 5 seconds are typical. An integrated shutter insures that light is only emitted as needed. An auto-switching power supply insures proper operation despite potential variations in input voltage.

The integrated shutter can be operated in manual or timed mode and can be actuated by either a foot pedal or PLC. The BlueWave™ 200 seamlessly integrates with a PLC providing output signals for the status of the bulb (lit, not lit, replace) and the status of the shutter (open, closed, fault).

DYMAX BlueWave™ 200



Bulb degradation curve (continuous operation) for BlueWave™ 200 and competitive lamps

BlueWave™ 200 Spot Curing System	
Part Number	***38905***
Peak Intensity	*18,000 mW/cm² (320-395 nm) using a 5 mm single pole lightguide*
Curing Area	*Up to 12 mm diameter*
Shutter	*Timed and manual modes; foot pedal or PLC controlled*
Bulb Life	*2,000 hours*
Power Requirements	*Auto-switching, 90-265 VAC, 47-63 Hz*

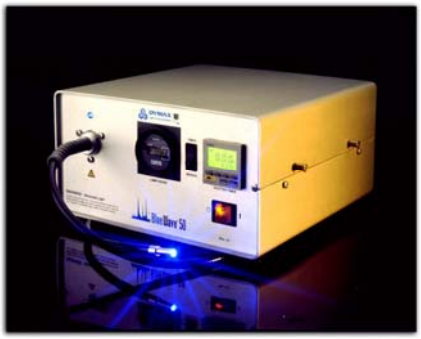
Single and Multi-Pole Liquid Lightguide Performance of the BlueWave™ 200 Spot Curing System

Number of Poles	Lightguide Description	UVA Intensity with BlueWave™ 200			% Intensity Exiting Lightguide**	Part Number
		Initial Intensity (W/cm²)	1,000 Hours* (W/cm²)	2,000 Hours* (W/cm²)		
1	5 mm x 120 mm, Simulator	20	14	12	100%	38408
1	5 mm x 1000 mm	18	12.6	10	90%	5720
1	5 mm x 1500 mm	16	11.2	9.6	80%	5721
1	8 mm x 1000 mm	13	9.1	5.2	65%	5722
2	2 x 3 mm x 1000 mm	10.5	7	6	50%	38476
3	3 x 3 mm x 1000 mm	9	6.3	5.4	45%	38477
4	4 x 3 mm x 1000 mm	7.4	5.5	4.4	37%	38478

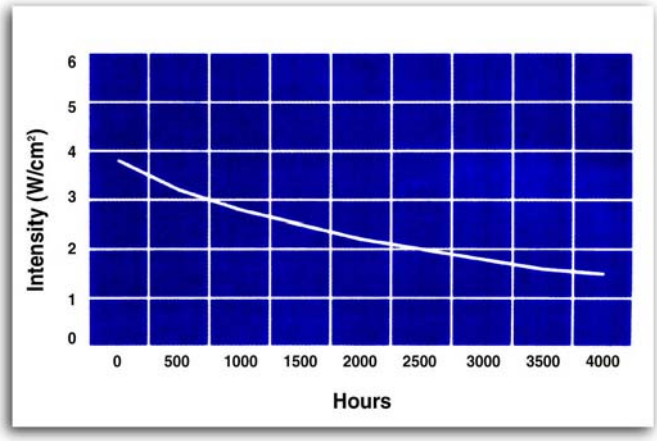
**Continuous operation*
***Measured in W/cm² using a DYMAX ACCU-CAL 20 Radiometer*

DYMAX BLUEWAVE™ 50

As its name suggests, the BlueWave™ 50 is essentially a lower intensity version of the BlueWave™ 200 (without the PLC output signals). With a peak intensity of over 3,000 mW/cm² (UVA), the BlueWave™ 50 is a powerful spot curing system. One to ten second cures are typical. The foot pedal actuated manual shutter mechanism insures light is emitted only as needed.



BlueWave™ 50	
Part Number	***38901*** *– 230V* ***38860*** *– 115V*
Peak Intensity	*3,000 mW/cm² (using a 5 mm single pole lightguide)*
Curing Area	*Up to 12 mm diameter*
Shutter	*Timed and manual modes; foot pedal*
Bulb Life	*Warranted for 2,000 hours*
Power Requirements	*Transformer, 230V/50 Hz or 115V/60 Hz*



Bulb Degradation curve (continuous operation) for the BlueWave™ 50

LIGHTGUIDES

Lightguides transmit UV and visible light from a bulb mounted inside of a spot curing light source to the curing area. There are several factors to consider when choosing a lightguide.

Diameter – Single pole lightguides are available with 3 mm, 5 mm or 8 mm inside diameters. Although the 5mm lightguide will register a higher intensity, the 8 mm lightguide provides more curing power (intensity x area). An 8 mm lightguide provides more curing power because a larger lightguide opening captures more of the light emitted from the bulb. Each pole of a multi-pole lightguide has an inside diameter of 3 mm.

Multiple Poles – Light emitting from a spot lamp can be channeled through a single lightguide (single pole) or split between multiple light guides (multiple poles). Each pole of a multi-pole lightguide emits equal intensity (typically ± 10% for liquid-filled lightguides) and all share a common shutter. Both liquid filled and quartz fiber multi-pole lightguides are available from DYMAX.

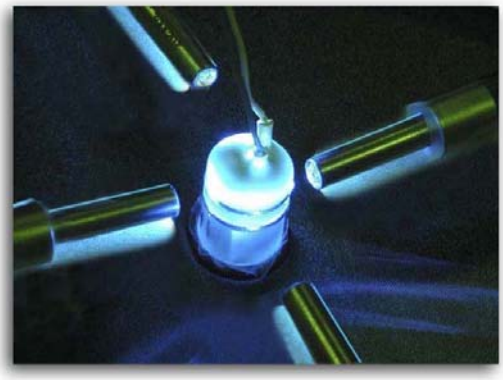
Common Lightguides *(poles x diameter x length)*	**Part Number**
1 x 5 mm x 1000 mm standard range, liquid filled	**5720**
1 x 8 mm x 1000 mm standard range, liquid filled	**5722**
2 x 3 mm x 1000 mm standard range, liquid filled	**38476**
3 x 3 mm x 1000 mm standard range, liquid filled	**38477**
4 x 3 mm x 1000 mm standard range, liquid filled	**38478**

Connection – There are basically two types of connectors used in the spot lamp industry, "Wolf" and "D" connectors. DYMAX provides lightguides with both connector types, although "D" connectors are an industry standard and compatible with current DYMAX lamp designs (older DYMAX designs utilized "Wolf" connectors).

Liquid-Filled and Extended-Range – Liquid-filled lightguides are the most common and cost effective lightguides on the market. Liquid-filled lightguides achieve transmission rates >90% for UVA and blue visible light, the regions typically required to cure UV adhesives, sealants, and coatings. UVB, UVC, and IR will quickly degrade a standard liquid-filled lightguide. DYMAX spot lamps include a proprietary filter between the bulb and lightguide that filters out these wavelengths, virtually eliminating liquid lightguide degradation. In rare cases where UVB, UVC, and IR wavelengths are desired, extended range liquid-filled lightguides that can better withstand UVB, UVC, and IR are available.

Quartz Fiber – Although they generally provide lower UV transmission rates, quartz fiber lightguides can provide more uniform intensity across multi-pole lightguides due to bundle randomization. Repeated bending of quartz fiber lightguides can degrade their performance. Quart fiber lightguides can be special ordered through DYMAX.

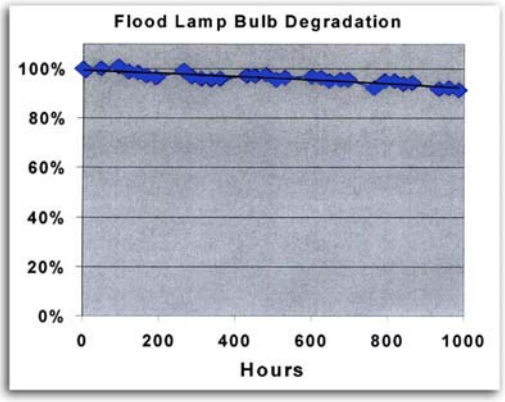
Length – Lightguides are commonly one meter long although longer and shorter lightguides are available.



UV FLOOD SYSTEMS

DYMAX UV flood curing systems are ideal for curing large parts or curing many small parts simultaneously. With intensities ranging from 75 to 225 mW/cm^2, DYMAX flood lamps are capable of curing most UV curing adhesives, sealants, and coatings, tack-free in 30 seconds or less. These flood lamps can be incorporated into automated assembly systems or mounted onto conveyors. DYMAX flood lamps can also be used as turnkey benchtop units (with optional shutters.)

20 cm x 20 cm Curing Area	12 cm x 12 cm Curing Area	
		
2000-PC Modular – 75 mW/cm^2 Shown with optional shutter and light shield **PN 38105**	5000-PC Modular – 225 mW/cm^2 Shown with optional shutter and light shield **PN 38100**	DYMAX PC-400 Flood Lamp provides UV and visible light curing of smaller assemblies, consistently and safely. Suitable for visible light curing dental resins.



The intensity generated by DYMAX flood systems is very consistent. With continuous use, bulb degradation of less than 20% over the first 1,000 hours is typical. On/off cycles will accelerate bulb degradation.

UV FLOOD SYSTEM SHIELDING and SHUTTERS

The 5000-PC and 2000-PC flood lamps can be outfitted with shutters and enclosures.

SHUTTERS

Turning a bulb off and on between cycles is not practical since each off/on cycle shortens bulb life and requires a 3 to 5 minute warm-up period. A shutter, however, can be used to shield a flood system between cycles. Shutters control exposure time, reduce heat on the work surface, and shield operators from exposure to UV light. There are two types of shutters pictured below. Both manual and pneumatic shutters are compatible with 2000-PC and 5000-PC flood lamps.

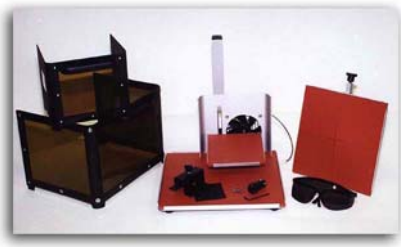
Pneumatic Shutter – Timed and manual modes. Foot pedal or PLC controlled. Requires 1.4 - 5.5 bar air. **PN 37861**

Manual Shutter – Most cost-effective shutter system. **PN 35572**

SHIELDING

DYMAX offers two standard shielding options for 2000-PC and 5000-PC flood lamps; the Light Shield, and the mounting stand kit shown below. Both shields are 100% UVA blocking and visibly tinted. Distance from the lamp to the curing surface is adjustable in both shielding systems.

Light Shield – 360° shielding with lifting door and sliding curing shelf. Compatible with DYMAX shutters. **PN 38125**



Mounting Stand Kits – Cost-effective, 3-sided shielding. Not compatible with DYMAX shutters.

PN 38290 – 2000-PC Mounting Stand Kit
PN 38289 – 5000-PC Mounting Stand Kit

UV CURING CONVEYORS

The standard DYMAX conveyor platform, the UVC series, has a belt width of 12 or 20 cm and can be outfitted with different UV curing systems.

The DYMAX UVC-8 Conveyor System is equipped with a 200 mm wide belt made of Teflon® and comes with 1 to 2 UV medium pressure bulbs (2000 W) and/or an IR-field. The distance between the bulb and the belt can be manually adjusted (between 70-120 mm) as well as the belt speed (1-15 m/min). Optional reflectors for curing material dispensed on temperature sensitive substrates are also available.

DYMAX UVC-8

Specifications		*Dimensions*	
Light Source	1-2x 2000 W	Length	2400 mm
VAC	380 V	Height	700 mm
Power	8 kW	Width	1100 mm

The DYMAX UVC-5 Conveyor System is equipped with a 120 mm wide belt. Curing time can be adjusted by changing the belt speed from 0.1 to 11 meters per minute. Unlike the UVC-8, the power supply was separated from the belt and the mounted UV-lamp, to create a minimal set-up area.

DYMAX UVC-5

Specifications		*Dimensions*	
Light Source	850 W	Length	800 mm
VAC	230 V	Height	280 mm
Power	1,4 kW	Width	240 mm

ADVANTAGES OF DYMAX UV CURING CONVEYORS

- *Fast cure for high throughput*
- *Dependable, heavy-duty conveyor design*
- *Fully shielded lamp enclosures*
- *Qualified technical support*

Additional Conveyors

Looking for a wider conveyor, shorter conveyor, or one with more clearance? Additional information upon request.

RADIOMETERS

A radiometer is a device that measures the intensity and/or energy associated with light of specified wavelengths. UV light is, by definition, not visible and so a radiometer is required to determine UV intensity. DYMAX offers the ACCU-CAL 20 radiometer for UV spot lamps and the ACCU-CAL™ 30 for spots, floods, and conveyors. The ability to measure light intensity is useful for three reasons:

1. ***Maintaining a light curing process*** *- A radiometer can measure whether a light curing system is providing intensity above the "bulb change" intensity. A radiometer is to a light curing process what a thermometer is to a heat curing process.*
2. ***Providing a worker friendly light curing process*** *– A radiometer can be used to determine if any UV light is reaching operators or bystanders.*
3. ***Measuring transmission rates through substrates*** *– A radiometer can be used to measure the transmission rates of various wavelengths through substrates that absorbs UV and/or visible light. To assure an effective curing process it is critical to measure the light intensity reaching the resin below the intervening substrate.*

ACCU-CAL 20 RADIOMETER

The ACCU-CAL 20 is an easy to use radiometer designed for intermittent readings of spot cure systems. The ACCU-CAL 20 measures UVA intensity emitting from 3 mm, 5 mm, and 8 mm lightguides. To use, simply insert the lightguide, press "Start" once, and an LCD displays the intensity in W/cm^2.

ACCU-CAL 20 Radiometer
The ACCU-CAL 20 should be recalibrated every six months.

ACCU-CAL 20 RADIOMETER	
Part Number	***38970***
Measures	*Intensity (W/cm^2); 320-395 nm (UVA)*
Intensity	*0-35 W/cm^2*
Resolution	*0.1 W/cm^2*
Battery Life	*12,500 Hours*

ACCU-CAL™ 30 RADIOMETER

DYMAX's ACCU-CAL™ 30 is capable of measuring both the light intensity (mW/cm^2) and energy (J/cm^2) emitted from spot lamps*, flood lamps, focused-beam lamps, and conveyors.

ACCU-CAL™ 30 Radiometer
The ACCU-CAL™ 30 should be recalibrated every 6 months.

ACCU-CAL™ 30 RADIOMETER	
Part Number	***38301*** *– UVA; compatible with all lamps except spot lamps** ***38302*** *– UVA; compatible with all lamps; includes lightguide simulator and*
Measures	*Intensity (W/cm^2); 320-395 nm (UVA)*
Intensity	*0-40 W/cm^2*
Resolution	*0.001 W/cm^2*
Battery Life	*100 Hours*

**Part #38302 includes lightguide attachments, part #38301 does not*

UV SAFETY

DYMAX ultraviolet curing technology has been used successfully for over 25 years. The fast cure, one component nature of our UV curing technology has made it the process of choice for many manufacturers requiring a Cure on Demand™ assembly process. There are three common questions/concerns related to UV curing systems: UV exposure, ozone, and bright visible light.

UV EXPOSURE

Standard DYMAX UV curing systems and bulbs have been designed to primarily emit UVA light[1]. UVA light is generally considered the safest of the three UV ranges: UVA, UVB, and UVC. Although OSHA does not currently regulate ultraviolet light exposure in the workplace, the American Conference of Governmental Industrial Hygienists (ACGIH) does recommend Threshold Limit Values (TLV's) for ultraviolet light. The strictest interpretation of the TLV (over the UVA range) for workers' eyes and skin is 1 mW/cm^2 (intensity), continuous exposure. Unless workers are placing bare hands into the curing area, it is unusual to exceed these limits. To put 1 mW/cm^2 limit into perspective, cloudless summer days regularly exceed 3 mW/cm^2 of UVA light and also include the more dangerous UVB light (primarily responsible for sun burns) as well.

The human eye can not detect "pure" UV light, only visible light. A radiometer should be used to measure stray UV light to confirm the safety of a UV curing process. A workstation that exposes an operator to more than 1 mW/cm^2 of UVA continuously should be redesigned. UV adhesive curing can be a regulatory compliant, "worker-friendly" manufacturing process when the proper safety equipment and operator training is utilized. There are two ways to protect operators from UV exposure: Shield the operator and/or shield the source.

SHIELDING THE OPERATOR

- ***UV-Blocking Eye Protection*** – *UV-blocking eye protection is recommended when operating UV curing systems.*
- ***UV-Blocking Skin Protection*** – *Where the potential exists for UV exposure upon skin, opaque, UV-blocking clothing, gloves, and full-face shields are recommended.*

SHIELDING THE SOURCE OF UV

Any substrate that blocks UV light can be used as a shield to protect workers from stray UV light. The following materials can be used to create simple shielding structures or blind corners:

- ***Sheet Metal*** – *Aluminum, steel, stainless steel, etc. Sheet metal should be coated black or black anodized to minimize reflection of UV and visible light.*
- ***Rigid Plastic Film*** – *Transparent, UV-blocking plastics (typically polycarbonate or acrylic) are commonly used to create shielding where transparency is also desired. These rigid plastic films are available either water-clear or tinted, (to reduce visible light glare).*
- ***Flexible Film*** – *UV-blocking, flexible urethane films can be used to quickly create workstation shielding. This UV-blocking, flexible urethane film is available from DYMAX.*

OZONE

Standard DYMAX bulbs (UVA type) generate an insignificant amount of UVC and therefore essentially no ozone[1]. Some UV curing systems, like those used to cure UV inks, emit primarily "shortwave" (UVB and UVC) energy. Upon exposure to UVC light (specifically <240 nm), oxygen molecules (O_2) split into oxygen atoms (O) and recombine with O_2 to create Ozone (O_3). The current, long-term ozone concentration limit recommended by ACGIH, NIOSH, and OSHA is 0.1 ppm (0.2mg/m^3).

BRIGHT, VISIBLE LIGHT

The bright, visible light emitted by some UV curing systems may be objectionable to some workers and may cause eyestrain. Tinted eye protection and/or opaque/tinted shielding can be utilized to address this concern.

SUMMARY

UV light sources can be more "worker friendly" than many commonly accepted industrial processes, provided the potential concerns are addressed. Contact your DYMAX representative for information regarding the proper use of DYMAX UV curing systems.

Tinted UV Protecting Eye Glasses
PN 35614

[1]DYMAX also provides special order "shortwave" bulbs that emit primarily UVB and UVC light. Contact DYMAX directly for information regarding the use of "shortwave" bulbs.

SETTING UP AND MONITORING A LIGHT CURING PROCESS

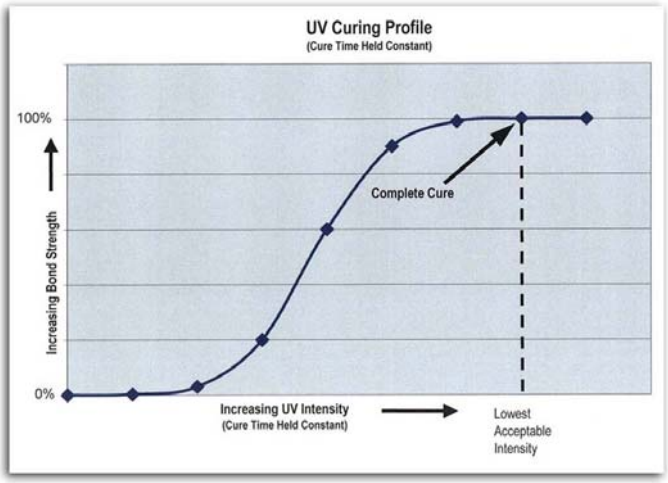
There are two parameters that must be considered to insure a successful light curing process, 1) intensity at the curing location and 2) cure time. DYMAX recommends setting up and monitoring a UV light curing process as follows:

1. ***Choose a light curing material (LCM)*** - Select an LCM that satisfies the performance of the application.
2. ***Determine available cure time*** – Determine the cure time available so that the UV curing process is not a "bottleneck" in the manufacturing process. For example, if dispensing and assembly requires 12 seconds per part in a one piece flow process, the maximum available cure time is 12 seconds. For UV curing conveyor, determine the minimum line speed required.
3. ***Choose a light curing system*** - Choose the appropriate light curing system that will fully cure the LCM within the cure time available. DYMAX Technical Service can help you identify the best light curing system for a specific application.
4. ***Determine the lowest acceptable intensity*** – The lowest acceptable intensity is that which fully cures the resin in the available cure time (determined above). The lowest acceptable intensity can be determined through quantitative testing of parts cured at various intensities as shown in the diagram to the right. In the case of a focused-beam lamp on a conveyor, determine the lowest acceptable energy‡, not intensity.

   The following techniques may be used to artificially modify intensity to facilitate determining the lowest acceptable intensity.

   - ***Increase distance*** – *Since light emitting from light curing lamps diverges, the intensity decreases as the distance from the lamp increases.*
   - ***Utilize an old bulb*** – *When increasing intensity is not practical, older bulbs can be used. As with any manufacturing process, it is advisable to operate with a safety factor. DYMAX recommends a "bulb change" intensity above the "lowest acceptable intensity."*
5. ***Monitor and maintain intensity*** – Using a radiometer, monitor the UV light intensity at the bond line. If the intensity reaches the "bulb change" intensity, install a new bulb or conduct appropriate maintenance (see Page 18 *Maximizing Lamp Performance*). In the case of a conveyor, curing energy (not intensity) should be monitored.

If the resulting cure process is causing heat damage, a cooling fan or shorter cure time is recommended. If the resulting bulb life is too short, a longer cure time or higher intensity lamp is recommended.



‡Both residence time and intensity varies with lamp height on conveyors with focused-beam lamps. For this reason, it is better to monitor energy (J/cm²) on these systems than intensity. The most practical way to artificially lower the energy on these systems is to adjust the line speed.

MAXIMIZING LAMP PERFORMANCE

There are three ways to maximize lamp performance…

1. ***Proper Set-Up*** – The first key to maximizing lamp performance is proper set-up. Reference the operation manual provided with each DYMAX lamp for instructions on proper set-up. After ignition, wait 3-5 minutes before use to allow the lamp to reach full intensity. Then, use the following techniques to maximize intensity at the curing location.

   - ***Spot Cure Systems*** – *Maximize curing intensity by minimizing distance from the end of the lightguide to the light curing material, while still covering the curing area. Positive airflow can prevent those vapors commonly emitted during cure from condensing on the end of a lightguide. Be aware that excessive bending, clamping or set screw tightening can damage lightguides. The minimum bend radii for standard lightguide diameters are as follows:*
     - *3 mm lightguides – 40 mm bend radius*
     - *5 mm lightguides – 60 mm bend radius*
     - *8 mm lightguides – 100 mm bend radius*
   - ***Flood Lamps*** – *Minimize distance from the bottom of the flood housing to the light curing material. Note that distances 76 mm or more from the lamp housing provide the most uniform intensity across the curing area.*
   - ***Focused-Beam Lamps*** – *Place light curing material at the focal point of the focused-beam lamp for maximum intensity.*

2. ***Optimizing Bulb Life*** – The intensity of light being emitted from UV bulbs gradually decreases with usage. This degradation cannot be avoided, but it can be minimized through proper operation.

   The longest bulb life is obtained by simply using the lamp continuously (not turning it off). The more often the lamp is cycled on and off, the more quickly the bulbs degrade. The general rule of thumb is to leave the lamp on if it will be used again within four hours.

   Once ignited do not turn the lamp off for at least 5 minutes. Turning the lamp off before it has reached its operating temperature can damage the bulb.

3. ***Proper Maintenance*** – As with all production equipment, routine maintenance will optimize performance. In the case of a spot lamp, keep the end of the light guide clean and replace it if it no longer transmits enough light (a light guide simulator is available from DYMAX to help determine light guide transmission). See *Lit#069 Light Guide Simulator* for more information on lightguide and bulb maintenance. In the case of a flood lamp, the reflector and lamp base (sockets that the bulb fit into) should be cleaned and/or replaced as necessary. Please refer to the Operation Manual for each lamp for further guidance on proper maintenance.

DYMAX RENTAL PROGRAM

The DYMAX Equipment Rental Program provides the opportunity to evaluate the benefits of light curing technology in-house. Rental fees are deducted from the cost at purchase. Customer pays the shipping both ways. Contact your DYMAX representative.

DYMAX Corporation is an ISO Certified manufacturing company whose corporate and production facilities are located in Torrington, CT, USA. Approximately 50% of corporate sales are in countries outside of the US. The Company operates wholly owned subsidiaries in Frankfurt Germany, Changzhou China and Hong Kong. Field service is provided by an international group of factory Sales Engineers, Manufacturers Representatives, and Specialty Distributors.

For further assistance with adhesive and equipment selection, contact your DYMAX Technical Service Representative.

Call: +49-69-7165-3568

OR

Visit DYMAX at:

www.dymax.com/products/curing_equipment/curing_systems.asp

Please note that most dispensing and curing system applications are unique. DYMAX does not warrant the fitness of the product for the intended application. Any warranty applicable to the product, its application and use is strictly limited to that contained in DYMAX's standard Conditions of Sale. DYMAX recommends that any intended application be evaluated and tested by the user to insure that desired performance criteria are satisfied. DYMAX is willing to assist users in their performance testing and evaluation by offering equipment trial rental and leasing programs to assist in such testing and evaluation. Data sheets are available for valve controllers or pressure pots upon request.

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