Silicone Encapsulation for LED
Advantages and Handling Precautions

AVAGO TECHNOLOGIES

Application Note 5288

Introduction

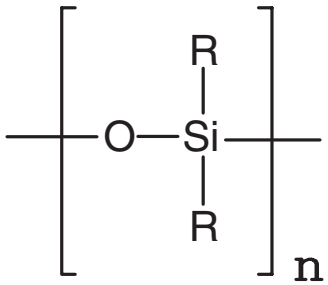
In recent years, LED brightness has improved tremendously due to advancement in LED die in terms of luminous efficiency and its ability to be driven under higher powered conditions. Due to these developments, the LED has been adopted in more applications, including high brightness illumination, backlighting and ESS that require high flux output and high driving current. Apart from the improvement in die technology, the challenges for the high brightness LED lies in the packaging technology, especially the encapsulation material, to ensure and further enhance its reliability.

Conventionally, epoxy has been used as the encapsulation material. Optical grade epoxy has good light transmission and high glass transition temperature (Tg) that is suitable for LED application. With expectation of higher luminous flux output, higher driving current and better long term reliability, silicone materials has been introduced to Avago's LED product line-up as the new generation of encapsulation material for LEDs.

Advantages of Silicone Encapsulant

Silicone can be formulated in different hardness properties, which are gel, elastic and hard types. Silicones used in optoelectronic products are generally elastic type to give the flexibility to encapsulated wire bond and die attach. This characteristic provides the ability to absorb thermal stress during the soldering process and during operation as well.

The chemical structure of silicone provides several advantages over epoxy encapsulant used in optoelectronic products. Its structure consists of bonding between Si and O called siloxane bond which has higher energy compare to the carbon (C) bond and oxygen (O) exist in epoxy. This characteristic gives the thermal and UV stability of silicone, which are the main characteristics needed for new generation LED products.



R = Organic groups

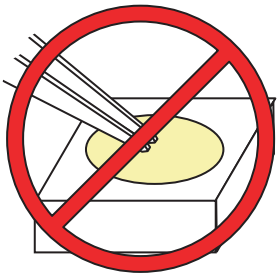
Figure 1. Example of Siloxane bond in silicone material

Prolonged exposure to high temperature, either from the environment or the internal LED die junction temperature, will cause deterioration of the encapsulation material including reduction of transmittance and yellowing of material. A similar deterioration issue applies to exposure to UV emission from sunlight for outdoor products and to the blue or white LEDs own near-UV emission. Silicone material exhibits superb stability towards heat and UV thanks to the strong siloxane bond, enabling long life performance of high brightness LEDs with little intensity degradation.

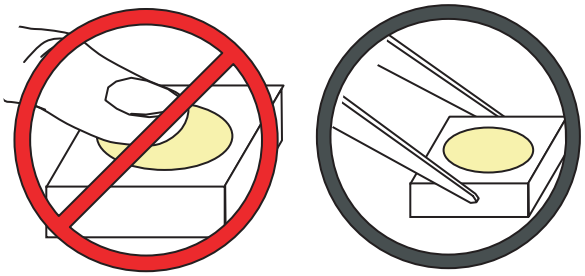
Handling Precautions

Compared to epoxy encapsulant that is hard and brittle, silicone is softer and flexible. Although its characteristic significantly reduces thermal stress, it is more susceptible to damage by external mechanical force. As a result, special handling precautions need to be observed during assembly using silicone encapsulated LED products. Failure to comply might lead to damage and premature failure of the LED.

1. Do not poke sharp objects into the silicone encapsulant. Sharp object like tweezers or syringes might pierce through the silicone and induce failures to the LED die or wire bond.



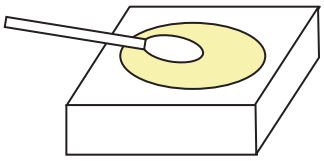
2. Do not touch the silicone encapsulant. Uncontrolled force acting on the silicone encapsulant might result in excessive stress on the wire bond. The LED should only be held by the body.



3. Do not stack assembled PCBs together. Abrasion between two PCBs assembled with silicone encapsulated LEDs might cause delamination of the silicone. Furthermore, components on the bottom side of the PCB might press or poke on the silicone. Use an appropriate rack to hold the PCBs.

4. Use the recommended nozzle size. For automatic pick and place, it is important to use nozzles that are within recommended size. Generally, the outer diameter or outer perimeter of the nozzle should be smaller than the silicone. For exceptions and details, please refer to the recommended nozzle size specified in the respective product datasheet.

5. Clean the silicone surface gently using a cotton bud. Silicone material attracts dusk and dirt easier than epoxy due to its surface tackiness. To remove foreign particles on the surface of silicone, a cotton bud can be used with Isopropyl alcohol (IPA) or acetone. During cleaning, rub the surface gently without putting much pressure on the silicone. Ultrasonic cleaning is not recommended for a silicone encapsulated LED.



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