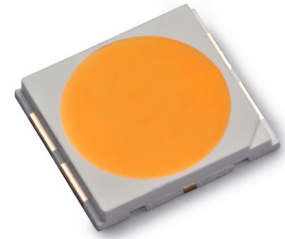


LUXEON 5258

Assembly and Handling Information



Introduction

This application brief addresses the recommended assembly and handling guidelines for LUXEON 5258 emitters. These emitters provide high luminance from a single package to enable cost effective, single optic and directional lamp designs. LUXEON 5258 uses an industry standard 5258 surface mount package and is available in 24V and 96V configurations to interface with high efficiency drivers. Proper assembly, handling, and thermal management, as outlined in this application brief, ensure high optical output and reliability of these emitters.

Scope

The assembly and handling guidelines in this application brief apply to LUXEON 5258 with the following part number designation:

L152 - aabb50dd00000

Where:

- aa - designates CCT (e.g. 27=2700K)
- bb - designates minimum CRI level (e.g. 80 for minimum 80 CRI)
- dd - designates forward voltage (24=24V and 96=96V)

In the remainder of this document the term LUXEON emitter refers to any product in the LUXEON series listed above.

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1. Component

1.1 Description

The LUXEON 5258 emitter (Figure 1) consists of a 5258 plastic molded lead-frame package with anode, cathode and electrically isolated thermal pad. A chamfer on the corner of the package marks the cathode side of the emitter package. Heat is being dissipated through the larger thermal pad. The light emitting surface (LES) is encapsulated with silicone and phosphor to protect the chips and generate white light (Figure 1). LUXEON 5258 is available in 24V and 96V configurations. The LUXEON emitter is ESD HBM rated at $\geq 8\text{kV}$ (JEDEC JS-001-2012) and does not include any transient voltage suppressor (TVS) chip.

1.2 Optical Center

The optical center coincides with the mechanical center of the LUXEON emitter. Optical rayset data for the LUXEON emitter are available on the Lumileds website at lumileds.com.

1.3 Handling Precautions

The LUXEON emitter is designed to maximize light output and reliability. However, improper handling of the device may damage the silicone coating and affect the overall performance and reliability. In order to minimize the risk of damage to the silicone encapsulation during handling, the LUXEON emitter should only be picked up from the side of the package (Figure 2).

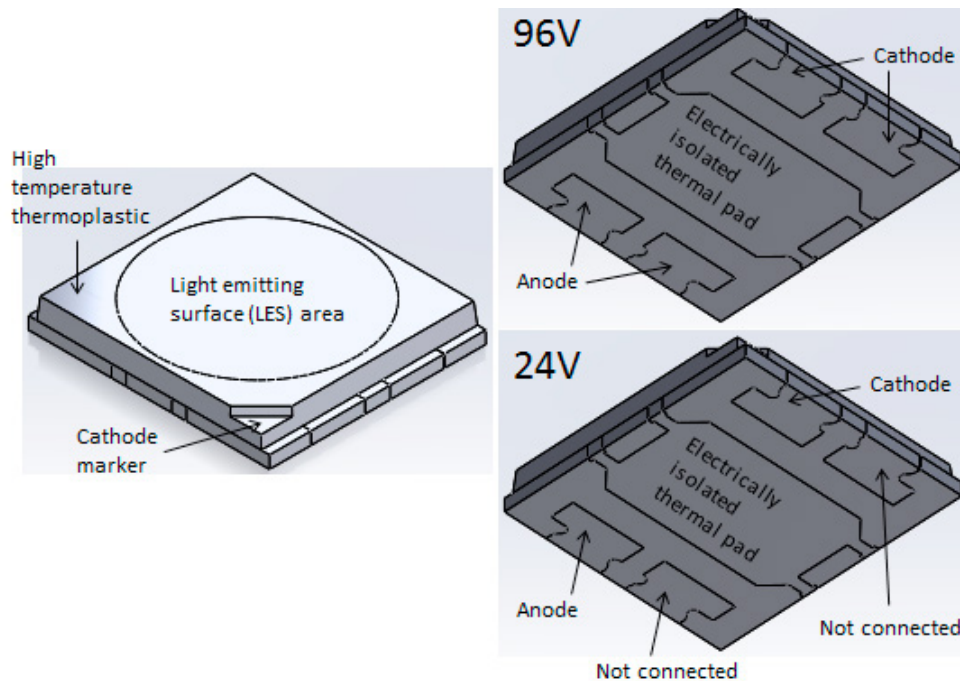


Figure 1. Package rendering of the LUXEON 5258 emitter.

1.4 Cleaning

The LUXEON emitter 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, first try a gentle swabbing using a lint-free swab. If needed, a lint-free swab and isopropyl alcohol (IPA) can be used to gently remove dirt from the silicone coating. Do not use other solvents as they may adversely react with the package of the LUXEON emitter. For more information regarding chemical compatibility, see Section 6.

1.5 Electrical Isolation

The LUXEON emitter has five pads on the package bottom. The minimum creepage distance for both 24V and 96V configurations, assuming the thermal pad is grounded or made electrically active is 0.65mm (Figure 3). For 24V configuration, if pad number 2 and/or 4 are grounded or made electrically active (Figure 3), the minimum creepage distance will reduce to 0.50mm (Figure 2).

In order to avoid any electrical shocks, flashover and/or damage to the LUXEON emitter, each design needs to comply with the appropriate standards of safety and isolation distances, known as clearance and creepage distances, respectively (e.g. IEC60950, clause 2.10.4).

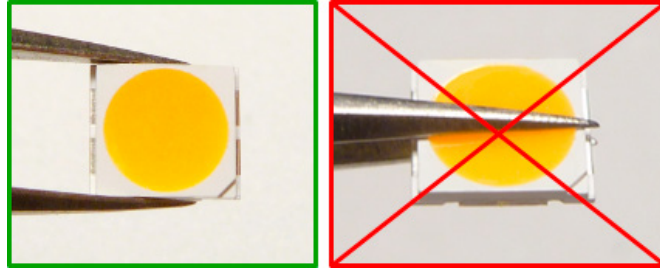


Figure 2. Correct tweezers handling of LUXEON 5252 (left). Incorrect handling (right).

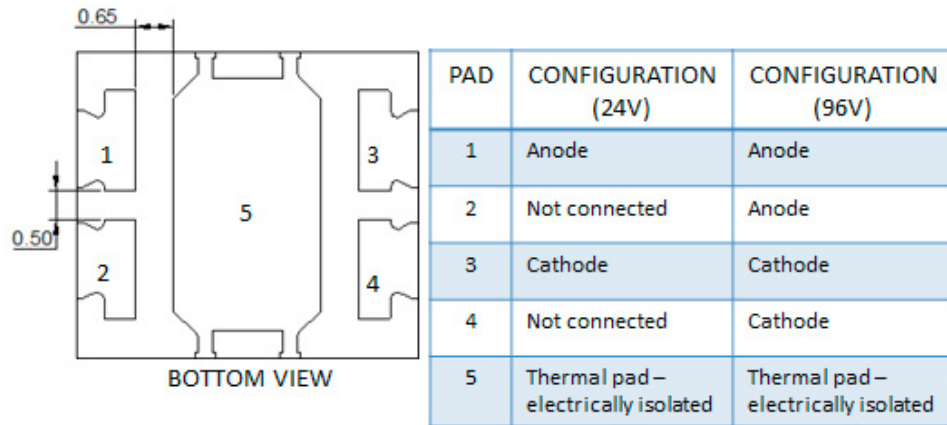


Figure 3. Pad configuration of LUXEON 5258 and minimum creepage distances (in mm) as shown.

1.6 Mechanical Files

Mechanical drawings for the LUXEON emitter are available on the Lumileds website at lumileds.com.

2. PCB Design Guidelines for the LUXEON Emitter

The LUXEON emitter is designed to be soldered onto a Printed Circuit Board (PCB). To ensure optimal operation, the PCB should be designed to minimize the overall thermal resistance between the LED package and the heat sink.

2.1 PCB Footprint and Land Pattern

The recommended PCB footprint design for the LUXEON emitter is shown in Figure 4. In order to ensure proper heat dissipation from the emitter to the PCB, it is best to extend the top copper layer of the thermal pad of the PCB beyond the perimeter of the LUXEON emitter by at least 3mm.

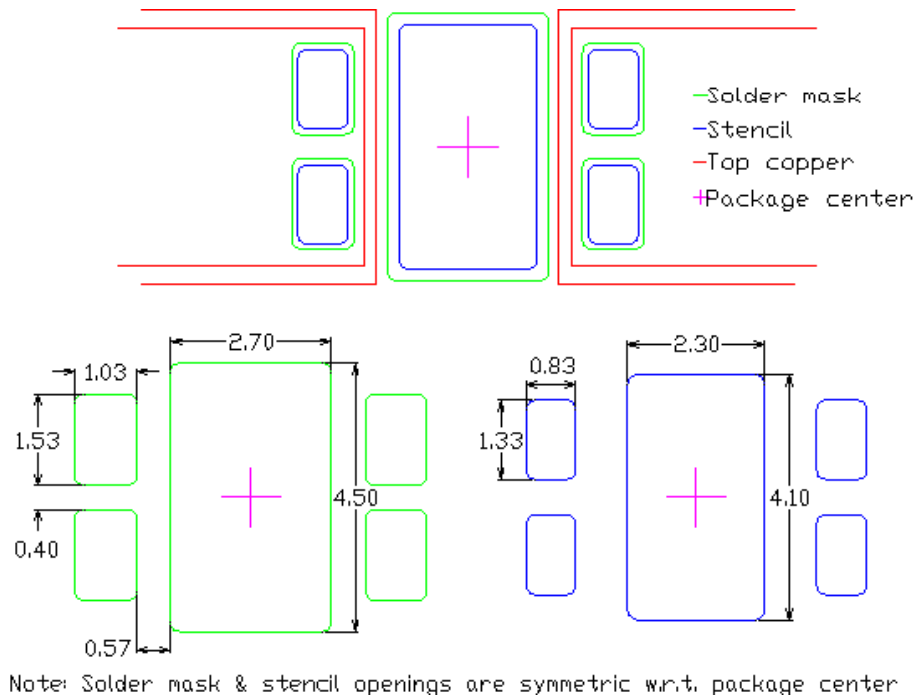


Figure 4. Top image shows the overall solder mask, stencil and copper trace layout. Bottom left and right images are the solder mask and stencil opening. Dimensions are in mm.

Depending on the choice of solder paste, copper finishing on the PCB, and manufacturer's SMT process capabilities, it may be necessary to subdivide the large thermal pad to reduce the occurrence of solder voids (Figure 5). Subdividing the solder mask is in general a better option than subdividing the stencil aperture pattern (Figure 5) because little islands of solder paste on a large open copper area may be squeezed into one large solder paste island during pick and place if the placement height of the LUXEON emitter is set too low. However both options are commonly used to address solder voiding on large pads and the principle behind these options is to improve the venting capability during solder reflow. The need to consider one of these two design options and the amount of solder mask/stencil subdivision depends on the factors described earlier. For optimal thermal contact, the total area of the subdivided solder mask should not be smaller than 80% of a single large solder mask opening.

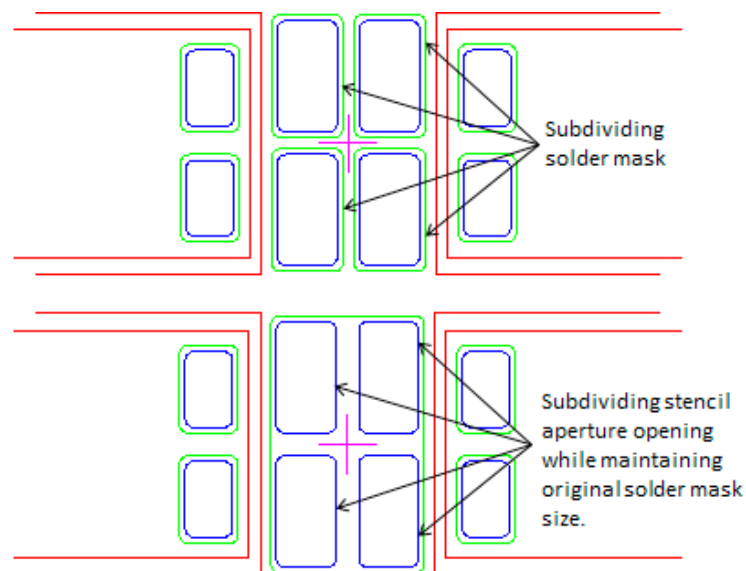


Figure 5. An illustration of subdividing solder mask and stencil aperture opening. Design and assembly process optimization are required for optimal solder void performance.

2.2 Solder Mask

A stable white solder mask finish (typically a polymer compound with inert reflective filler) with high reflectivity in the visible spectrum will typically meet most application needs. The white finish should not discolor over time when exposed to elevated operating temperatures. Customers are encouraged to work with their PCB suppliers to determine the most suitable solder mask options which can meet their application needs.

2.3 Surface Finishing

Lumileds recommends using a high temperature organic solderability preservative (OSP) or electroless nickel immersion gold (ENIG) plating on the exposed copper pads.

2.4 Minimum Spacing

Lumileds recommends a minimum edge to edge spacing between LUXEON emitters of 0.5mm. Placing multiple LUXEON emitters too close to each other may adversely impact the ability of the PCB to dissipate the heat from the emitters.

2.5 PCB Quality and Supplier

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").

3. Thermal Management

The overall thermal resistance between a LUXEON emitter and the heat sink is strongly affected by the design and material of the PCB on which the emitter is soldered. Metal Core PCBs (MCPCB) have been historically used in the LED industry for their low thermal resistance and rigidity.

Lumileds investigated the thermal performance of LUXEON emitters with the following PCB star board characteristics as shown in Table 1. The overall thermal resistance from LED junction to bottom of the star board ($R\theta_{j-hs}$) mounted on temperature controlled heat sink is 7K/W.

Table 1. PCB characteristics used for thermal characterization.

PCB Construction	Aluminum metal core PCB (Al-MCPCB)
Metal substrate thickness	1.6mm
Top copper thickness	35 μ m (1 oz)
Dielectric thermal conductivity	3W/(m·K)
Dielectric thickness	0.08mm

4. Thermal Measurement Guidelines

The typical thermal resistance $R\theta_{j-case}$ between the junction and the solder pads of the LUXEON emitter is provided in the datasheet. With this information, the junction temperature T_j can be determined according to the following equation:

$$T_j = T_{case} + R\theta_{j-case} \cdot P_{electrical}$$

In this equation T_{case} is the temperature at the bottom of the solder pads of the LUXEON emitter and $P_{electrical}$ is the electrical power going into the emitter. In typical applications it may be difficult, though, to measure the temperature T_{case} directly. Therefore, a practical way to determine the junction temperature of the LUXEON emitter is by measuring the temperature T_s of a predetermined sensor pad on the PCB with a thermocouple.

The recommended location of the sensor pad is right next to the thermal pad of the LUXEON emitter on the PCB, as shown in Figure 6. To ensure accurate readings, the thermocouple (TC) tip must make direct contact to the copper of the PCB onto which the LUXEON emitter thermal pad is soldered, i.e. any solder mask or other masking layer must be first removed before mounting the thermocouple onto the PCB. The tip of the TC wire, where two dissimilar metals are welded

together, should be placed as close as possible to the LUXEON emitter package on the exposed copper layer of the thermal pad. The thermal resistance $R\theta_{j-s}$ between the sensor pad and the LUXEON emitter junction was experimentally determined based on the MCPCB as described in section 3. The junction temperature can then be calculated as follows:

$$T_j = T_s + R\theta_{j-s} \cdot P_{\text{electrical}}$$

where the typical $R\theta_{j-s}$ is 6.2 K/W.

It is recommended to secure the tip of TC wire to the exposed copper area with a good thermal conductive epoxy such as Artic Silver™ thermal adhesive. Note that the Artic Silver™ epoxy is not formulated to conduct electricity. Make sure to dispense sufficient epoxy onto the TC to secure it on the PCB. However, do not flood the TC with epoxy. Putting more epoxy than needed may change the thermal behavior of the surrounding area.

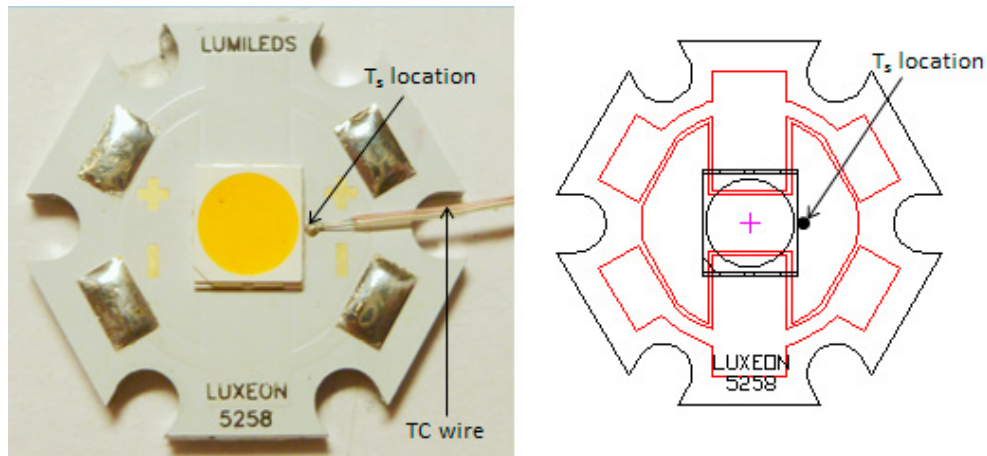


Figure 6. Left photo shows actual placement of TC wire secured with thermal conductive epoxy. The thermal epoxy volume should be kept to minimum as shown. Right photo shows the MCPCB copper trace pattern (with solder mask removed) of the actual star board used and the recommended T_s location.

5. Assembly Process Guidelines

5.1 Stencil Design

The recommended solder stencil thickness is 4mils.

5.2 Solder Paste

Lumileds recommends lead-free solder for the LUXEON emitter. Good results have been obtained with lead-free solders such as SAC 305 solder paste from Alpha Metals (SAC305-CVP390-M20 type 3). However, since application environments vary widely, Lumileds recommends that customers perform their own solder paste evaluation in order to ensure it is suitable for the targeted application.

5.3 Solder Reflow Profile

The LUXEON emitter is compatible with standard surface-mount and lead-free reflow technologies. This greatly simplifies the manufacturing process by eliminating the need for adhesives and epoxies. The reflow step itself is the most critical step in the reflow soldering process and occurs when the boards move through the oven and the solder paste melts, forming the solder joints. To form good solder joints, the time and temperature profile throughout the reflow process must be well maintained.

A temperature profile consists of three primary phases:

1. Preheat: the board enters the reflow oven and is warmed up to a temperature lower than the melting point of the solder alloy.
2. Reflow: the board is heated to a peak temperature above the melting point of the solder, but below the temperature that would damage the components or the board.
3. Cool down: the board is cooled down rapidly, allowing the solder to freeze, before the board exits the oven.

As a point of reference, the melting temperature for SAC 305 is 217°C.

5.4 Pick and Place

The LUXEON emitter is packaged and shipped in tape-and-reel which is compatible with standard automated pick-and-place equipment to ensure the best placement accuracy. Note that pick and place nozzles are customer specific and are typically machined to fit specific pick and place tools. Lumileds advises customer to take the following general pick and place guidelines into account:

- a. The nozzle tip should be clean and free of any particles since it may interact with the top surface of the silicone encapsulation of the LUXEON emitter package.
- b. During setup and the first initial production runs, it is a good practice to inspect the top surface of the LUXEON emitters after reflow under a microscope to ensure that the emitters are not accidentally damaged by the pick and place nozzle.

An example of a nozzle evaluated is shown in Figure 7.

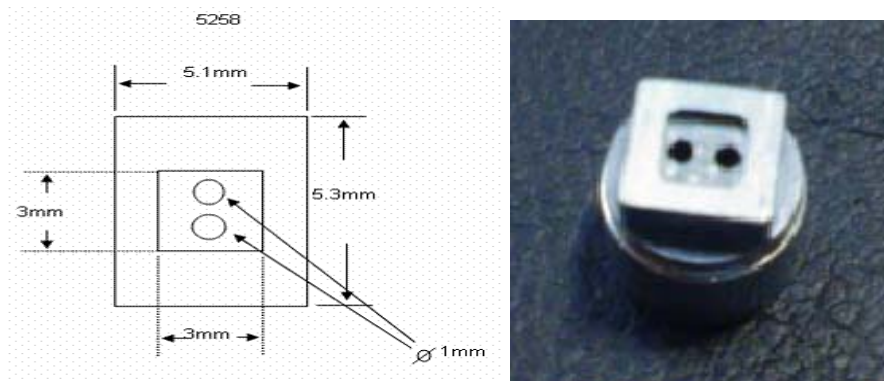


Figure 7. The nozzle tip dimensions (left) and the actual picture of a nozzle (right) .

5.5 Electrostatic Discharge Protection

The LUXEON emitter does not include any transient voltage suppressor (TVS) chip to protect against electrostatic discharges (ESD). Therefore, Lumileds recommends observing the following precautions when handling the LUXEON emitter:

- During manual handling always use a conductive wrist band or ankle straps when positioned on a grounded conductive mat.
- All equipment, machinery, work tables, and storage racks that may get in contact with the LUXEON emitter should be properly grounded.
- Use an ion blower to neutralize the static discharge that may build up on the surface and lens of the plastic housing of the LUXEON emitter during storage and handling.

LUXEON emitters which are damaged by ESD may not light up at low currents and/or may exhibit abnormal performance characteristics such as a high reverse leakage current, and a low forward voltage (leaky diode). It is also important to take note that ESD can also cause latent failure, i.e. failure or symptoms as described above may not show up immediately but until after use. Hence continuous ESD protection is needed during assembly.

5.6 JEDEC Moisture Sensitivity

The JEDEC moisture sensitivity level (MSL) for this LUXEON emitter is rated as level 2. Proper storage, handling and/or baking guidelines must be observed to prevent damage to the LUXEON emitter during reflow (see Table 2).

Table 2. Storage and baking conditions. Note that if any of the temperature, relative humidity, humidity indicator card or the period is not met, baking is required. For more information, see IPC/JEDEC J-STD-033C.

Operation	Packing bag status	Temperature	Relative humidity (RH)	Humidity indicator card	Period
Storage	As received	≤ 40°C (non-condensing atmospheric environment)	≤ 90%	n/a	Within 2 year of shipment date code
Storage	After opening bag	≤ 30°C	≤ 60%	If 60% color spot is no longer blue	1 year
Baking (drying)	n/a	60 ± 5°C	≤ 5%	n/a	20 hours

6. Packaging Considerations—Chemical Compatibility

The LUXEON emitter package contains a silicone overcoat to protect the LED chip 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 used 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 heat and “blue” light, VOCs captured inside the silicone may partially oxidize and create a silicone discoloration, particularly on the surface of the LED where the flux energy is the highest. 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. Also, some VOCs can photo-degrade over time.

Table 3 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 3 are typically not directly used in the final products that are built around LUXEON emitters. 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 heat sinks. 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 3. List of commonly used chemicals that will damage the silicone overcoat of the LUXEON emitter. Avoid using any of these chemicals in the housing that contains the LED package.

CHEMICAL NAME	NORMALLY USED AS
Acetic acid	acid
Hydrochloric acid	acid
Nitric acid	acid
Sulfuric acid	acid
Ammonia	alkali
Potassium hydroxide	alkali
Sodium hydroxide	alkali
Acetone	solvent
Benzene	solvent
Dichloromethane	solvent
Gasoline	solvent
MEK (Methyl Ethyl Ketone)	solvent
MIBK (Methyl Isobutyl Ketone)	solvent
Mineral spirits	solvent
Tetracholorometane	solvent
Toluene	solvent
Xylene	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
Cyanoacrylate	adhesive

About Lumileds

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