INFRARED

LUXEON IR Domed Line

Assembly and Handling Guidelines

Introduction

This application brief addresses the recommended assembly and handling guidelines for LUXEON IR Domed emitters. Proper assembly and handling, as outlined in this application brief, ensures high optical output and long light output maintenance of LUXEON IR Domed emitters.

Scope

The assembly and handling guidelines in this application brief apply to the following products:

L 1 I 0 – 0 A A A B B B X X X X X X	
Where:	
A A A	– designates nominal peak wavelength
B B B	– designates full width half maximum of the emitter's radiation pattern
X X X X X X	– reserved for further customization

In the remainder of this document, the term LUXEON emitter refers to any product in the LUXEON IR Domed Line.

Table of Contents

1. Component

1.1 Description

The LUXEON IR Domed emitter consists of a high power LED chip mounted onto a ceramic substrate, which is encapsulated in silicone (see Figure 1) to protect the underlying chips. The ceramic substrate provides mechanical support and thermally connects the LED chip to the bottom pads. A transient voltage suppressor (TVS) chip is added to all LUXEON IR Domed products to protect against ESD events.

The bottom of the LUXEON IR Domed LED contains three metallization pads (gold finish), two anodes including a large thermal pad in the center and a cathode. The cathode pad can be easily identified by the cathode reference marker shown in Figure 1.

The LUXEON IR Domed LED is designed to be compatible with a standard surface mount technology (SMT) process.

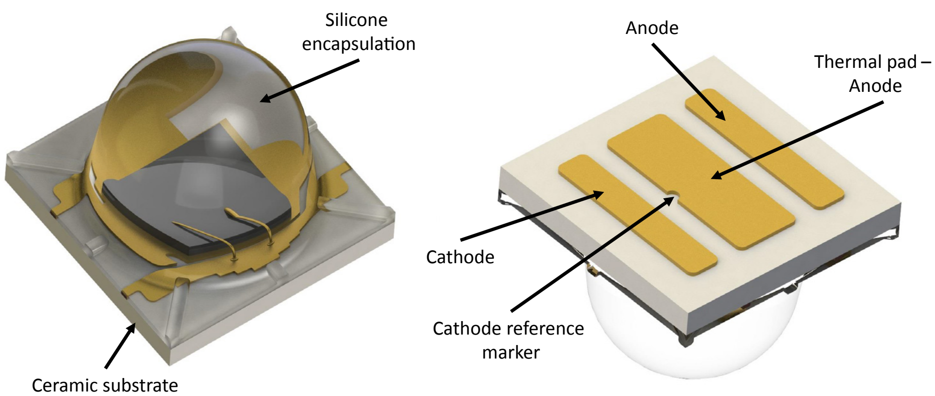

Figure 1. Image rendering of a LUXEON IR Domed LED.

1.2 Optical Center

The theoretical optical center of the LUXEON IR Domed emitter coincides with the mechanical center of the package (see Figure 2).

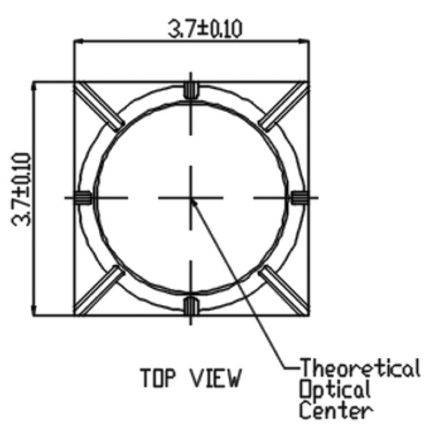

Figure 2. Optical center (all dimensions are in millimeters).

Optical rayset files for the LUXEON IR Domed Line are available at lumileds.com.

1.3 Handling Precautions

LUXEON IR Domed emitters are designed to maximize light output and reliability. However, improper handling may damage the silicone dome of the emitter and can affect its overall performance and reliability. In order to minimize the risk of damage to the silicone dome during handling, LUXEON IR Domed emitters should only be picked up from the side of the ceramic frame as illustrated in Figure 3.

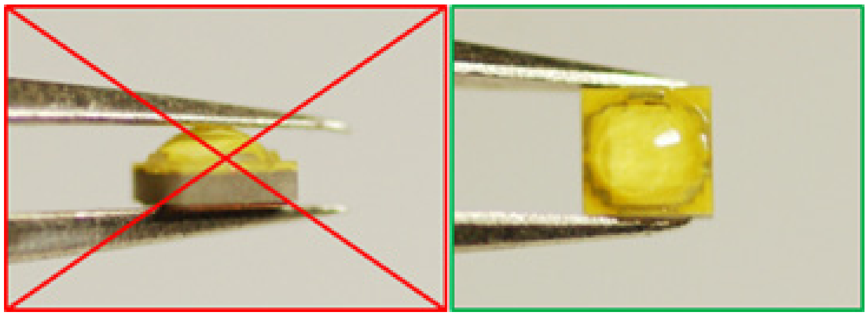

Figure 3. Incorrect handling (left) and correct handling (right) of a domed LED package.

Assembled boards must not be stacked on top of each other or placed upside down on any surface to avoid damaging the dome (see Figure 4).

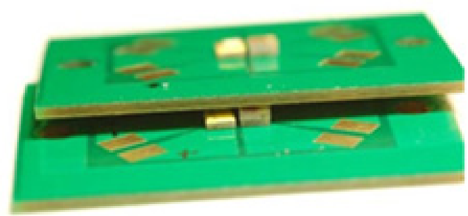

Figure 4. Boards that have LUXEON emitters on them should not be stacked on top of each other.

1.4 Cleaning

LUXEON IR Domed emitters should not be exposed to dust and debris. Excessive dust and debris may cause a drastic decrease in optical output. In the event that a LUXEON emitter requires cleaning, a compressed gas duster at a distance of 6” away will be sufficient to remove the dust and debris or a clean air gun with 20 psi (at nozzle) from a distance of 6” will also work. Make sure the parts are secured first.

In the event that a LUXEON emitter dome requires additional cleaning, try gently swabbing using a lint-free swab. If needed, a lint-free swab and isopropyl alcohol (IPA) can be used to gently remove stubborn dirt from the lens. Be careful that the dirt to be removed does not scratch the dome. Do not use any other solvents as they may adversely affect the LED assembly. For more information regarding chemical compatibility, see section 4.

It is safe to clean LUXEON IR Domed emitters with deionized water (DI). Using municipal or city water may introduce other contaminants that may adversely affect the LED assembly.

1.5 Electrical Isolation

In order to avoid any electrical shock and/or damage to the LUXEON emitter, each PCB design needs to comply with the appropriate standards of safety and isolation distances, known as clearance and creepage distances, respectively (e.g. IEC 60950-1 ed.2.2, clause 2.10.4).

For more information about circuit board design to protect LED emitters during electrical overstress or electrical transient, please review Lumileds document AB06, "Circuit Design and Layout Practices to Minimize Electrical Stress."

1.6 Polarity Identification

To identify the polarity from the top view of the LUXEON IR Domed emitter, see Figure 5.

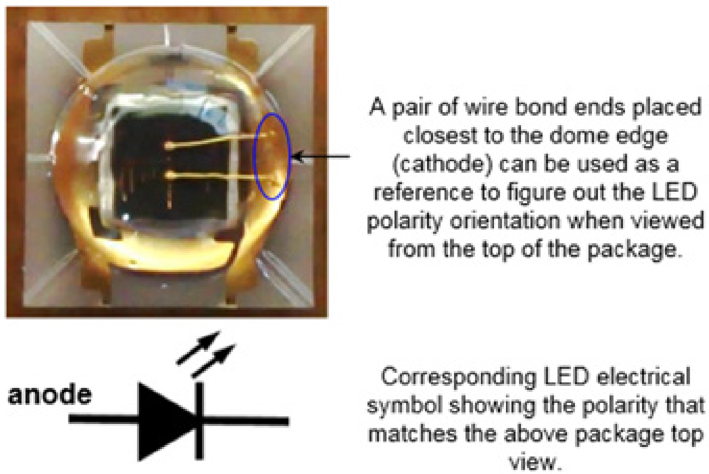

Figure 5. Polarity identification of the LUXEON IR Domed LED when viewed from the top.

1.7 Mechanical Files

CAD drawings (3D STEP file) for the LUXEON IR Domed Line are available at lumileds.com.

2. Printed Circuit Board Design

LUXEON IR Domed Line is engineered to be surface mounted onto a ceramic, metal-core PCB (MCPCB) or FR-4/CEM-3 substrate. To ensure optimal operation of the LUXEON IR Domed emitters, the PCB should be designed to minimize the overall thermal resistance between the LED package and the heatsink.

2.1 Footprint and Land Pattern

The recommended PCB footprint and stencil pattern for the LUXEON IR Domed Line is shown in Figure 6.

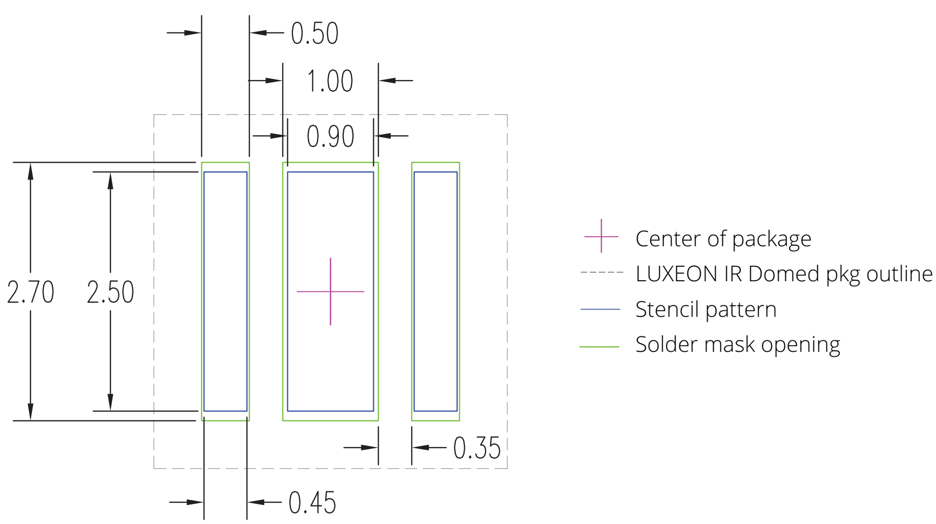

Figure 6. PCB footprint for the LUXEON IR Domed Line (all dimensions are in millimeters).

2.2 Surface Finishing

Lumileds recommends using electroless nickel immersion gold (ENIG) or high temperature organic solderability preservative (OSP) on the exposed copper pads of the PCB to protect the pads from oxidation prior to reflow. Hot air solder leveling (HASL) should not be used because it yields poor co-planarity (leveling) and is, therefore, not suitable for assembly of small pad devices such as the LUXEON IR Domed emitter.

2.3 Solder Mask

A stable white solder mask finish (typically a polymer compound with inert reflective filler) with high reflectivity in the spectrum range of interest will typically meet most application needs; the white finish should not discolor over time. Customers are encouraged to work with their PCB suppliers to determine the most suitable solder mask options that meet their application needs. It is important to note that the thickness of the solder mask will have an impact on the overall solder paste thickness. Lumileds has positive performance testing results for the Taiyo PSR-4000 LEW3 white solder mask.

2.4 Silkscreen (Ink) Printing

Ink markings within and around the LUXEON IR Domed emitter outline should be avoided because the height of the ink may impact the alignment accuracy of the solder stencil (solder paste) printing process and/or may interfere with the ability of the LUXEON emitter to self-align during reflow. If needed, the ink printing should be at least 1mm away from the emitter outline.

2.5 PCB Substrate Selection and Design Consideration

A summary of various relevant performance characteristics of common PCB substrates to aid material selection is shown in Table 1 below.

Table 1. General PCB substrate characteristics for consideration when designing a PCB for the LUXEON IR Domed Line.

SUBSTRATE	FR-4/CEM-3	MCPCB	CERAMIC PCB
Cost	Low to Medium	Medium	High
PCB thermal conductivity performance	Very low to medium for filled and capped vias	Medium to excellent	High to excellent
Coefficient of thermal expansion (CTE)	Good CTE matching with LUXEON emitter	Moderate CTE matching with LUXEON emitter	Good CTE matching with LUXEON emitter
LED assembly packing density (thermal resistance consideration)	Suitable for low density applications with large spacing between LEDs and/or low operating current	Suitable for medium density applications with moderate spacing between LEDs	Suitable for high density applications with minimal spacing between LEDs
Mechanical assembly and handling	Easy, as board does not easily break	Easy, as board does not easily break	Extra precaution to prevent ceramic breakage (hard and brittle)
Supplier availability	High	High	Limited

Note: Specific PCB design considerations for each substrate material are summarized below.

Metal Core PCB

The most common MCPCB construction consists of the following layers (see Figure 7):

- *A metal substrate, typically aluminum.* In some applications, a copper substrate may be more appropriate due to its higher thermal conductivity than aluminum (401 $Wm^{-1}K^{-1}$ versus 237 $Wm^{-1}K^{-1}$) but more expensive.
- *Epoxy dielectric layer.* This is the most important layer in the MCPCB construction, as it affects the thermal performance, electrical breakdown strength and, in some cases, the solder joint performance of the MCPCB system. The typical thermal conductivity of the dielectric layer on a MCPCB is at least 2 $Wm^{-1}K^{-1}$. A higher value is better for good thermal performance. A thinner dielectric layer is better for thermal performance, as well, but can negatively impact the ability of the MCPCB to withstand a Hi-Pot (high potential) test to meet minimum electrical safety standards as required in certain lighting markets. The typical dielectric thickness layer is about 100μm. In critical applications, which need to meet strict solder joint reliability requirements, it is desirable to work with PCB manufacturers to design and engineer a low

stress dielectric layer. The low stress dielectric layer can then absorb the stress generated when there is a moderate CTE mismatch between the LUXEON emitter and the PCB substrate.

- *Top copper layer.* A thicker copper layer improves heat spreading into the PCB but may pose challenges for PCB manufacturers when fabricating narrow traces or spaces. A copper thickness of 1 oz. (35μm) or 2 oz. (70μm) is common. For optimum thermal performance on both 1 oz. and 2 oz. copper designs, the copper area should extend at least 3mm from the package outline.

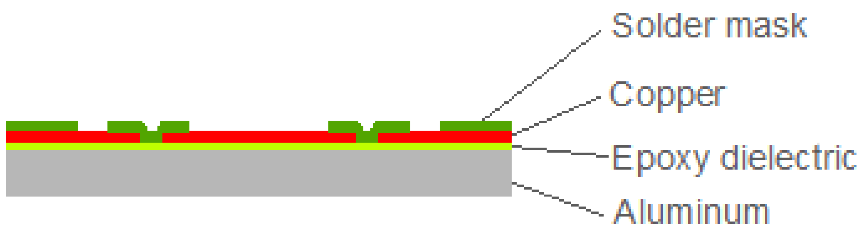

Figure 7. MCPCB typical cross section of the three-pad openings with aluminum substrate.

FR-4/CEM-3 PCB

FR-4/CEM-3 board construction consists of the following layers (see Figure 8 and Figure 9):

- *FR-4 sheet (woven fiber glass fabrics reinforced epoxy laminate) or CEM-3 (composite epoxy material constructed from both woven and non-woven fiber glass fabrics).* These two materials have excellent electrical insulation properties but have very poor thermal conductivity. Both are priced economically and are widely available. For detailed specifications on PCBs, it is best to refer to a standard generated by Association Connecting Electronics Industries (www.ipc.org); IPC-4101C ***"Specification for Base Materials for Rigid and Multilayer Printed Boards"*** standard.

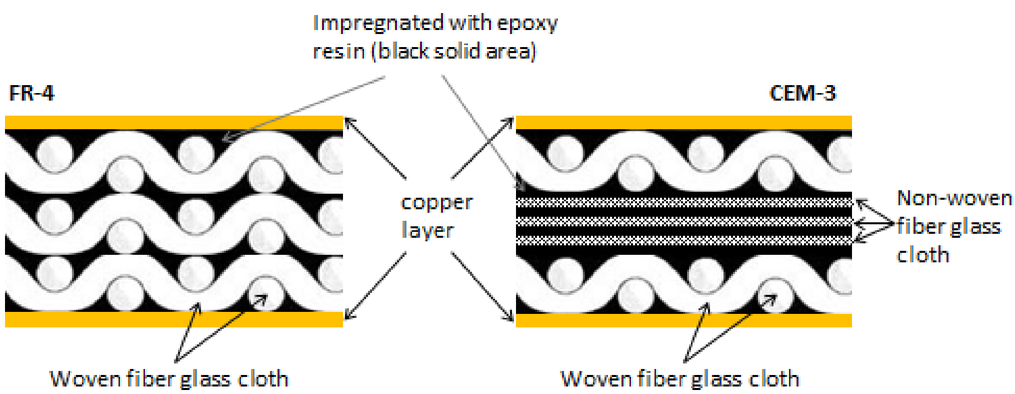

Figure 8. Cross sections of FR-4 and CEM-3 PCBs. Not drawn to scale; for illustration purposes only.

- *Top and bottom copper layers*. To improve thermal performance, add thermal vias around the electrically isolated thermal pad when using plated-through-hole design (see Figure 9) or within the thermal pad when using filled and capped via design. It is not desirable to put thermal vias on copper trace, which connect to the electrodes of the emitters, as this may interfere with the electrical insulation strength of the PCB and the heatsink. The filled and capped approach gives better thermal performance than open via design but at a much higher manufacturing cost. In addition, it requires good surface co-planarity when assembling small packages. The diameter of the vias, their position, and quantity need to be studied to find the optimum thermal performance at acceptable cost. For simple designs without thermal vias, having a larger area and thicker (e.g. 2 oz.) top copper layer around the LUXEON emitter can improve the thermal performance when compared to a smaller area and thin (e.g. 1 oz.) top copper layer. The bottom copper layer does not aid the thermal flow.

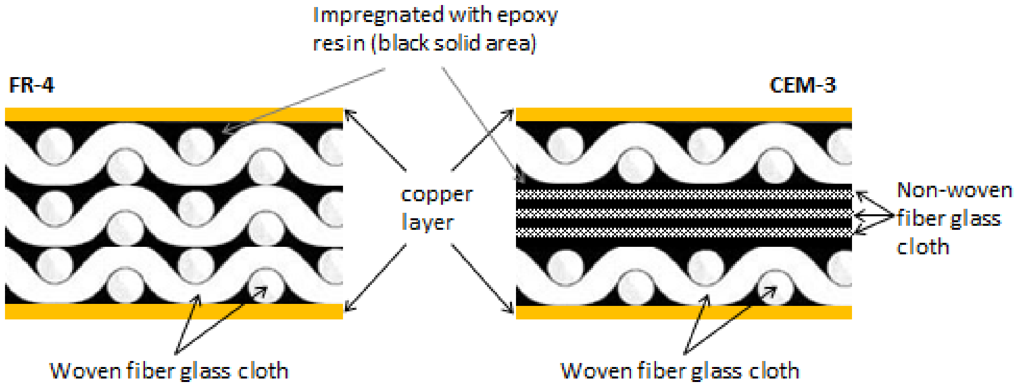

Figure 9. Cross section of an open via with plated through hole design with one pad opening where the LED pad is soldered onto (left image). Cross section of a filled and cap via design with one pad opening. One of the LED pads is then soldered on top of the flush area where the filled and capped vias are underneath it to create direct thermal path connection between LED and bottom of PCB (right image).

Ceramic PCB

Ceramic PCB construction consists of the following layers (see Figure 10):

- Ceramic substrate. Commonly used materials are alumina (Al2O3) or aluminum nitride (AlN). The thermal conductivity of alumina ranges from 20 to 30 $Wm^{-1}K^{-1}$, depending on the grades of alumina material in the substrate. The thermal conductivity of aluminum nitride ranges from 170 to 230 $Wm^{-1}K^{-1}$.
- Top copper layer.
- Solder mask.

Ceramic has an excellent thermal conductivity and is a very good electrical insulator. Therefore, there is no need to include any epoxy dielectric layer, allowing the LUXEON emitter to be directly attached to the ceramic via copper and solder material. This enables very tight packing of multiple LUXEON emitters and operation of LUXEON emitters at much higher current.

However ceramic can be brittle and may require extra handling precautions during assembly and handling.

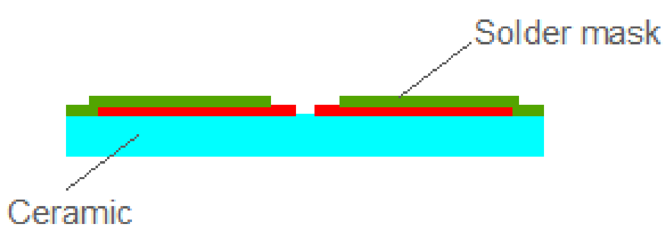

Figure 10. Cross section of ceramic based PCB. Note that there is no dielectric epoxy layer between the copper (red layer) and the ceramic substrate, which makes ceramic PCB an excellent solution for high current operation with high density packing.

2.6 PCB Quality and Supplier

It is important to select PCB suppliers that are capable of delivering the required level of quality. At a minimum, the PCBs must comply with IPC standard (IPC-A-600H, 2010 *"Acceptability of Printed Boards"*). The choice of PCB classification (Class 1, 2 or 3) as per IPC standard largely depends on the intended end product and/or customer requirement. Things to watch for include:

- PCB bowing and twisting
- Significant solder mask mis-registration

- Cracks in the solder mask layer which may result in undesirable exposure of the copper layer underneath
- Contaminated copper pad openings
- Out of tolerance pad openings

It is recommended to work with individual PCB manufacturers on the PCB tolerances that will ensure high PCB assembly yield and quality.

3. Assembly Process Guidelines

The LUXEON IR Domed Line is designed to be compatible with standard SMT processes. A SMT process typically consists of SMT components, PCBs, stencil plate, solder paste, pick & place machine, solder heat reflow oven and optional x-ray and cleaning equipment.

3.1 Solder Paste

Lumileds successfully tested and mounted the LUXEON IR Domed LEDs on PCBs with Alpha Lumet P30 (type 4). Given the large variety of solder pastes in the market, customers should always perform their own solder paste evaluation in order to determine if a solder paste will meet the customer's assembly and application requirements.

3.2 Stencil Design and Printing

Stencil apertures are commonly created using either electroforming or laser-cutting. A suitable stencil thickness for the LUXEON IR Domed Line is 4 mils (102µm). It may be necessary to make some adjustments to the stencil thickness (for example, with the use of thicker solder mask) and aperture openings to optimize quality of the solder joint under customer's own assembly process. In some cases, applying nano-coating material to the stencil aperture can improve the paste transfer efficiency (shape and volume) and reduce solder bridging. There are also several other important factors for consideration in obtaining good quality stencil printing (see Figure 11). They are:

1. The aperture (stencil opening) wall should be smooth, free of debris, dirt, and/or burrs, and have a uniform thickness throughout the stencil plate.
2. Positional tolerance between the stencil plate and the PCB substrate must be small enough to ensure that the solder paste is not printed outside the footprint area. Hence, both the stencil plate and the PCB must be secured properly during screen printing of the solder paste.
3. During solder paste printing, the stencil plate must be flush with the top of the solder mask. Large particles between the stencil plate and PCB may prevent a good contact.
4. The PCB substrate must be mechanically supported from the bottom to prevent flexing of the PCB during solder paste printing.

Using an automatic stencil printing machine with proper fiducials or guiding feature on the PCB and the stencil plate will yield the best accuracy and repeatability for the solder paste deposition process. A manual stencil printing process is not recommended for the small pad features.

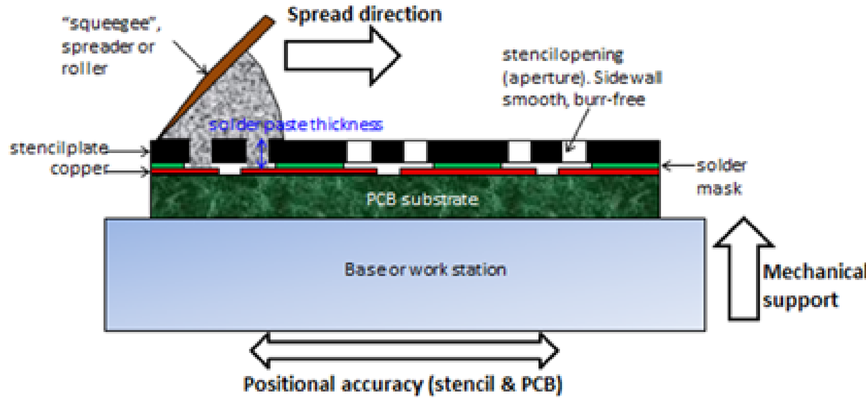

Figure 11. Stencil printing process.

Figure 12 shows some examples of good and bad solder paste printing processes for two and three pad LED emitters. A good reference to acceptable solder paste printing criteria can be found in the IPC-7527 ***"Requirements for Solder Paste Printing"*** document. A good solder paste printing is achieved when the solder paste on the PCB, after dispense, provides good coverage per stencil design and is centered to the PCB land pattern.

Figure 12. Examples of good and bad solder paste printing on two and three pad emitters. Visual inspection of the quality of the dispensed solder paste is recommended during process setup or during troubleshooting.

Stencil printing direction should follow the long side of the pads to increase success of the stencil opening being completely filled with solder paste. (see Figure 13).

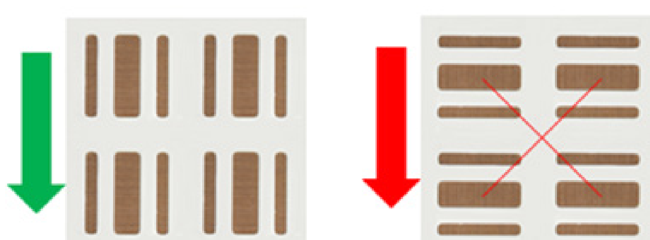

Figure 13. Orientate the PCB such that the stencil printing direction is along the long side of the pads (left, green arrow image). Avoid the stencil printing direction perpendicular to the long side of the pads (right, red arrow image.

3.3 Pick and Place Nozzle

Automated pick and place equipment provides the best handling and placement accuracy for LUXEON IR Domed emitters. However, pick and place nozzles are, in general, customer specific and are typically machined to fit specific pick and place tools.

Lumileds recommends taking the following general pick and place guidelines into account:

1. The nozzle tip should be clean and free of any particles since this may interact with the silicone surface of the LUXEON emitter during pick and place.
2. During setup and the first initial production run, it is good practice to inspect the top surface or the dome of the LUXEON emitters under a microscope to ensure that the emitters are not accidentally damaged by the pick and place nozzle.
3. You should check for emitters sticking to the nozzle or emitters coming out from the pocket tape during the initial run.
4. Check that the emitter orientation is correctly placed onto the PCB board.

Nozzle Design

It is preferred that the LUXEON emitter is picked up from the outer sides of the domed area. Picking up from the domed area should be avoided to prevent possible dome damaged, poor pick-up and/or poor placement of parts onto PCB. Below are suitable nozzle designs for Samsung SM421 (Figure 14) and Juki KE2080L (Figure 15) machines for all configurations in the LUXEON IR Domed Line. The nozzle inner and outer diameters are 3.55mm and 3.95mm, respectively, and made of metal. Please contact Ching Yi Technology Pte Ltd for ordering or technical support.

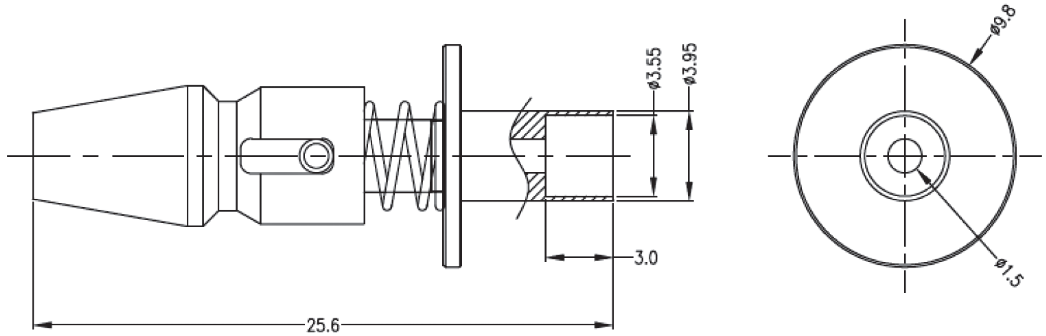

Figure 14. Samsung SM421 nozzle. Part number: SAM-0354/16. Drawing number: 13761. Drawing courtesy from Ching Yi Technology Pte Ltd. (all dimensions are in millimeters).

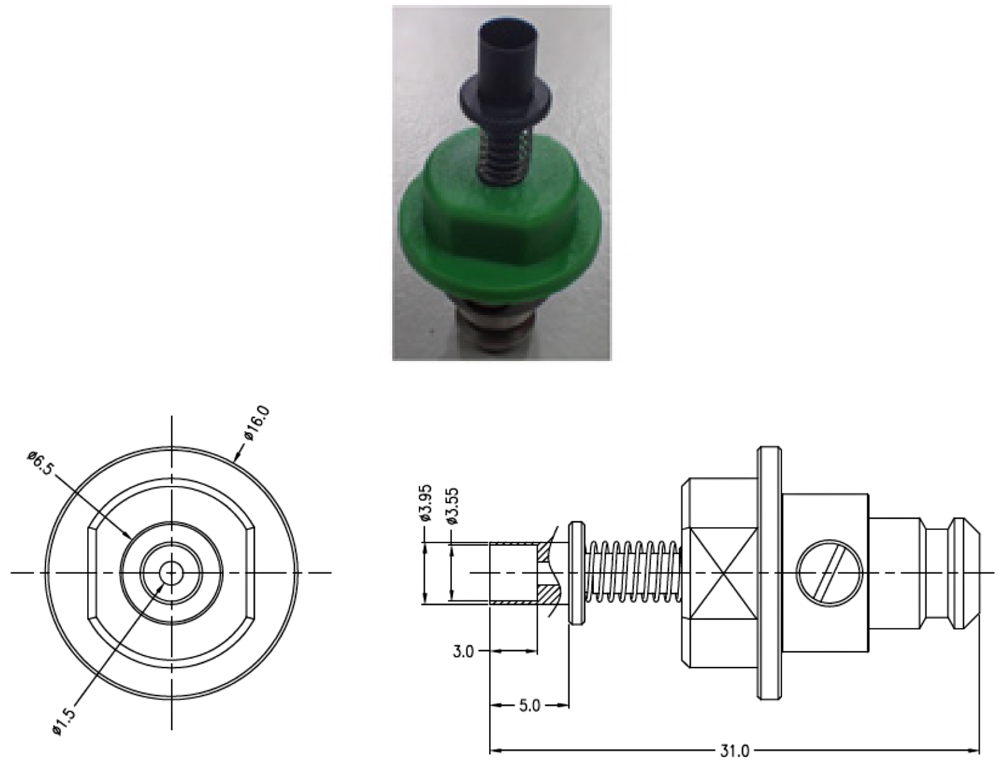

Figure 15. Juki KE2080L nozzle. Part number: JUK-0355/16. Drawing number: 13762. Drawing courtesy from Ching Yi Technology Pte Ltd. (all dimensions are in millimeters).

Pick and Place Parameters

For the nozzles described above, a suitable starting point in setting up the machine pick and place parameters for Samsung SM421 and Juki KE2080L are shown in Table 2 and Table 3.

Table 2. Samsung SM421 pick and place parameters.

PICK AND MOUNT INFORMATION		
Pick Height	L1I0-0xxx060000000	-2.88 mm
	L1I0-0xxx090000000	-2.69 mm
	L1I0-0xxx150000000	-1.70 mm
Mount Height	L1I0-0xxx060000000	0mm
	L1I0-0xxx090000000	0mm
	L1I0-0xxx150000000	0mm
Delay – Pick Up		30 msec
Delay – Place		30 msec
Delay – Vac Off		0
Delay – Blow On		0
Speed – XY		1
Speed – Z Pick Down		1
Speed – Z Pick Up		1
Speed – R		1
Speed – Z Place Down		1
Speed – Z Place Up		1
Z Align Speed		1
Soft Touch		Do not use
VISION INFORMATION		
Camera No		Fly Cam4
Side		15
Outer		0

Table 3. Juki KE2080L pick and place parameters.

PICK AND MOUNT INFORMATION		
Placing Stroke		0mm
Mount Height	L1I0-0xxx060000000	2.8 mm
	L1I0-0xxx090000000	2.6 mm
	L1I0-0xxx150000000	1.7 mm
XY Speed		Fast 2
Picking Z Down		Fast 2
Picking Z Up		Fast 2
Placing Z Down		Fast 2
Placing Z Up		Fast 2
Laser Position	L1I0-0xxx060000000	-0.37
	L1I0-0xxx090000000	-0.37
	L1I0-0xxx150000000	-0.37
VISION INFORMATION		
Centering Method		Laser
Comp Shape		Corner Square

Feeder System

Pick and place machines are typically equipped with special pneumatic or electric feeders to advance the tape containing the LEDs. In pneumatic feeders, air pressure is used to actuate an air cylinder which then turns the sprocket wheel to index the pocket tape; electric feeders, in contrast, use electric motors to turn the sprocket wheel (see Figure 16). Electric feeders often also contain a panel which allows an operator to control the electric feeder manually.

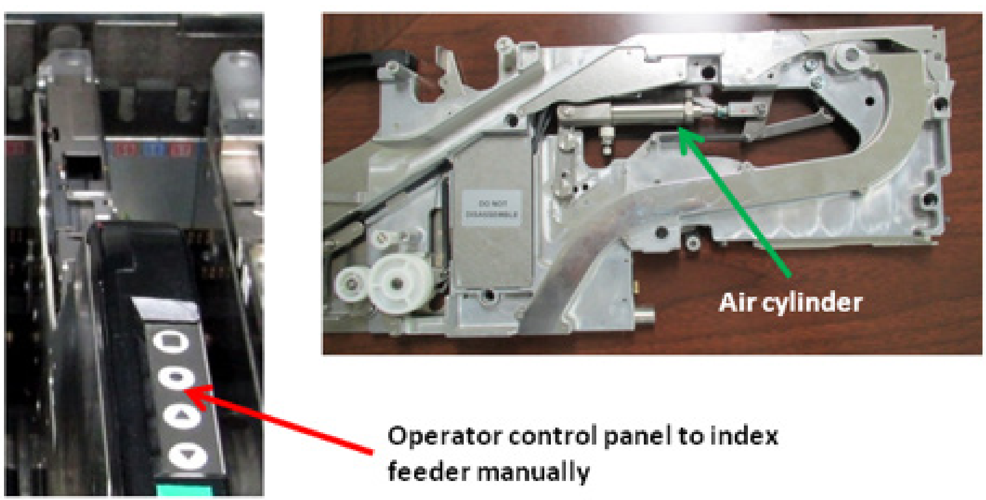

Figure 16. Examples of an electric feeder (left) and a pneumatic feeder (right), which are typically used in pick and place machines to advance the tape with LEDs.

The indexing step in the pick and place process may cause some LEDs to accidentally jump out of the pocket tape or may cause some LEDs to get misaligned or misplaced inside the pocket tape, resulting in pick-up errors. Depending on the feeder design, minor modifications to the feeder can substantially improve the overall pick and place performance of the machine and reduce/eliminate the likelihood of scratch or damage to the LEDs.

There are many types of pick and place feeder designs available. Some feeders can be used as-is without any further modifications, some feeders require a shift in the position where the cover tape is peeled off the tape reel, and yet other feeders require the shutter to be completely removed so that the cover tape peeling position can be adjusted. Figure 17 shows representative pictures of each feeder design. Since there are many different feeder designs in use, it is important to understand the basic principle behind modifying the feeders so that effective modifications can still be carried out when different feeder designs are encountered.

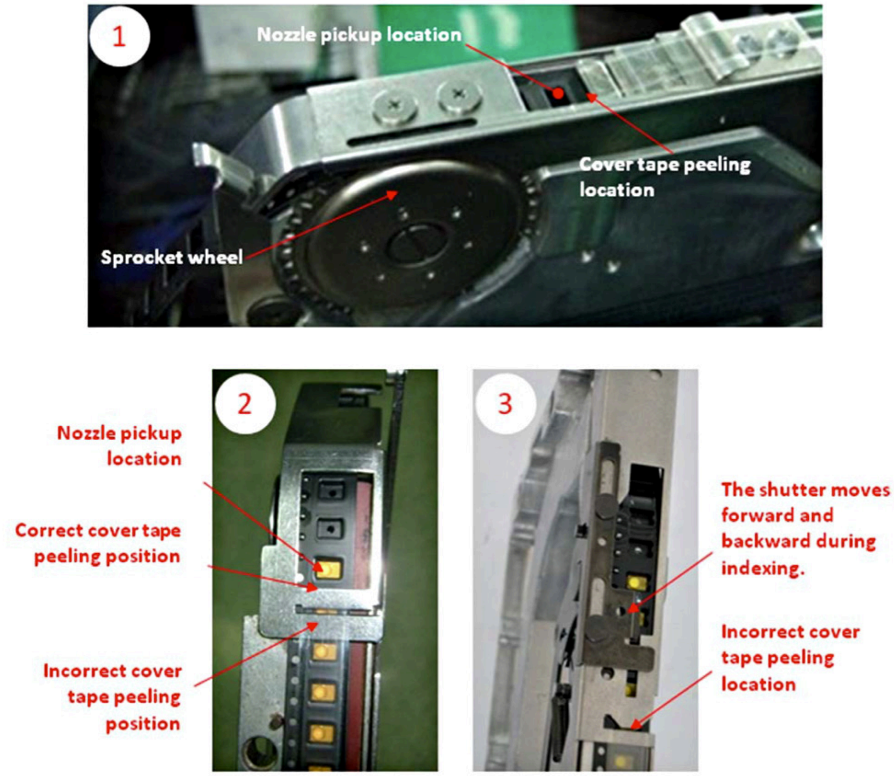

Figure 17. Three representative feeder designs. Feeder 1 does not require any modification. Feeder 2 requires the cover tape peeling position to be shifted. Feeder 3 requires the shutter to be removed before the cover tape peeling position can be adjusted.

The underlying principle behind each feeder modification is to protect the silicone dome with the cover tape until the LED is ready to be picked up by the nozzle. To achieve this, the cover tape should only be peeled off just before the nozzle picks up the LED (see Figure 18 and Figure 19).

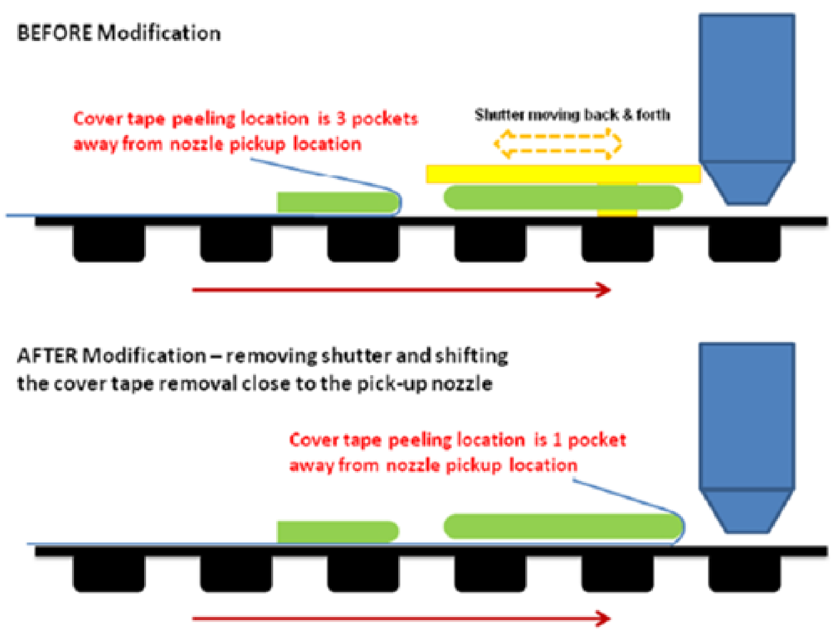

Figure 18. Illustration of the general principle behind the feeder modification.

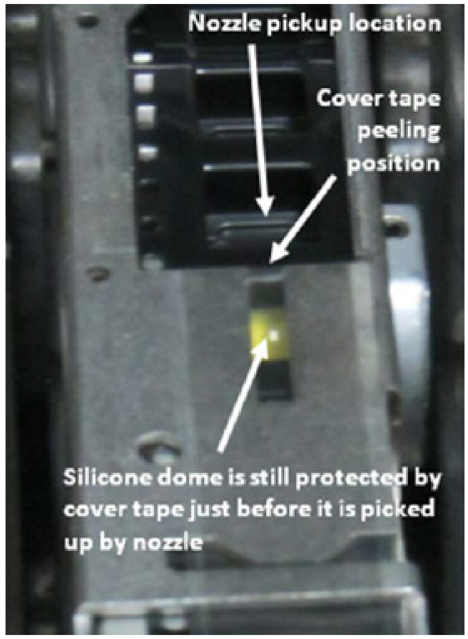

Figure 19. Example of a modified feeder, which protects the silicone dome prior to pick up.

To minimize the jerking or movement of components within the pocket tape in pneumatic feeders during indexing, some mitigating actions should be considered:

a. *Install an air pressure control valve.* In some pneumatic feeder designs, said control valve is already integrated by the machine supplier; in others, an external control valve may have to be installed (see Figure 20).

Figure 20. Pneumatic feeder with integrated air pressure control valve (left) and pneumatic feeder with air pressure control valve installed afterwards (right).

b. *Use a smaller indexing gear pitch.* A 2mm indexing gear pitch, as shown in Figure 21, will have smoother tape movement through the feeder system than a 4mm indexing gear pitch. Same principle applies for larger tape width.

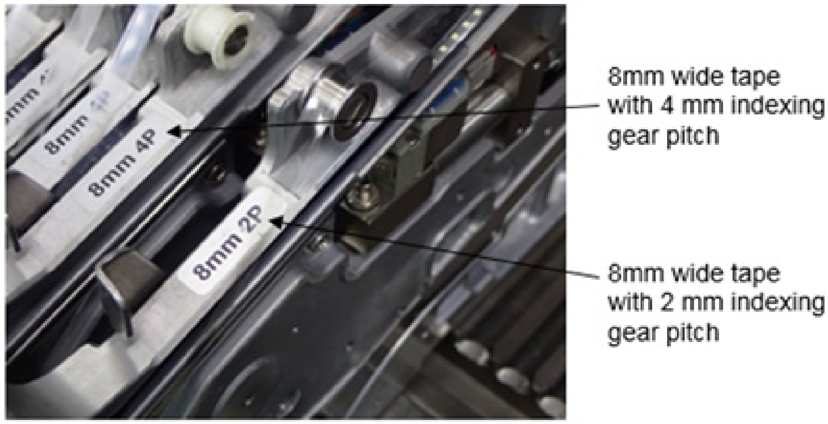

Figure 21. Example of 8mm width tape with 4mm and 2mm indexing gear pitch. Same principle for 12mm width tape.

c. Install magnet bar or strips on the pneumatic feeder as shown in Figure 22. The metallization pads of the LUXEON IR Domed LEDs is magnetic and will hold the LED in place during tape indexing.

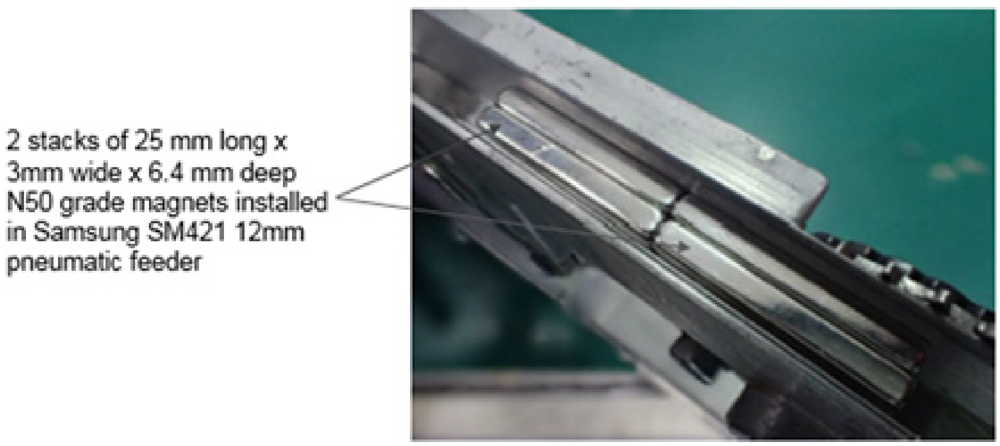

Figure 22. Installing a magnet to better hold the LUXEON IR Domed LEDs during feeder movement. It can be installed anywhere on the feeder path as needed

3.4 Reflow

A standard SMT lead-free reflow profile can be used to reflow the LUXEON emitter onto a PCB. The LUXEON IR Domed emitters have been shown to self-align during the reflow process if the recommended PCB footprint and automated SMT process are used.

Things to watch for after reflow include:

1. Solder voids (see Figure 23) – perform x-ray inspection. As a general guideline, it is best to keep the solder void as recommended by latest version of the IPC-A-610 "Acceptability of Electronic Assemblies" document.
2. Any visible damage, tilt or misplacement of LUXEON emitters.
3. Change in color and/or reflectivity (i.e. dull appearance) of the solder mask. This may impact the light output extraction or cause color shift.
4. Functional test (open/short).
5. Solder balls. Loose solder balls that are not entrapped (i.e. movable) and/or violate minimum electrical distance should be removed (refer to IPC-A-610).

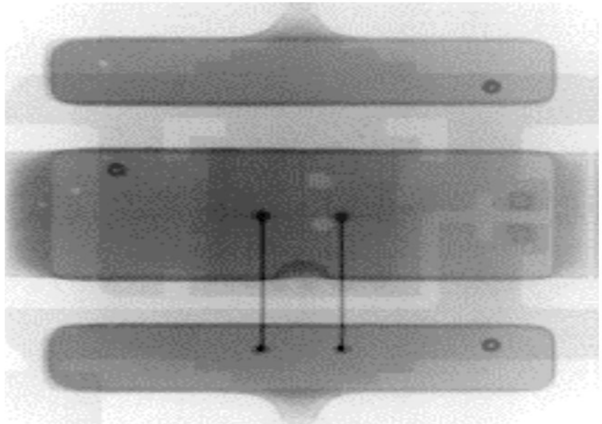

Figure 23. Example of good x-ray result.

3.5 Component Spacing

The minimum allowable spacing between neighboring LUXEON IR Domed packages is 300µm, assuming the recommended LUXEON IR Domed PCB footprint is used and the pick and place machine has a placement accuracy of less than ±50µm.

3.6 Board Handling and Bending

The LED package handling precaution as described in section 1.3 must also be applied when handling completed boards.

Bending of PCBs is a common handling problem seen on large boards. Unlike FR-4 or CEM-3 material, MCPCB and ceramic based PCB should not be bent due to the property of metal and ceramic substrate. For example, when a MCPCB is bent, it is difficult to return it to its original flatness and this could create problems when used in combination with a thermal interface material for good thermal contact.

Bending of a FR-4 or a CEM-3 board should be kept to a minimum to prevent damage to the LUXEON emitter and/or solder joint.

3.7 Rework

Since rework of PCBs typically involves manual processes such as heating up a section of a PCB for repair/component replacement, manual cleaning of PCB pads, manual dispensing of solder paste and manual placement of replacement component, they can all create uncontrollable processes which may yield unpredictable, long term performance results. Lumileds currently does not provide any guidelines on how to rework the LUXEON IR Domed emitters.

4. Packaging Consideration—Chemical Compatibility

The LUXEON IR Domed package contains a silicone overcoat to protect the LED chips and extract the maximum amount of light. As with most silicones used in LED optics, care must be taken to prevent any incompatible chemicals from directly or indirectly reacting with the silicone.

The silicone overcoat in the LUXEON emitter is gas permeable. Consequently, oxygen and volatile organic compound (VOC) gas molecules can diffuse into the silicone overcoat. VOCs may originate from adhesives, solder fluxes, conformal coating materials, potting materials and even some of the inks that are used to print the PCBs.

Some VOCs and chemicals react with silicone and produce discoloration and surface damage. Other VOCs do not chemically react with the silicone material directly but diffuse into the silicone and oxidize during the presence of heat or light. Regardless of the physical mechanism, both cases may affect the total LED light output. Since silicone permeability increases with temperature, more VOCs may diffuse into and/or evaporate out from the silicone.

Careful consideration must be given to whether LUXEON emitters are enclosed in an "air tight" environment or not. In an "air tight" environment, some VOCs that were introduced during assembly may permeate and remain in the silicone. Under high temperature operation, the VOCs inside the silicone coating may partially oxidize and create an appearance of silicone discoloration. In an air rich or "open" air environment, VOCs have a chance to leave the area (driven by the normal air flow). Transferring the devices, which were discolored in the enclosed environment, back to "open" air may allow the oxidized VOCs to diffuse out of the silicone and may restore the original optical properties of the LED.

Determining suitable threshold limits for the presence of VOCs is very difficult since these limits depend on the type of enclosure used to house the LEDs and the operating temperatures.

Table 4 provides a list of commonly used chemicals that should be avoided as they may react with the silicone material. Note that Lumileds does not warrant that this list is exhaustive since it is impossible to determine all chemicals that may affect LED performance.

The chemicals in Table 4 are typically not directly used in the final products that are built around the LUXEON emitter. However, some of these chemicals may be used in intermediate manufacturing steps (e.g. cleaning agents). Consequently, trace amounts of these chemicals may remain on (sub) components, such as heatsinks or on PCBs. Lumileds, therefore, recommends the following precautions when designing your application:

- When designing secondary lenses to be used over an LED, provide a sufficiently large air-pocket and allow for "ventilation" of this air away from the immediate vicinity of the LED.
- Use mechanical means of attaching lenses and circuit boards as much as possible. When using adhesives, potting compounds and coatings, carefully analyze its material composition and do thorough testing of the entire fixture under High Temperature over Life (HTOL) conditions.

Table 4. List of commonly used chemicals that may damage the silicone overcoat of LUXEON IR Domed LEDs.

CHEMICAL NAME	TYPICAL USE
Hydrochloric Acid	Acid
Sulfuric Acid	Acid
Nitric Acid	Acid
Acetic Acid	Acid
Sodium Hydroxide	Alkali
Potassium Hydroxide	Alkali
Ammonia	Alkali
MEK (Methyl Ethyl Ketone)	Solvent
MIBK (Methyl Isobutyl Ketone)	Solvent
Toluene	Solvent
Xylene	Solvent
Benzene	Solvent
Gasoline	Solvent
Mineral spirits	Solvent
Dichloromethane	Solvent
Tetracholorometane	Solvent
Castor Oil	Oil
Lard	Oil
Linseed Oil	Oil
Petroleum	Oil
Silicone Oil	Oil
Halogenated Hydrocarbons (containing F, Cl, Br elements)	Misc.
Rosin Flux	Solder Flux
Acrylic Tape	Adhesive

Note: Avoid using any of these chemicals in the housing that contains the LED package.

About Lumileds

Companies developing automotive, mobile, IoT and illumination lighting applications need a partner who can collaborate with them to push the boundaries of light. With over 100 years of inventions and industry firsts, Lumileds is a global lighting solutions company that helps customers around the world deliver differentiated solutions to gain and maintain a competitive edge. As the inventor of Xenon technology, a pioneer in halogen lighting and the leader in high performance LEDs, Lumileds builds innovation, quality and reliability into its technology, products and every customer engagement. Together with its customers, Lumileds is making the world safer, better and more beautiful—with light.

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