

LUXEON Core Range CoBs

Assembly and Handling Information



Introduction

This application brief addresses the recommended assembly and handling procedures for the LUXEON CoB emitters. These emitters deliver high efficacy and quality of light for distributed light source applications in a compact LES Array. 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 the following LUXEON CoB products:

LUXEON CoB Core Range

LUXEON CoB Core Range PW

LUXEON CoB Core Pro

LUXEON CoB Core Range - High Density Gen 2

LUXEON Core Range CoB with CrispColor Technology

LUXEON CoB with FreshFocus Technology

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

Table of Contents

| | |
|--|-----------|
| Scope..... | 1 |
| Introduction..... | 1 |
| 1. Component | 3 |
| 1.1 Description..... | 3 |
| 1.2 Optical Center | 3 |
| 1.3 Handling Precautions..... | 3 |
| 1.4 Cleaning | 3 |
| 1.5 Electrical Isolation | 3 |
| 1.6 Mechanical Files..... | 3 |
| 1.7 Soldering..... | 3 |
| 2. Assembly Process | 4 |
| 2.1 Introduction | 4 |
| 2.2 Solder-less Connector Assembly Guideline | 5 |
| 2.3 Direct Attachment of LUXEON CoB to a Heat Sink | 5 |
| Part 1 — Make Electrical connections to LUXEON CoB:..... | 5 |
| Part 2 — Attach the LUXEON CoB to the heat sink: | 6 |
| 3. Thermal Management | 6 |
| 3.1 Thermal Interface Materials (TIM) Selection | 6 |
| 3.2 Heat Sink | 7 |
| 3.3 Temperature Probing and Characterization..... | 7 |
| 3.4 Thermal Measurements..... | 9 |
| Supplies and Equipment | 9 |
| Thermocouple Mounting Procedure | 10 |
| 4. Packaging Considerations—Chemical Compatibility..... | 11 |

1. Component

1.1 Description

The LUXEON CoB emitter consists of an array of LED chips which are mounted onto a metal-core printed circuit board (MCPCB) to facilitate assembly and handling. The MCPCB is made out of aluminum to ensure a good thermal path between the LEDs and the heat sink on which the LUXEON CoB is mechanically mounted.

The LED array is covered with a phosphor silicone mixture to enhance light uniformity and to shield the chip array from the environment. LUXEON CoB emitters include a transient voltage suppressor (TVS) chip under the silicone to protect the emitter against electrostatic discharge (ESD).

The backside of the MCPCB contains a 2D barcode which includes a unique serial number for each emitter.

1.2 Optical Center

The optical center coincides with the mechanical center of the LUXEON CoB emitter. Optical rayset data for the LUXEON CoB emitters are available at [lumileds.com](https://www.lumileds.com).

1.3 Handling Precautions

The LUXEON CoB 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 coating during handling, the LUXEON CoB emitter should only be picked up from the side of the package.

1.4 Cleaning

The LUXEON CoB 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 CoB 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 LUXEON CoB package. For more information regarding chemical compatibility, see Section 4.

1.5 Electrical Isolation

The aluminum substrate of the LUXEON CoB emitter is electrically isolated from the LED cathode and anode.

1.6 Mechanical Files

Mechanical drawings for the LUXEON CoB emitter are available at [lumileds.com](https://www.lumileds.com).

1.7 Soldering

LUXEON CoB emitters are designed to be mechanically secured onto a heat sink. For detailed assembly instructions, see Section 2.

2. Assembly Process

2.1 Introduction

A typical assembly with LUXEON CoB emitter consists of a LUXEON CoB mounted onto a heat sink with screws through a use of a suitable CoB holder (Figure 1). A thermal interface material (TIM) is applied between the LUXEON CoB and the heat sink to improve thermal conductivity. Secondary optics typically can be added to the LED module and secured via the holder. The holder also acts as a conduit for making electrical connections to LUXEON CoB, also known as connector. Lumileds does not recommend soldering wires to the LUXEON CoB electrode pads.

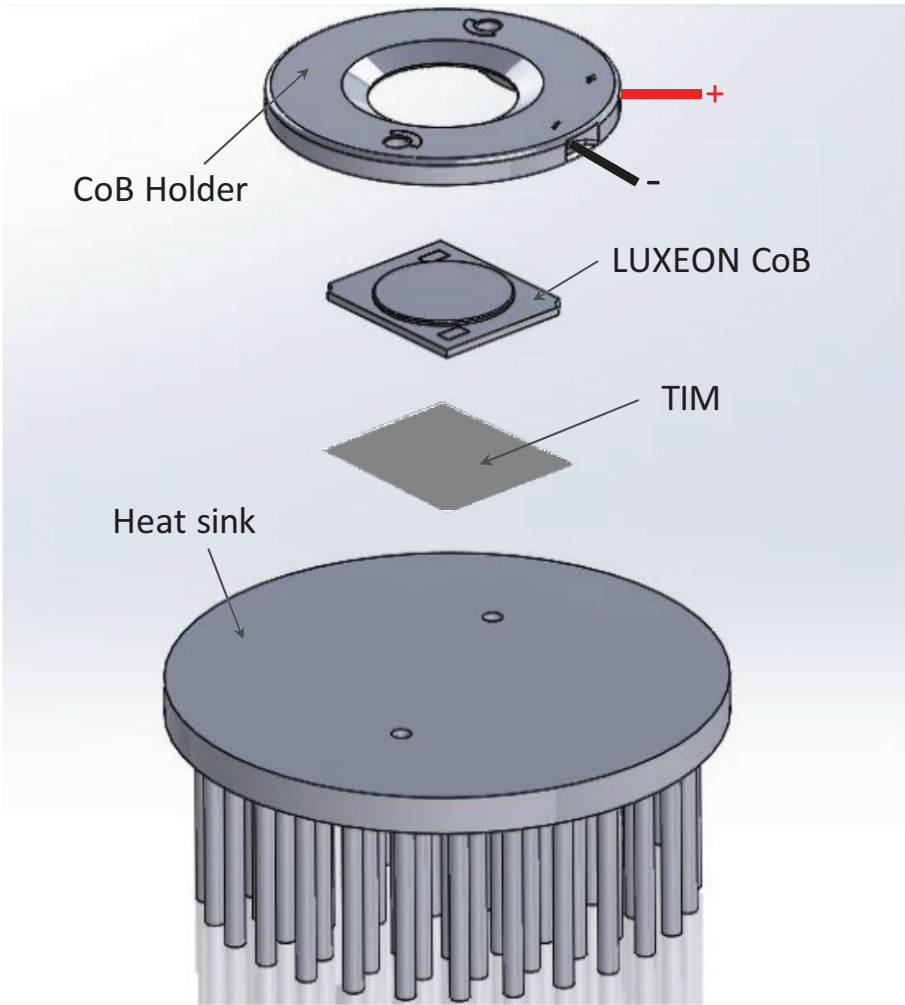


Figure 1. A typical LUXEON CoB assembly.

2.2 Solder-less Connector Assembly Guideline

Figure 2 shows a solder-less connector for the LUXEON CoB emitters. While there are multiple connector solutions, the assembly process is essentially the same and consists of four steps; heat sink preparation, Thermal Interface Material (TIM) application, LED/connector assembly and wire attachment.

1. Prepare the heat sink according to the connector manufacturers recommendations. This usually consists of drilling clearance holes for locating pins and drilling and tapping threaded holes at the screw locations. Once this is done, the heat sink should be cleaned thoroughly to remove any trace of tapping lubricants and metal shavings.
2. TIM should be applied to the back of the LUXEON CoB emitter or to the heat sink in preparation for the next step. Application method is dependent upon the type of TIM selected. For more details regarding suitable TIMs, see Section 3.1.
3. Mounting of the LUXEON CoB is dependent upon the type of solder-less connector chosen. For some types of solder-less connector solutions, the LUXEON CoB device must be snapped into place in the solder-less connector before placing the assembly onto the heat sink. For other types of solder-less connectors, place the LUXEON CoB onto the heat sink, align and drop the solder-less connector into place. Install mounting screws to the torque specified by the solder-less connector manufacturer.
4. The final step is to install wire leads to the connectors as recommended by the manufacturer and power up the device to test the connections.



Figure 2. A typical LUXEON CoB connector.

2.3 Direct Attachment of LUXEON CoB to a Heat Sink

This method is not recommended for production. It is provided for information only.

Part 1 — Make Electrical connections to LUXEON CoB:

Follow these steps to attach the electrical wires to the LUXEON CoB emitter:

Please Note: The phosphor layer should be covered when wires are soldered to the LUXEON CoB emitter. Please ensure that no solder flux or debris lands on the phosphor layer because this may impact the long-term performance of the LUXEON CoB emitter.

1. Prepare the electrical wires:
 - a. Cut the wires to size.
 - b. Strip a few millimeters of insulating material from the ends of the wires.
 - c. Pre-tin the wires with a small amount of solder.

2. Prepare the LUXEON CoB emitter:
 - a. Clean the electrical pads of the LUXEON CoB emitter with a lint-free swab and isopropyl alcohol to remove any debris or particles.
 - b. The substrate of the LUXEON CoB emitter is designed to dissipate heat quickly. This may make it difficult to get the temperature of the electrical pads to a point where the solder will reflow. Therefore it is important to place the LUXEON CoB emitter on a thermally insulating surface. Alternatively, place the LUXEON CoB emitter on a pre-heated hot plate set to 100°C/212°F, not to exceed 120°C/250°F.
 - c. Place the tip of the soldering iron on the electrical pad, apply solder and allow it to wet the electrical pad. Do not place the soldering iron on the electrical pad for more than 3 seconds to prevent any damage to the LUXEON CoB emitter.
3. Solder the pre-tinned wires to the pre-tinned electrical pads:
 - a. Place the pre-tinned LUXEON CoB emitter on a thermally insulating surface. Alternatively, place the LUXEON CoB emitter on a pre-heated hot plate set to 100°C/212°F, not to exceed 120°C/250°F.
 - b. Place the pre-tinned wire on the pre-tinned electrical pad.
 - c. Place the tip of the soldering iron on the electrical pad and allow the solder to reflow around the wire. Do not place the soldering iron on the electrical pad for more than 3 seconds to prevent any damage to the LUXEON CoB emitter. If a solder joint cannot be established within this time, allow the LUXEON CoB emitter to cool before reapplying the heat.
 - d. Remove the soldering iron and allow the solder to joint to cool.

Part 2 — Attach the LUXEON CoB to the heat sink:

1. Prepare the heat sink:
 - a. Ensure that the heat sink surface is clean and flat, with no crowns or peaks in the mounting area; crowns or peaks on the heat sink surface may adversely impact the thermal conductance between the LUXEON CoB emitter and the heat sink.
 - b. Wipe the heat sink surface clean with isopropyl alcohol (IPA).
 - c. Apply thermal interface material (TIM) onto the heat sink. For more details regarding suitable TIMs, see Section 3.1.
2. Place the LUXEON CoB emitter onto the heat sink and align the screw slots in the substrate with the tapped screw holes in the heat sink.
3. Secure the LUXEON CoB emitter to the heat sink with two screws.

3. Thermal Management

3.1 Thermal Interface Materials (TIM) Selection

Due to the low thermal resistance of the LUXEON CoB emitter and its large thermal footprint, a variety of thermal interface materials can be used to thermally connect the emitter to the heat sink (e.g. phase change materials, thermal tapes, graphite sheets). However, TIM selection should be made with the following considerations:

1. Pump out—Some TIMs will move out of the thermal path during extreme temperature excursions and create voids in the thermal path. These materials should not be used.
2. TIM thickness—Excessive thickness of some TIMs will present an unacceptable thermal resistance even though the thermal conductivity may be high.
3. Surface roughness—In order to fill the air gaps between adjacent surfaces, choose the appropriate TIM that minimizes the interfacial contact resistance.
4. Operating temperature—Some TIMs perform poorly at elevated temperatures. Care should be exercised to select a TIM that will perform well under the anticipated operating conditions.

5. Out-gassing—Out-gassing of some TIMs at design temperatures may produce undesirable optical or appearance qualities (e.g. fogging) in a sealed system. Special consideration must be given to limit this effect.
6. Clamping force—TIMs such as thermal tape or pads perform better when the right pressure is applied. Screws on corners only may not be suitable for certain TIMs which require high contact pressure between the substrate of LUXEON CoB and the heat sink. See Figure 3 and Figure 4 for more information.

Table 1 lists several TIMs that have been tested with LUXEON CoB. This data is provided for informational purposes only. Lumileds cannot guarantee the performance of the listed TIMs since LED operating conditions and long-term performance specification will vary with the application design.

Table 1. List of TIM materials that meet the TIM considerations outlined in this section. Note, though, that the actual performance of these TIM materials will depend on the final application.

| MANUFACTURER | TIM |
|-----------------|--------------------------------|
| Arctic Silver | Arctic Silver® #5 |
| GrafTech | Graphite Sheet 1205 |
| Thermalloy Inc. | Thermal Joint Compound (white) |

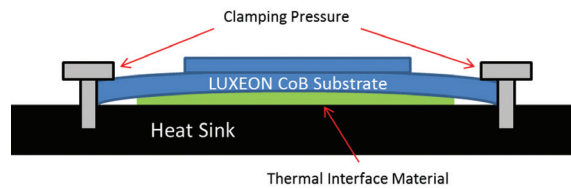


Figure 3. Example of poor TIM selection with direct attachment method. Clamping pressure causes deformation of the substrate at the edges because of TIM hardness. This method requires softer TIM types.

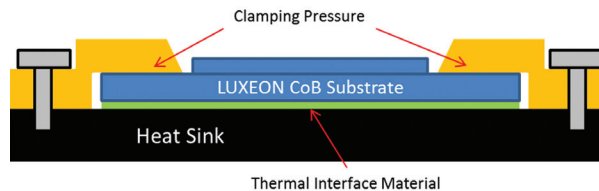


Figure 4. Example of a proper match between the TIM and attachment method. The clamping pressure in this example is more uniform and is less likely to cause substrate distortion even with harder style TIMs.

3.2 Heat Sink

A suitably rated heat sink (cooling capacity) should be selected and evaluated to allow the operation of LUXEON CoB to be operated below the maximum rated junction temperature under a wide range of operating conditions (can be influenced by installation and environment).

3.3 Temperature Probing and Characterization

The typical thermal resistance $R\theta_{(j-c)}$ between the junction and case for the different LUXEON CoB emitter configurations are published in the datasheet. With this information, the junction temperature T_j can be calculated according to the following equation:

$$T_j = T_c + R\theta_{j-c} \cdot P_{\text{electrical}}$$

In this equation T_c is the case temperature at the bottom of the LUXEON CoB emitter and $P_{\text{electrical}}$ is the electrical power going into the LUXEON CoB emitter.

In typical applications it may be difficult to measure the case temperature T_c directly. Therefore, a practical way to determine the junction temperature of a LUXEON CoB emitter is by measuring the temperature T_s of a predetermined sensor pad with a thermocouple. Each LUXEON CoB emitter has a circular sensor pad area in the lower right hand corner of the emitter. LUXEON CoB 1825 and 1321 packages are the exception, as these packages share the T_s pad with the Anode connector pad. Proper thermocouple attachment to the T_s or sensor pad area is shown in Figure 5.

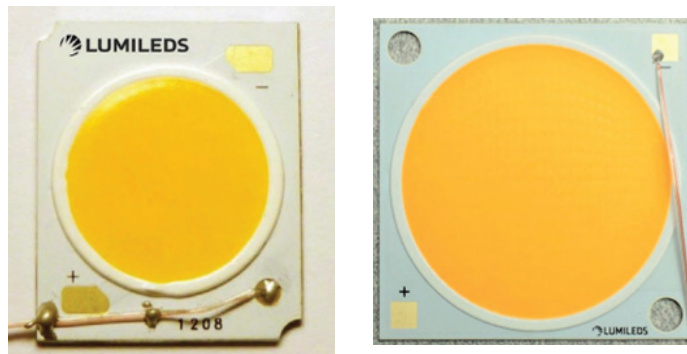


Figure 5. The recommended temperature measurement point T_s is located on the circular gold pad at lower right hand corner of LUXEON CoB 1208 emitter on the PCB (left). Note: LUXEON CoB 1321 and CoB 1825 emitters have a shared location for T_s and Cathode pad (right). T_c must be placed where it will not interfere with the electrical connection.

The thermal resistance $R\theta_{j-s}$ between the sensor pad and the junction of the LUXEON CoB emitter was experimentally determined. Table 2 summarizes the typical thermal resistance values for each LUXEON CoB emitter configuration.

Table 2. Typical thermal resistance from junction to T_s point of LUXEON CoB.

| PRODUCT FAMILY | MODEL | TYPICAL $R\theta_{j-T_s}$ (K/W) |
|--|-------|---------------------------------|
| LUXEON CoB Core Range Gen 5 LUXEON CoB Core Range Gen 6 | 1202S | 1.24 |
| | 1202 | 1.24 |
| | 1203 | 0.97 |
| | 1204 | 0.70 |
| | 1205 | 0.43 |
| | 1208 | 0.33 |
| | 1210 | 0.28 |
| | 1211 | 0.24 |
| | 1216 | 0.12 |
| | 1812 | 0.10 |
| | 1816 | 0.063 |
| LUXEON COB CORE RANGE Gen 3 and Gen 4 | 1202S | 1.24 |
| | 1202 | 1.24 |
| | 1203 | 0.72 |
| | 1204 | 0.57 |
| | 1205 | 0.48 |
| | 1208 | 0.37 |
| | 1210 | 0.26 |
| | 1211 | 0.27 |
| | 1213 | 0.18 |
| | 1216 | 0.15 |
| | 1321 | 0.14 |
| 1812 | 0.2 | |
| 1825 | 0.09 | |

Table continued on next page.

Table 2. Typical thermal resistance from junction to T_s point of LUXEON CoB, Continued.

| PRODUCT FAMILY | MODEL | TYPICAL $R\theta_{j-T_s}$ (K/W) |
|--|-------|---------------------------------|
| LUXEON CoB Core Range PW Gen 5 LUXEON CoB Core Range PW Gen 6 | 1202S | 1.24 |
| | 1202 | 1.24 |
| | 1203 | 0.97 |
| | 1204 | 0.70 |
| | 1205 | 0.43 |
| | 1208 | 0.33 |
| | 1210 | 0.28 |
| | 1211 | 0.24 |
| LUXEON CoB Core Range PW Gen 4 | 1203 | 0.43 |
| | 1205 | 0.33 |
| | 1208 | 0.28 |
| | 1210 | 0.24 |
| | 1211 | 0.27 |
| LUXEON CoB Core Pro | 1202 | 1.2 |
| | 1203 | 0.72 |
| | 1205 | 0.48 |
| | 1208 | 0.37 |
| | 1210 | 0.26 |
| | 1211 | 0.27 |
| LUXEON CoB Core Range HD Gen 2 | 1202s | 0.38 |
| | 1204 | 0.31 |
| | 1205 | 0.3 |
| LUXEON Core Range CoB with CrispColor Technology | 1202 | 1.2 |
| | 1202s | 1.41 |
| | 1203 | 0.95 |
| | 1204 | 0.83 |
| | 1205 | 0.62 |
| | 1208 | 0.55 |
| | 1211 | 0.29 |
| LUXEON CoB with FreshFocus Technology | 1216 | 0.19 |
| | 1208 | 0.55 |
| | 1211 | 0.29 |

3.4 Thermal Measurements

This section describes in detail how to mount a thermocouple onto the LUXEON CoB emitter in order to determine the junction temperature T_j .

Supplies and Equipment

Below is a list of supplies and equipment that is needed for T_j measurements:

- Type T precision fine wire (0.003" gauge diameter) thermal couple from Omega Engineering Inc. (part number: 5SRTC-TT-T-40-36)
- Eccobond one component, low temperature curing, thermal conductive epoxy adhesive from Emerson and Cuming (part number: E 3503-1) or Arctic Alumina Thermal Adhesive compound from Arctic Silver Inc. (part number: AATA-5G)
- Disposable 0.016" inner diameter fine needle tip from EFC Inc. (part number: 5122-B)
- Kapton tape
- Convection oven (for curing of Eccobond epoxy)
- Thermometer
- Magnifying glass or low power microscope (e.g. 5x to 30x)

Thermocouple Mounting Procedure

1. Familiarize yourself with the manufacturer's Material Safety Data Sheet (MSDS) and preparation procedures for the epoxy or adhesive compound.
2. Place the thermocouple tip on the sensor pad area T_s . The thermocouple must touch the substrate of the LUXEON CoB emitter to ensure an accurate reading. Note: LUXEON CoB 1321 and LUXEON CoB 1825 use the cathode pad as the T_s pad. Special care should be taken when attaching the thermocouple so that it does not interfere with the electrical connection or compromise the thermal measurement.
3. Use Kapton tape to secure the thermocouple wire onto the LUXEON CoB emitter.
4. Follow step a or step b below depending on the compound or adhesive that is used to thermally connect the thermocouple to the LUXEON CoB emitter.
 - a. Eccobond Thermal Adhesive Epoxy
 - I. Thaw the thermal conductive epoxy per manufacturer's recommendations.
 - II. Dispense sufficient epoxy into the 3CC barrel syringe with the fine needle tip. Store the balance per manufacturer's recommendations.
 - III. Drop a small amount of thermal conductive epoxy just enough to cover the thermocouple tip.
 - IV. Cure the epoxy per the manufacturer's recommendations. Make sure that the oven temperature does not exceed the maximum rated temperature of the LUXEON CoB emitter.
 - V. Let the board cool down to room temperature before starting any measurements.
 - b. Arctic Alumina Thermal Adhesive compound
 - I. Since this is a two part epoxy system with an approximate pot-life at room temperature after mixing of 3–4 minutes, make sure that proper setup is done to ensure that the epoxy can be dispensed within the pot-life span.
 - II. After mixing, put the epoxy immediately into the 3CC barrel syringe with the fine needle tip and dispense onto the thermocouple tip. Close to the end of the pot-life, it becomes difficult to dispense.
 - III. Alternatively, you can dip the fine needle tip into the epoxy mix and then "touch" the thermocouple tip to dispense the epoxy via surface tension.
 - IV. Cure the epoxy at room temperature (25°C) for at least two hours.
5. Once the epoxy/compound has hardened, the LUXEON CoB emitter can be mechanically mounted onto the heat sink as explained in Section 2.
6. Plug in the thermocouple connector to the thermometer. The thermocouple now measures the temperature T_s .
7. Connect the power supply to the LUXEON CoB emitter and power up the emitter with a drive current that corresponds to normal operating conditions. If possible, attach all fixtures (e.g. heat sink, lens and any cover) to closely simulate the actual application environment.
8. Record the temperature T_s once the LUXEON CoB emitter stabilizes. This may take several minutes or more depending on the overall design and thermal mass.
9. The junction temperature can then be estimated as follows:

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

4. Packaging Considerations—Chemical Compatibility

The LUXEON CoB 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 CoB 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 CoB 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 dome. Under heat and “blue” light, the VOCs inside the dome 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 dome 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 CoB 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 |
|---|----------------------------|
| 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 ^[1] |
| Acrylic Tape | adhesive |

Note for Table 3:

1. Other than the use of no-clean solder paste qualified by customer. Avoid secondary solder flux, for example, when manually soldering wires close to LUXEON emitter. Solder flux should not spit onto the LUXEON emitter surface or leave excessive secondary solder flux residue on the PCB when operating LEDs in an air tight enclosure or poorly ventilated enclosure.

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