

LED lamp packaging procedure

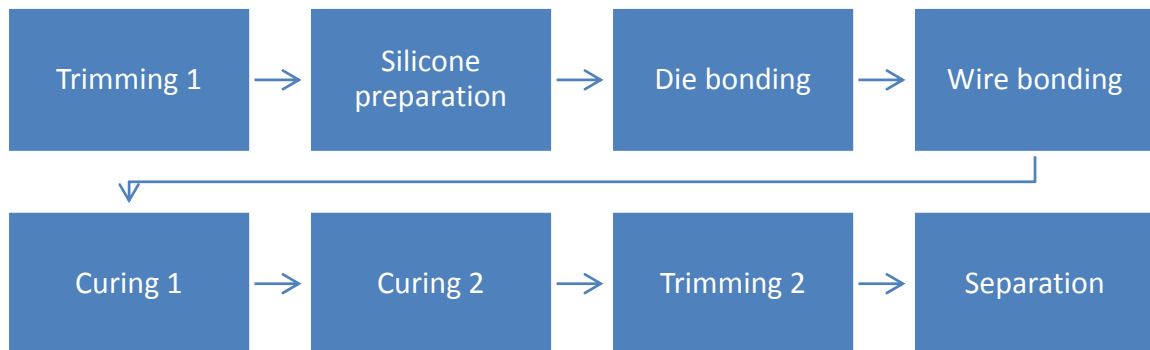
Purpose:

Light-emitting diode (LED) chips are usually mounted in a package that provides two electrically isolated leads (cathode and anode) and a transparent encapsulant which serves as a lens. Widely used encapsulant materials are transparent polymers with a refractive index ranging from 1.4 to 1.7. The purpose of using an encapsulant in LED lamp is to protect LED chips as well as increase the light-extraction efficiency. In this note, we would like to provide a fabrication procedure for encapsulating a conventional 5-mm-diameter (5-mm- ϕ) LED lamp by using a silicone encapsulant.

Components and necessities:

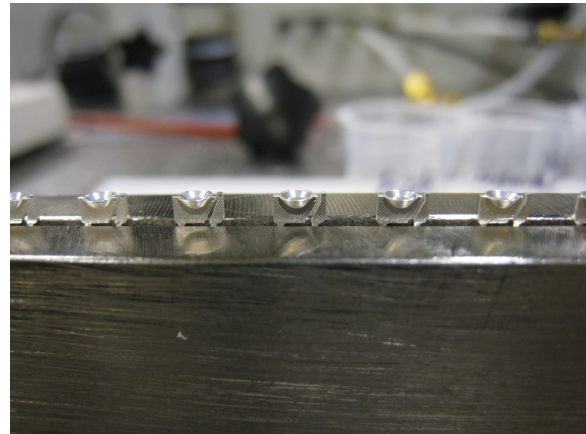
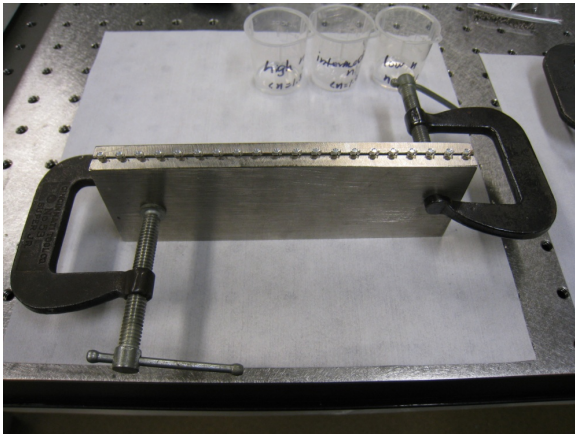
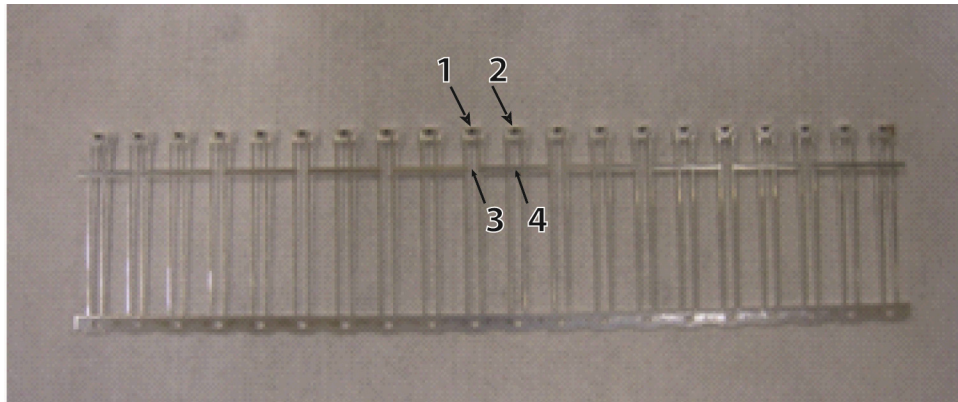
- a) Ag-coated lead frame
- b) Ag paste for die attachment (die bonding)
- c) Silicone encapsulant materials from Dow Corning and Nusil
- d) 5-mm- ϕ round-top molding cup
- e) Oven and electronic balance accurate to the milligram (mg) range
- f) Syringe, plastic bottle, and needle

A flow chart of the whole lamp packaging procedure is as follows:



Procedure

1. **Trimming and stabilizing of the lead frame.** There are 20 reflector cups in one lead frame. Usually we place LED chips on every other reflector cups, starting with the second one from left to right. The ones without LED chips are used for supporting purpose. As we can see from the photograph below, the reflector cup 1 is the one that is holding the LED chips, while the reflector cup 2 is the one that is not. The lead bars between the cathode and anode of the reflector cups which are holding LED chips, are cut at this time (as indicated by arrow 3), while the rest are kept for supporting purpose (as indicated by arrow 4). Two metal plates and two clips are used to stabilize the lead frame as well as to support it for the process of wire bonding. The two metal plates and two clips are shown in the photographs below.

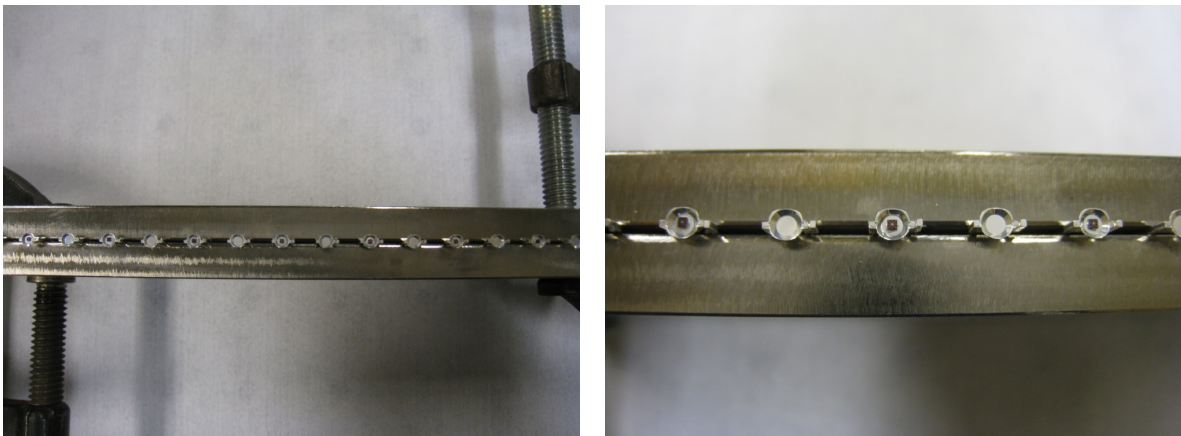


2. **Silicone preparation.** Usually a silicone encapsulant is a mixture of two parts (Part A and Part B, or Base and curing agent). Pour each part of the silicone into a small plastic bottle with the required ratio of two parts by using an electronic balance. For example, the LS-6257 silicone requires a mass ratio of 1:1 (equal mass) between part A and part B. Usually we measure 1 gram of each part and then mix them thoroughly by stirring the

mixture with a needle or a small stick for 2 or 3 minutes. The photograph below shows the silicone mixture right after mixing; as we can see, some bubbles have appeared due to the stirring. Wait until all the bubbles have vanished before using the mixture. Usually this will take about 20 minutes.

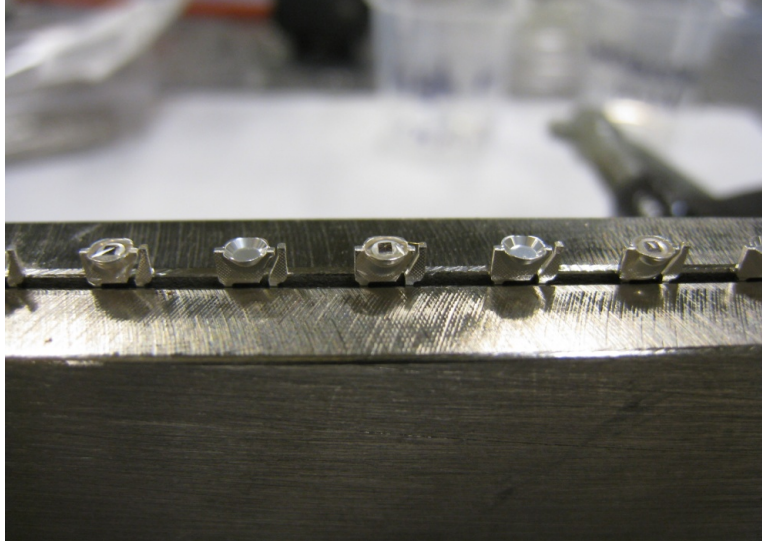


3. **Die bonding.** Use a needle to place a very small amount of silver-loaded electrically conductive epoxy (silver epoxy) into the reflector cups of the lead frame, and then put LED chips on top of the silver epoxy into the reflector cups. Move the LED chips with the die bonding machine and make sure they stay in the center of the reflector cup. After that, put the lead frame in an oven to cure the silver epoxy. For the epoxy we use, the curing temperature and time is 150 °C and 15 minutes, respectively.

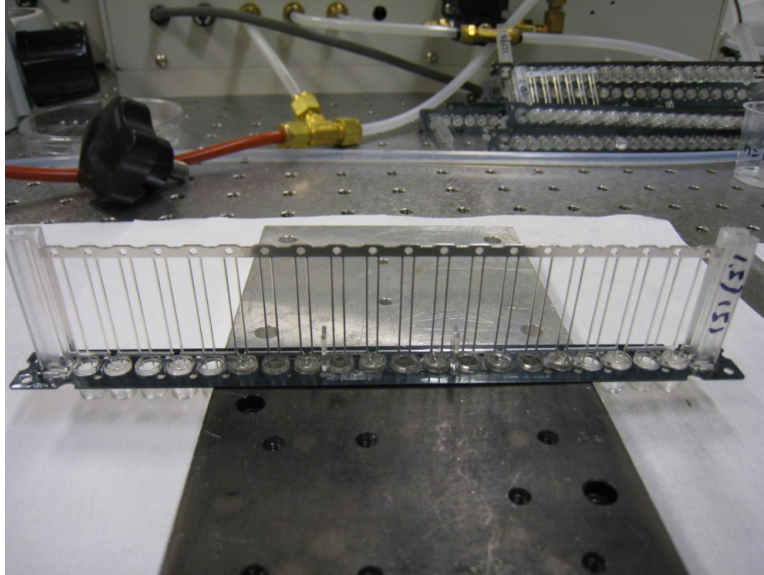


4. **Wire bonding and first silicone curing.** After the silver epoxy is cured, take the lead frame out of the oven and immediately do the wire bonding by using a wire-bonding machine. After wire bonding, use a needle to fill the reflector cups with silicone. The

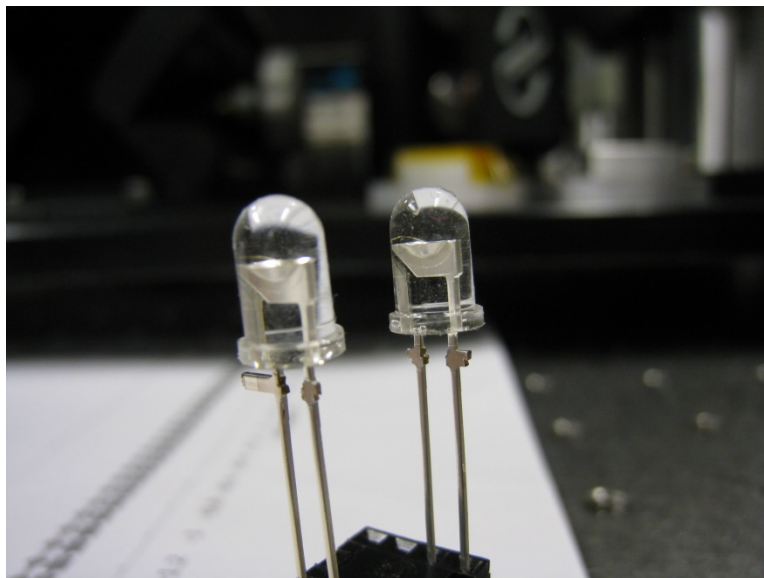
silicone should fill into the whole reflector cup, completely cover the LED chip, and have an arc top when finished, as shown in the photograph below. Then put the lead frame into the oven to cure the silicone in the reflector cup. For the silicone we used, the common curing temperature is about 150 °C, and the curing time ranges from 30 minutes to 1 hour.



5. **Second curing of silicone in the mold.** After the silicone in the reflection cup is cured, test by poking a needle on the silicone to see whether it has a desired viscosity or not. Take the lead frame out of the oven and let it cool down to room temperature. Then carefully loosen the clips and take the lead frame out of the metal plates and put it into the mold which has already been filled with silicone (if needed, a mold release spray could be coated onto the mold before filling it with silicone). After this has been accomplished, put the lead frame in the oven to cure the silicone in the mold.



6. **Second trimming and separation from the mold.** After the sample is cured, take it out of the oven and carefully trim the lead frame to separate the lamps. Be very gentle and careful during the trimming process because mechanical vibrations can easily break the gold bonding wires. We suggest slipping a glass slide between two leads of the lead frame when cutting the wires to reduce mechanical vibration during trimming. Finally, pull out the LED lamp from the mold cup. The photograph below shows two encapsulated LEDs.



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