

XBright® & XThin® Au/Sn Die Attachment Recommendations

XBright and XThin LEDs are the latest generation of solid-state light emitting diodes available from Cree. XBright and XThin chips use a geometrically shaped Epi-down chip design combined with InGaN epitaxy and Cree’s proprietary SiC substrate, which results in a product providing superior light output and outstanding performance.

This applications note provides the user with a basic understanding of the XBright and XThin chip, information on the recommended packaging, and an overview of some constraints to be considered when packaging XBright and XThin LEDs.

A cross-sectional diagram of the die attach side of an XBright and XThin LED is shown in Figure 1 with nominal dimensions. During the wafer fabrication process, a highly reflective layer is added to the bottom of the chip to increase luminous intensity. Outside the reflector metal, a die attach metal layer is added. This die attach layer is composed of metals which act as a barrier to protect the reflector and terminates with gold/tin. Although passivation protects the edge of the epi layer, it should be noted that the distance from the bottom of the chip to the silicon-carbide substrate is 5 microns as shown in Figure 2. See “Schottky or Shunt Formation” section for additional information.

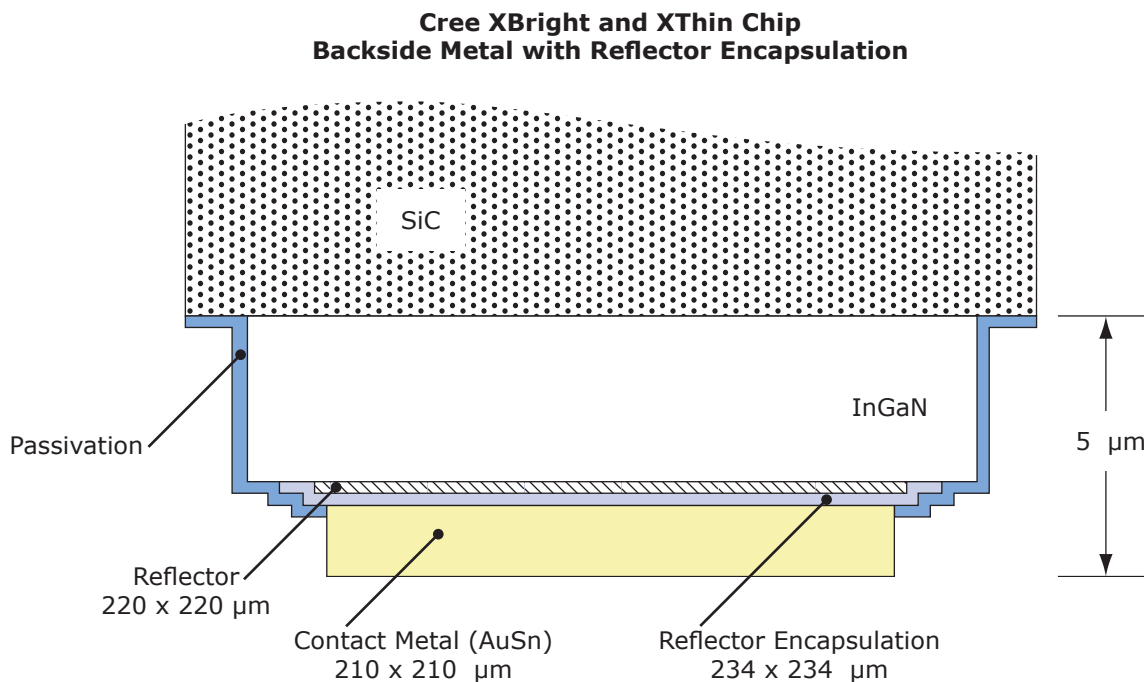


Figure 1. XBright and XThin chip design

"FLUX-EUTECTIC" DIE ATTACH

A robust die attach process is critical to achieve low electrical resistance, low thermal resistance and good mechanical and electrical integrity. The "flux-eutectic" die attach method is recommended for packaging XBright and XThin Au/Sn LEDs. In this attach method, there is no external force applied throughout the process. The advantage of this method is that no squeeze-out of the die attach metal occurs, reducing the risk of forming a Schottky contact to the n-substrate of the device.

During chip fabrication, an 80% Au / 20% Sn eutectic metal layer is deposited on the bottom of the chip. The melting temperature of this metal is 282°C. During assembly, a very small volume of flux is placed on the package substrate by pin transfer or other precision dispense method, and the chip is placed into the flux.

For example, a no-clean flux (such as Alpha Metals UP78) is dispensed into the cup via pin transfer with a dot size of approximately 200µm. After die placement, the leadframe is heated to 305°C for 5-8 seconds with direct heating method or hot air guns to reflow the AuSn metal. Subsequent cleaning in isopropyl alcohol in an ultrasonic bath for 15 minutes removes flux residue prior to wirebond and encapsulation. Figure 2 shows an XBright chip attached and wire bonded in a vertical leadframe cup.

When using the flux-eutectic die attach process, the user should take into account the following recommendations and precautions:

- Careful control of flux dispense volume is critical to minimize risk of die movement during reflow. In addition, the die should be placed through the flux and in contact with the package substrate prior to reflow.
- The peak temperature should be 20-30°C above the melting temperature of the solder that is used.
- An RMA flux results in good shear strengths; however, using too much flux causes poor melting of the AuSn.
- When packaging XBright and XThin LEDs, a flux clean is highly desirable – even if a "no-clean" flux is used. A 15-minute ultrasonic isopropyl alcohol clean is recommended.

In summary, the type of flux, the amount of flux used, and the reflow time and temperatures are critical factors that must be fully understood and controlled by the user to optimize die attach results and long term reliability of the packaged LED.

NOTE: All die attach process conditions listed above are provided only as an initial baseline. As each package and assembly system is unique, the user should thoroughly characterize their process conditions to optimize the performance of their product.

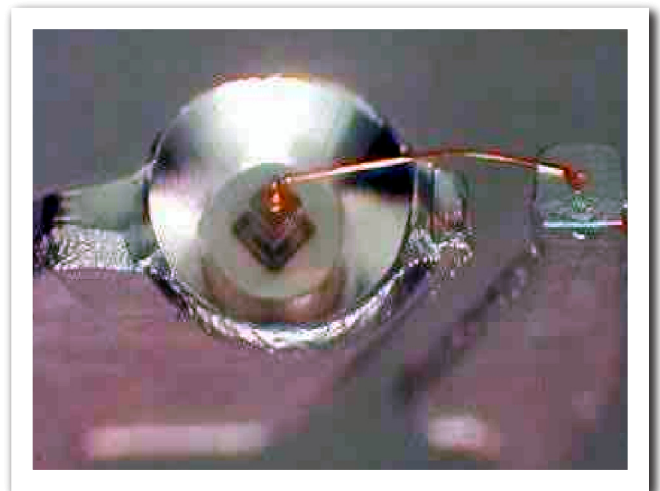


Figure 2. XBright chip attached and wire bonded in a vertical leadframe cup.

Other Considerations

Schottky or Shunt Formation

The close proximity of the edge of the silicon-carbide substrate to the metal on the bottom of the chip (~5 microns) must be considered when packaging XBright and XThin LEDs. A conductive path will be created if residual die attach material (i.e., AuSn) extends up the edge of the chip and contacts the silicon carbide. The flux-eutectic attach process was developed to minimize the likelihood of this defect occurring. However, it is still recommended that the customer verify that no shunt or Schottky contact has formed. A simple measurement of the forward voltage of a lamp at low current can easily determine if this problem exists. As can be seen in Figure 3, an acceptable lamp has a forward voltage, V_f , of $\geq 1.9V$ at $1 \mu A$, while an “unacceptable” device has a $V_f < 1.9V$ at $1 \mu A$. **It is highly recommended that the user perform this test in both product (reliability) qualification and production phases to verify acceptable packaging process control.**

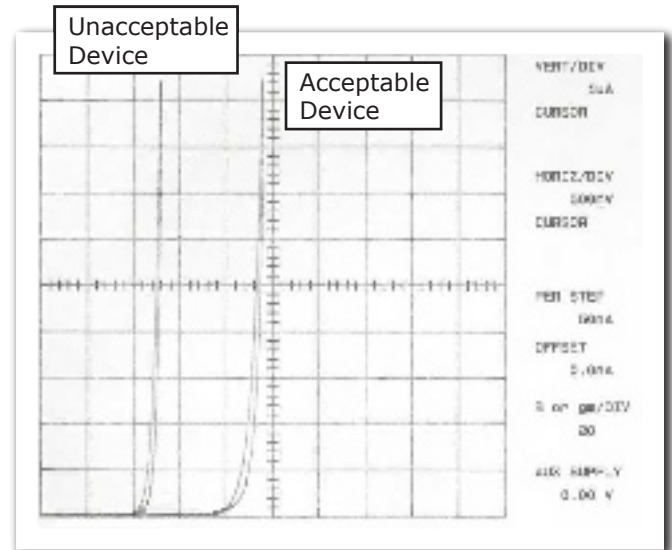


Figure 3. Criteria for Schottky formation.

Maintaining Barrier Layer Integrity

As noted previously, the backside metal layers act as a barrier to prevent tin from migrating into the reflector and reducing light output. When using automatic pick and place equipment during packaging operations, damage to the backside metal must be avoided to insure this barrier remains intact. **Ejector pin pressure must be kept at a minimum, and the Ejector pin travel should be synchronized to the pickup collet, to ensure the metal is not damaged.**

Post-Attach Processing Temperatures

Post packaging assembly temperature conditions must be controlled. Although the XBright and XThin chip itself is capable of withstanding temperatures of up to $325^{\circ}C$ for 5 seconds, long exposure of assembled lamps to temperatures above the melting temperature of the die attach material can cause the die to separate from the package substrate (i.e., leadframe cup). This could in-turn cause cracks in the die attach and ultimately failure of the product.