Processing and Mounting Information for the CERAMOS® LED

Application Note

Abstract

This document provides information for processing and surface mounting of the CERAMOS® LED.

Introduction

The CERAMOS® LED was primarily developed for use as a flash lamp in mobile telephones with integrated digital cameras.

The LED consists of a miniature package with dimensions of 2.1 mm x 1.65 mm x 0.75 mm combined with the latest highly-efficient Thinfilm and ThinGaN® chip technologies.

In addition to its use as a flash lamp, the CERAMOS® LED is also used in other areas. Especially for applications in which the available space is critical and requirements for high light power exist, it represents an ideal choice.
Depending on the chip technology used, the CERAMOS® LEDs can be deployed as a light source in the following areas, for example:

- Flashlights
- Replacement of miniature incandescent lamps
- Video lamps
- Panel lighting (interior, Dashboard)
- Display backlighting with high brightness requirements

Presently, the CERAMOS LED is primarily available as a white LED in various nuances of color with a clear or diffused silicone encapsulant, and in red and yellow.

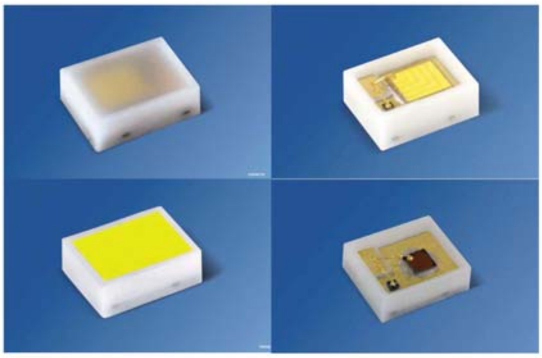

Figure 1: Overview of the CERAMOS® LEDs

Handling

In order to protect the semiconductor chip from environmental influences, the CERAMOS® is equipped with a silicone encapsulant.
Due to its elastic properties, however, mechanical stress to the silicone must be minimized or avoided to the extent possible (see Application Note "Handling of Silicone Resin LEDs").

In general, the use of all types of sharp objects should be avoided in order to prevent damage or penetration of the encapsulant, since this can lead to a degradation or complete failure of the component.

For manual assembly and placement such as for the production of prototypes, for example, the use of so-called vacuum tweezers is recommended. By means of individually exchangeable soft rubber suction tips, the effective mechanical stress on the LED is minimized (Figure 2).

Figure 2: Examples of vacuum styluses.

The vacuum stylus functions such that by pressing on the button, a vacuum is created, similar to vacuum tweezers, with which the component (e.g. the LED) can be lifted. By releasing the pressure on the button, the vacuum is removed and the component can be placed at the desired position.

When processing by means of automated placement machines, care should be taken that an appropriate pick and place tool is used and that the process parameters conform to the package characteristics.

The use of a typical small, round tool can cause damage (e.g. cracks, breaks) to the housing or to the entire component.

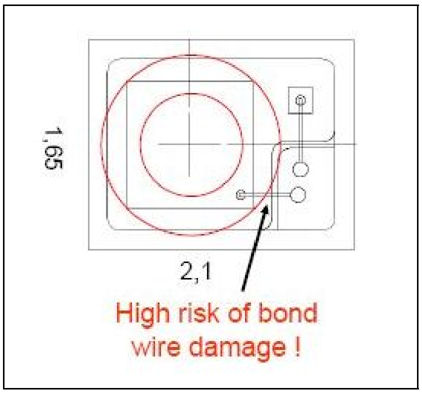

Figure 3: Orientation of a typical tool

Figure 4 shows the recommended design of a placement tool for damage-free processing of the CERAMOS® LED.

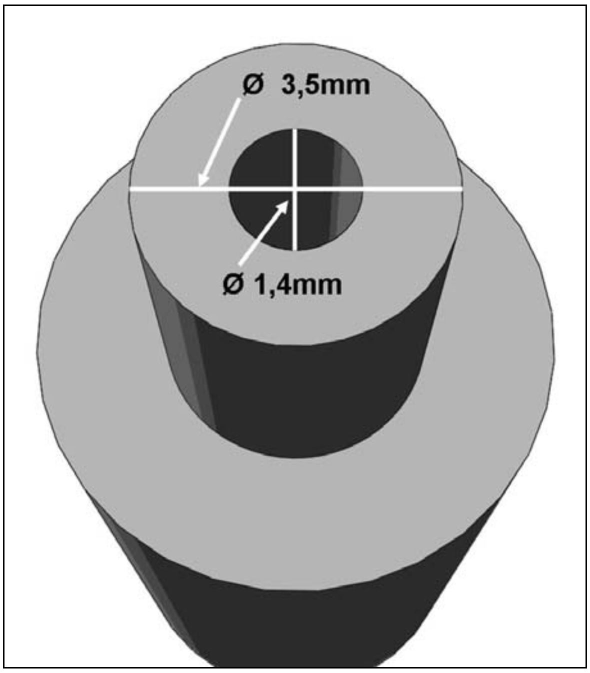

Figure 4: Recommended design of the pick and place tool for the CERAMOS® component

With automatic processing, care should generally be taken that the forces acting upon the LED are kept as low as possible.

Processing (Mounting and Soldering)

Delivery of the CERAMOS® LEDs occurs by tape and reel.
Each reel consists of a single brightness group and a single wavelength group per color or color coordinate group.
That is, from the various family groups available, each consisting of several brightness groups, a single tape contains only one of the groups.

Generally, the CERAMOS® is compatible with existing industrial SMT processing methods, so that all current populating techniques can be used for the mounting process.

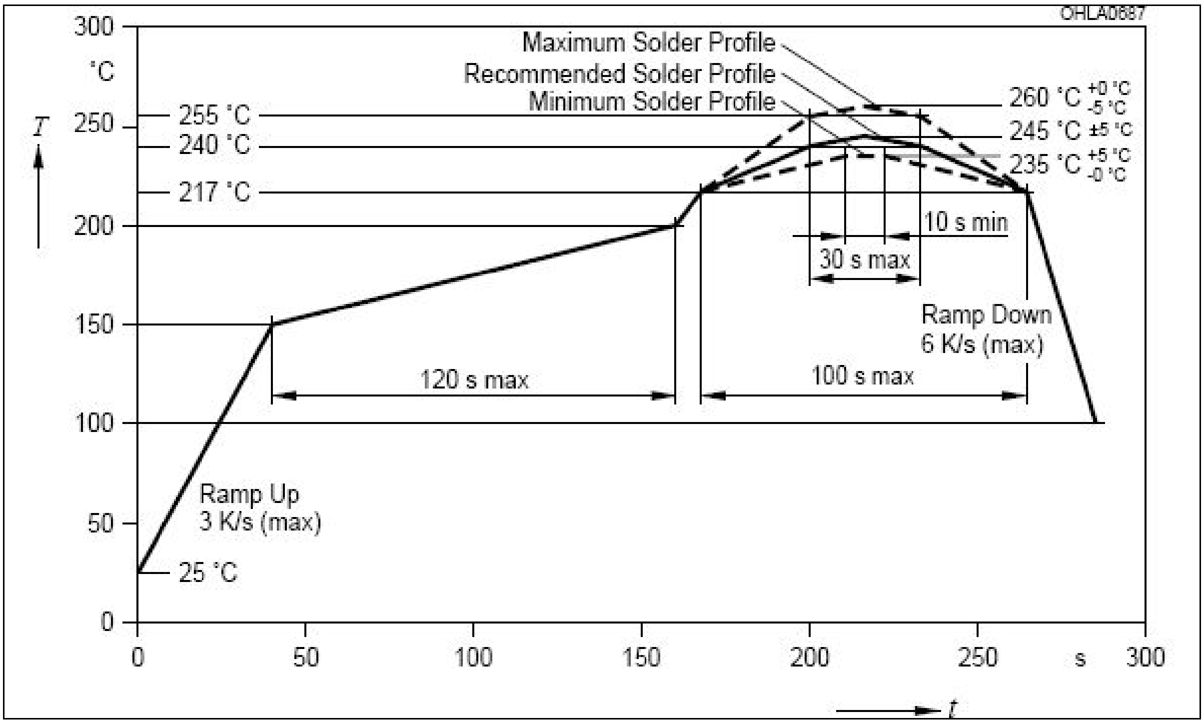

Figure 6: Reflow solder profile for lead-free solder

A standard reflow soldering process is recommended for mounting the component, in which an ordinary lead-free SnAgCu metal alloy is used as solder.
Figure 6 shows the soldering conditions and temperature profile for lead-free reflow soldering.

Prehandling of the LED should correspond to JEDEC Level 4.

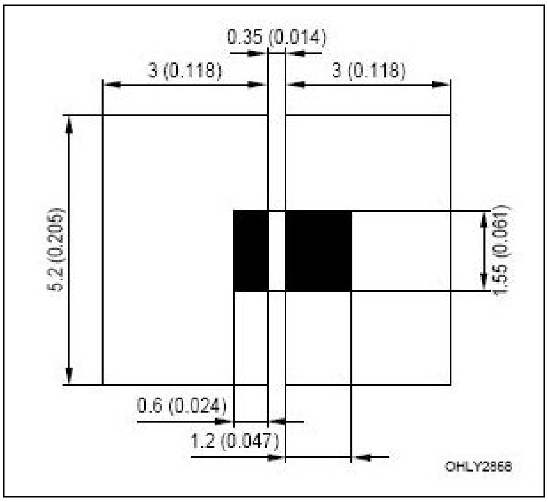

Figure 7: Recommended solder pad design for the CERAMOS® LED

In order to achieve an optimal mounting of the LED to the circuit board and therefore guarantee the performance of the LED, it is advantageous to use the recommended solder pad design (Figure 7) in most cases.

Since the solder pad effectively forms the direct contact between the LED and the circuit board, the design decisively contributes to the performance of the solder connection.
The design has an influence on the adhesive strength, the self-centering effect and the thermal dissipation, for example.

Manual soldering for prototypes and repair

Manual processing of the CERAMOS® LED is only conditionally possible with increased effort due to the position of the connection contacts on the underside of the package.

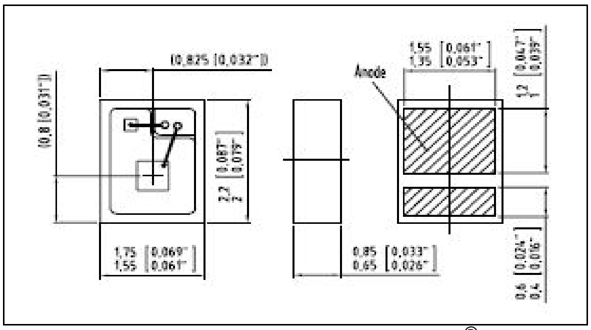

Figure 8: Views of the CERAMOS® LED

Since soldering with a normal soldering iron is not possible, it is recommended that the LED be mounted with the assistance of solder paste or soldering plates and an oven or regulated heating plate.
Hot air (e.g. from hot air driers, gas soldering irons) is also suitable for manual soldering of the CERAMOS® LED.

Figure 9: Example of a gas soldering iron with hot air functionality

In general, care should be taken that the temperature is not too high and that the circuit board can withstand the thermal stress. Ideally, the approach should be tested up front.

The same applies for the repair or exchange of a defective LED from a board.

Thermal Considerations

Since thermal loads of up to 3 Watts are achieved when the CERAMOS® LED is used as a flash lamp, it is recommended to investigate and test the thermal management with regard to its appropriateness.

Only with a functioning thermal management (thermal dissipation) the optimal LED performance can be achieved for the application.

The following mounting methods were therefore investigated with regard to their thermal characteristics and their behavior in various modes of operation was simulated.

In the process, mounting on three typical circuit board materials was considered.

1. LED mounted on FR4 main PCB
2. LED mounted on Flex on Al PCB
3. LED mounted on IMS

For the thermal simulation, the following limit conditions were specified:

- Ambient Temperature: T_{amb} = 35°C
- Heat transfer coefficient of mobile phone cover: $\alpha = 8\ Wm^{-1}K^{-1}$

Figures 19, 20 and 21 show three different PCB materials on which the CERAMOS® LED (Flash LED) is mounted. The material characteristics of the PCBs are given below.

1. FR4 PCB

- LED on FR4 main board
- PCB with 8 Cu layers
- PCB thickness 1.15 mm
- Size 10x10 mm

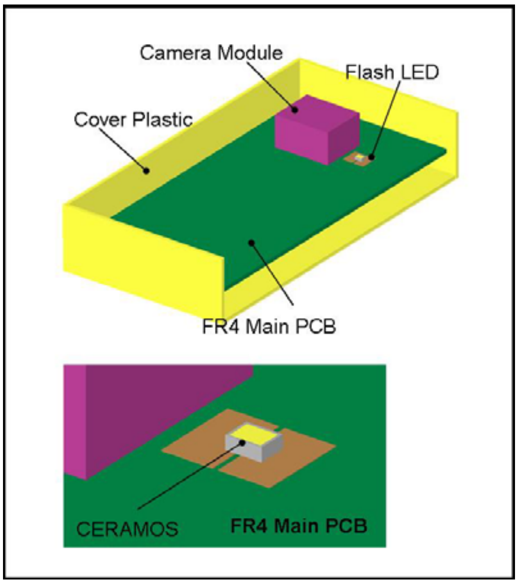

Figure 19: LED on FR4 main PCB

2. Flex PCB on aluminum

- LED on Flex PCB on Al
- PCB with 1 mm Al and 50 µm adhesive
- Flex Layer with 50 PI
- Size 10x10 mm

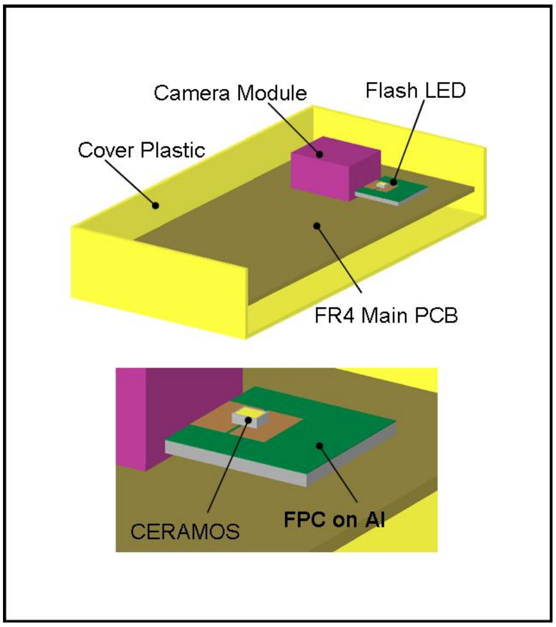

Figure 20: LED on separate Flex on Al PCB

3. IMS (insulated metal substrate)

- LED on IMS
- PCB with 1 mm Al and 75 µm enhanced dielectric
- Size 10x10 mm

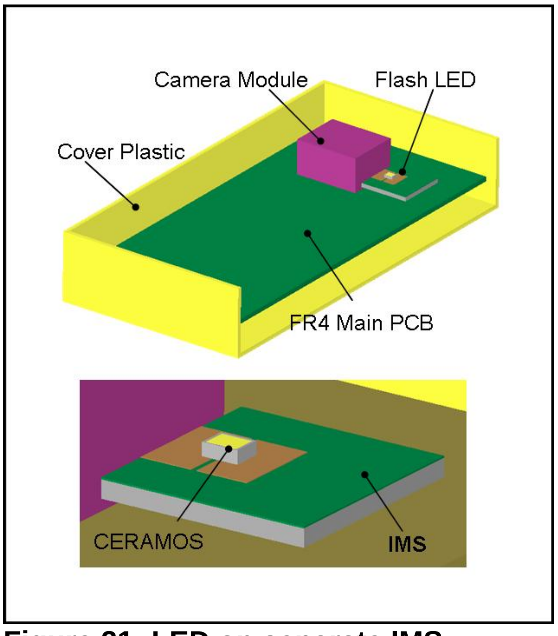

Figure 21: LED on separate IMS

The thermal simulation was done for 5 flash cycles with a flash pulse condition of

- t_P = 300 ms
- T_{total} = 3 s
- D = 0.1
- I_f = 750 mA

The results of the thermal simulation are shown in Figure 22.
The simulation demonstates that there is only a minor difference in the thermal behavior between the two materials FR4 main PCB and flex on aluminum.
Both materials show sufficiently good thermal conductivity for flash operation since the increasing junction temperature remained below the allowable maximum of 175°C during flash operation.

The design with IMS material had significantly better characteristics in comparison to the two others and showed better thermal characteristics during flash operation.
Even after 5 pulses, the junction temperature remained significantly below the allowable maximum.
The design with IMS material also included considerable potential for operation at higher currents.

According to the results of the thermal simulation, all three materials are suitable for mounting the CERAMOS LED as a flash lamp in mobile telephones.
The somewhat more expensive IMS material possesses the best thermal characteristics, and is also the one material which is suitable for operation at higher currents (up to 1 A).
Mounting onto a normal FR4 main board or flexible PCB with aluminum is less expensive but results in more restrictive thermal characteristics.

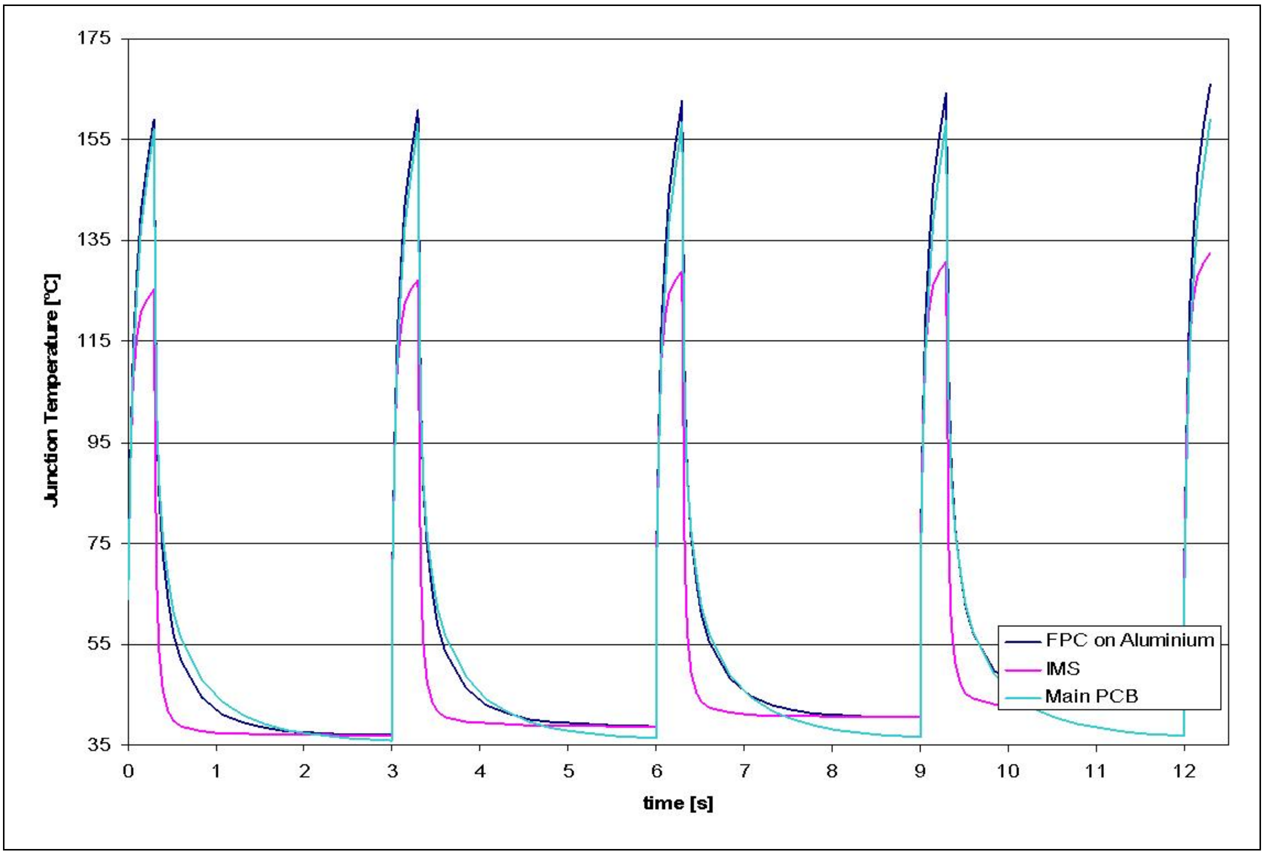

Figure 22: Comparison of different PCB materials for flash operation @ I=750 mA

Summary

With its compatibility to customary processing techniques, the CERAMOS® LED places no exceptional requirements with respect to processing.

Under consideration of the generally available standards for SMT mounting of the CERAMOS® LED and observance of the recommended mounting guidelines, excellent soldering results can be achieved.

In general, it should be noted, however, that the housing of the CERAMOS® LED is made of ceramic and therefore is significantly more brittle than plastic housings.

When developing the circuitry, special attention should be given to the position and orientation of the LED on the circuit board.
Depending on the position and orientation of the LED, the mechanical stress on the LED can vary.

In general, it is recommended that all twisting, warping, bending and other forms of stress to the circuit board to be eliminated after soldering in order to prevent breakage of the LED housing.
In addition, separation of the circuit boards should not be done by hand, but should exclusively be carried out with a specially designed tool.

Appendix

Don't forget: LED Light for you is your place to be whenever you are looking for information or worldwide partners for your LED Lighting project.

www.ledlightforyou.com

Author: Andreas Stich

About Osram Opto Semiconductors
Osram Opto Semiconductors GmbH, Regensburg, is a wholly owned subsidiary of Osram GmbH, one of the world's three largest lamp manufacturers, and offers its customers a range of solutions based on semiconductor technology for lighting, sensor and visualisation applications. The company operates facilities in Regensburg (Germany), San José (USA) and Penang (Malaysia). Further information is available at www.osram-os.com.