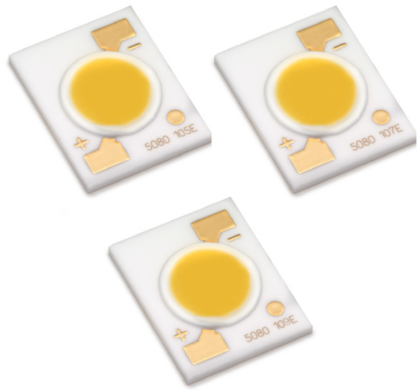
LUMILEDS

ILLUMINATION

LUXEON CoB Compact Range and LUXEON CoB 109 with CrispWhite Technology



Assembly and Handling Information

Introduction

LUXEON CoB Compact Range offers the industry's smallest Light Emitting Surface (LES) that enables more cost effective designs and provides good Center Beam Candle Power (CBCP) for crisp light beams with the best luminance and color uniformity. LUXEON CoB Compact parts are available in 3-step (80CRI and 90CRI) MacAdam ellipse, ensuring uniform optical performance in retrofit lamps and spotlight applications. LUXEON CoB Compact Range LEDs are all hot-tested at 85°C—real world operating conditions—which means that luminaire design is simplified and testing can be minimized. 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 Compact Range products:

LUXEON CoB 105 (L2C3-xxxx105E06000)
LUXEON CoB 107 (L2C3-xxxx107E06000)
LUXEON CoB 109 (L2C3-xxxx109E06000)
LUXEON CoB 109 with CrispWhite Technology (L2C3-xxxx109E06C00)

In the remainder of this document the term LUXEON CoB Compact LEDs refers to any product in the LUXEON CoB Compact Range of products listed above.

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1. Component

1.1 Description

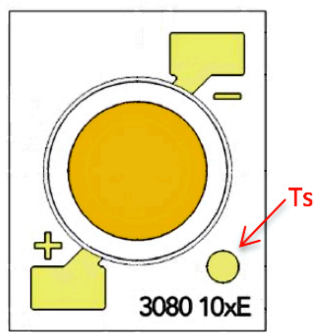
The LUXEON CoB Compact emitter consists of an array of LED chips which are mounted onto a ceramic substrate to facilitate assembly and handling. The substrate also ensures a good thermal path between the emitter and the heat sink on which the LUXEON CoB Compact emitter is mechanically mounted.

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 Compact emitters include a transient voltage suppressor (TVS) chip under the silicone to protect the emitter against electrostatic discharge (ESD).

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

LUXEON CoB Compact emitters come in 3 different illumination levels with a single form factor in order to meet different performance requirements. Figure 1 summarizes the key dimensions and thermal characteristics for each LUXEON CoB Compact emitter configuration.

LUXEON CoB Compact Range (105, 107 and 109)
and LUXEON CoB Compact 109
with CrispWhite Technology:



Outer Dimensions: 15mm x 12mm

LUXEON Compact CoB 105: $R\theta_{(J-S)} = 4.2$ °C/W
LUXEON Compact CoB 107: $R\theta_{(J-S)} = 2.3$ °C/W
LUXEON Compact CoB 109: $R\theta_{(J-S)} = 2.1$ °C/W
LUXEON Compact CoB 109CRSP: $R\theta_{(J-S)} = 2.3$ °C/W

Figure 1. Mechanical and thermal characteristics by LUXEON CoB Compact emitter configuration.

1.2 Optical Center

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

1.3 Handling Precautions

The LUXEON CoB Compact 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 Compact emitter should only be picked up from the side of the package (see Figure 2).

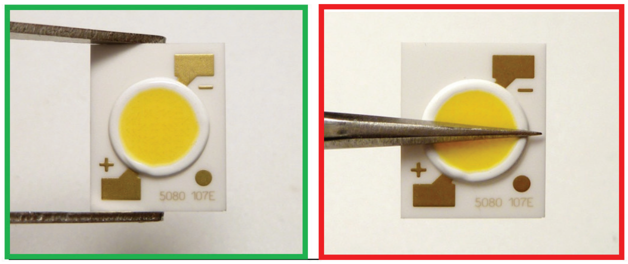


Figure 2. Pictures demonstrating correct (left) and incorrect (right) handling of a LUXEON CoB Compact emitter.

1.4 Cleaning

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

1.5 Electrical Isolation

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

1.6 Mechanical Files

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

1.7 Soldering

LUXEON CoB Compact emitters are designed to be mechanically secured onto a heat sink. For some installations, electrical wires may have to be soldered onto the electrical pads. For detailed assembly instructions, see Section 2.

1.8 Design Resources: Eco-System for the LUXEON CoB Compact Range

Design tools and compatible components can be found at: lumileds.com/designtools. Registration is required to access this website.

2. Assembly Process

2.1 Introduction

LUXEON CoB Compact emitters are designed to be mechanically mounted onto a heat sink, facilitating the design and assembly of retrofit and down-light applications. Several types of solder-less connectors are currently available for the LUXEON CoB Compact emitters. Care must be taken to determine the appropriate mounting solution for each application. Section 2.2 provides general guidelines for mounting a LUXEON CoB Compact emitter onto a heat sink with a solder-less connector. A list of LUXEON CoB Compact compatible clamps can be found on the LUXEON Eco-System webpage at: lumileds.com/designtools.

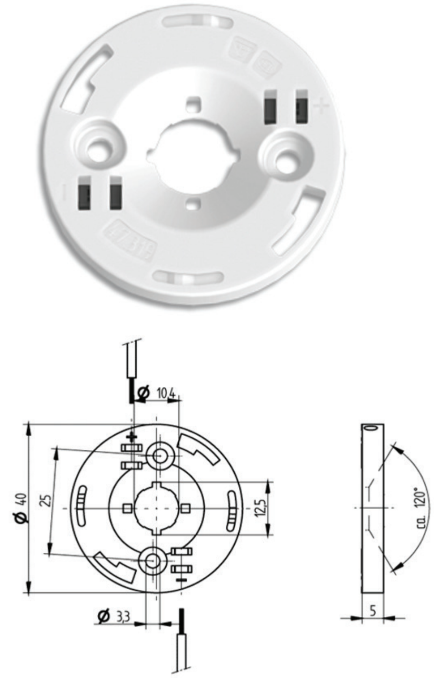


Figure 3. Reference dimensions for BJB 47.319.6180.50, a solder-less connector for mounting LUXEON CoB Compact emitters.

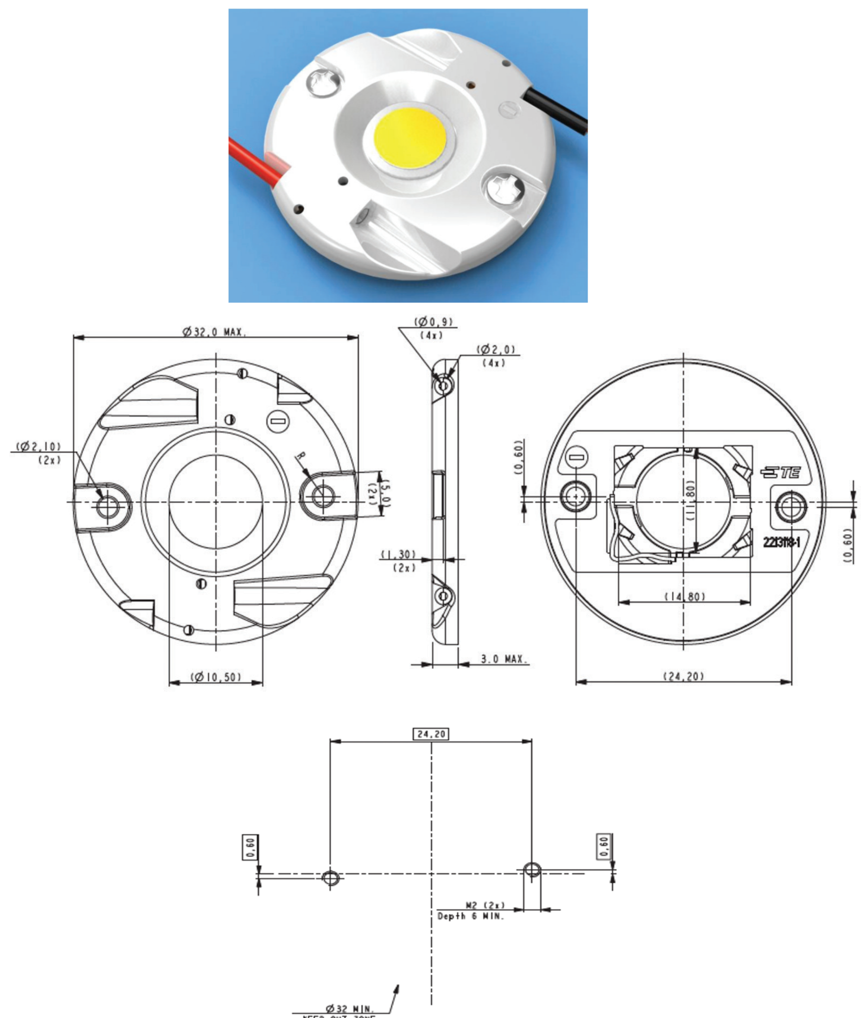


Figure 4. Reference dimensions for a LUMAWISE LED Holder, Type Z32 (TE 2213118-1). This is a solder-less connector for mounting LUXEON CoB Compact emitters. See TE Application Specification 114-32045 for detailed mounting instructions.

2.2 Solder-less Connector Assembly Guideline

Figure 3 and Figure 4 show just two examples of solder-less connectors which are available for LUXEON CoB Compact. While there are multiple connector solutions, the assembly process is essentially the same and consists of four steps: heat sink preparation, application of thermal interface material (TIM), LED/ connector assembly, and wire attachment. More details for each step are provided below:

1. Prepare the heat sink according to the connector manufacturer's 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 traces of tapping lubricants and metal shavings.
2. The TIM be should be applied to the back of the LUXEON CoB Compact emitter or to the heat sink in preparation for the next step. The application method is dependent upon the type of TIM selected. For more details regarding suitable TIMs, see Section 3.1
3. The mounting sequence of the LUXEON CoB Compact is dependent upon the type of solder-less connector chosen. For some types of solder-less connector solutions, such as TE 2213118-1, the LUXEON CoB Compact 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 Compact emitter 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.

2.3 Direct Attachment of Wires to the LUXEON CoB Compact Range

Some custom clamping systems may require that wires are directly attached to the LUXEON CoB Compact emitter. Please note: The phosphor layer should be covered when wires are soldered directly to the LUXEON CoB emitter to prevent any solder flux or debris from landing on the phosphor layer. Any flux residue which is left after assembly on the LUXEON CoB Compact emitter may negatively impact its long-term performance.

Follow these steps to attach electrical wires to LUXEON CoB Compact:

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 Compact emitter:
    a. Clean the electrical pads of the LUXEON CoB Compact emitter with a lint-free swab and isopropyl alcohol to remove any debris or particles.
    b. The substrate of the LUXEON CoB Compact 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 Compact emitter on a thermally insulating surface. Alternatively, place the LUXEON CoB Compact emitter on a pre-heated hot plate set to 100°C/212°F.
    c. Cover the LES area prior to soldering with aluminum foil or similar heat resistant material to prevent solder, solder flux, or debris from coming in contact to the phosphor layer.
    d. 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 Compact emitter.
3. Solder the pre-tinned wires to the pre-tinned electrical pads:
    a. Place the pre-tinned LUXEON CoB Compact emitter on a thermally insulating surface. Alternatively, place the LUXEON CoB Compact emitter on a pre-heated hot plate set to 100°C/212°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 Compact emitter. If a solder joint cannot be established within this time, allow the LUXEON CoB Compact emitter to cool before reapplying the heat.
    d. Remove the soldering iron and allow the solder to joint to cool.
    e. The final step is to remove protective shield from LES area of the LUXEON CoB Compact emitter prior to operation.

3. Thermal Management

3.1 Thermal Interface Material (TIM) Selection

Due to the low thermal resistance of the LUXEON CoB Compact emitter and its relatively 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 Compact emitter and the heat sink. See Figure 5 and Figure 6 for more information.

Table 1 lists several TIMs that have been tested with LUXEON CoB Compact. This data is provided for informational purposes only. Lumileds cannot guarantee the performance of the listed TIMs in customer applications since LED operating conditions and long-term performance specifications 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)

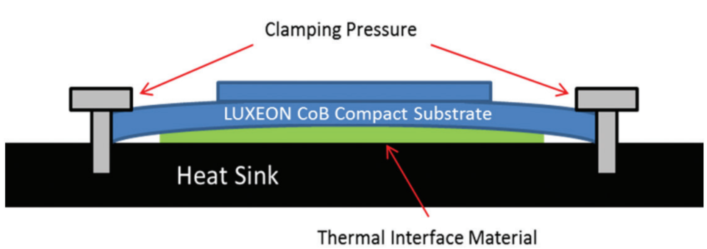


Figure 5. Example of poor TIM selection with direct attachment method. Clamping pressure causes deformation of the substrate at the edges because of TIM hardness. This method requires softer TIM types.

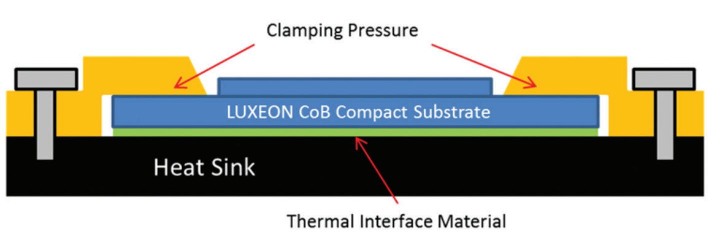


Figure 6. Example of a proper match between the TIM and attachment method. The clamping pressure in this example is more uniform and is less likely to cause substrate distortion even with harder style TIMs.

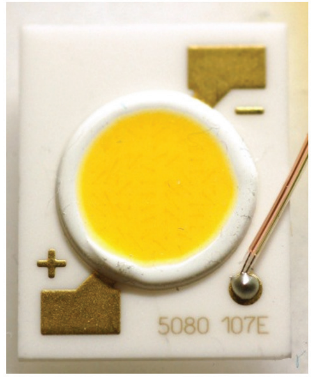


Figure 7. The recommended temperature measurement point T_S is located on the circular gold pad at lower right hand corner of LUXEON CoB Compact emitter on the PCB.

3.2 Heat Sink

LUXEON CoB Compact emitters must be mounted onto a properly sized heat sink in order to keep the junction temperature below the maximum acceptable junction temperature specified in the datasheet. A LED System Calculator is available at lumileds.com/designtools to aide in determining a properly sized heat sink for the expected operation conditions. The table below shows a sample of the expected LED junction temperatures for each LUXEON CoB Compact emitter type at the defined operating conditions.

Table 2. Calculated junction temperatures of various LUXEON CoB Compact emitters at defined system conditions.

SAMPLE SYSTEM THERMAL CALCULATIONS					
PRODUCT	AMBIENT TEMPERATURE (°C)	LED JUNCTION TEMPERATURE (°C)	SYSTEM THERMAL RESISTANCE $R_{th\ J\text{-}A}$ (°C/W)	LED DRIVE CURRENT (mA)	LED ELECTRICAL POWER (W)
LUXEON CoB 105	35	110	12	150	5.37
LUXEON CoB 107	35	110	10	200	7.00
LUXEON CoB 109	35	110	8	250	8.78
LUXEON CoB 109 with CrispWhite Technology	35	110	8	250	8.78

3.3 Temperature Probing and Characterization

The typical thermal resistance $R\theta_{(J\text{-}C)}$ values between the junction and case for the different LUXEON CoB Compact emitter configurations are published in datasheet DS139. With this information, the junction temperature T_J can be calculated according to the following equation:

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

In this equation T_C is the case temperature at the bottom of the LUXEON CoB Compact emitter and $P_{elecrical}$ is the electrical power going into the LUXEON CoB Compact 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 Compact emitter is by measuring the temperature T_S of a predetermined sensor pad with a thermocouple. Each LUXEON CoB Compact emitter has a circular sensor pad area in the lower right hand corner of the emitter. This sensor pad area is identified in Figure 2. Proper thermocouple attachment to the T_S or sensor pad area is shown in Figure 7.

The thermal resistance $R\theta_{(J\text{-}S)}$ between the sensor pad and the junction of the LUXEON CoB Compact emitter was experimentally determined. Figure 2 summarizes the typical thermal resistance values for each LUXEON CoB Compact emitter configuration.

3.4 Thermal Measurements

This section describes in detail how to mount a thermocouple onto the LUXEON CoB Compact 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 3CC barrel syringe from EFD Inc. (part number: 5109LL-B)
- 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 (see Figure 2 and Figure 7). The thermocouple must touch the substrate of the LUXEON CoB Compact emitter to ensure an accurate reading.
3. Use Kapton tape to secure the thermocouple wire onto the LUXEON CoB Compact 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 Compact 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 Compact 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 Compact 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 Compact 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 Compact 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:

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

4. Packaging Considerations — Chemical Compatibility

The LUXEON CoB Compact 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 Compact 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 Compact 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 Compact 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 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 dome of the mid-power 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
Acrylic tape	adhesive

About Lumileds

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To learn more about our portfolio of light engines, visit lumileds.com.

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