APPLICATION NOTE

LED Chip Heat Dissipation Mapping

The LED chip is the core component of LED lighting. If the chip temperature is too high, the LED life and luminous quality could be severely affected.

What is a heat sink and why is it important?

A heat sink is a common component in many electronic devices. It transfers the heat created by a device, acting to reduce the device's temperature to prevent overheating. Heat sinks are an important part of LED lighting, more specifically LED chips. The heat sink aids in heat dissipation of the chip, ensuring that the temperature of these chips stays within the appropriate range. Testing heat sinks in the production process of LED chips is critical to ensuring quality.

Infrared cameras can be used in the R&D process to check LED heat sinks. The readings from a camera can help manufacturers find potential problems with materials and designs, to better analyze and improve heat sink quality.

Relationship between the LED chip temperature and the heat sink

To continue operating properly, LED chip temperature should not exceed 120 °C. As chip temperature increases, the unfortunate reality is that service life decreases. So, if the chip temperature is very high, or even worse, exceeds 120 °C, service life of the chip will be shortened.

Therefore it is important to stay below 120 °C to maintain chip performance and service capability. This emphasizes the importance of the heat sink—the heat sink is what cools the LED chip. If the heat sink is unavailable, poorly designed, or made of improper material, the heat dissipation effect will be seriously affected, thus shortening the LED service life or resulting in a change of LED color.

CASE:

We worked with the R&D department for a large LED manufacturer to understand how LED chips are tested. The manufacturer stated the importance of the heat dissipation effect and heat sink size when designing a heat dissipation scheme for the chip. Six types of heat sinks were designed for research.

As shown in Figure 1, the heat sink area increases as you move from bottom left to top right. These figures have the same chip under the same input voltage, current and the same lighting time.

In Figure 2, the temperature at the upper middle position is 48.1 °C, inconsistent with the temperature trend of heat sink size. Normally the estimated value should be in the range of 43 °C to 44 °C. Since we see in the figure that the temperature falls outside of this range, it is likely that the design or material selection of the heat sink here is flawed. The image can also be used to calculate the heat dissipation per unit area by focusing on the area size and

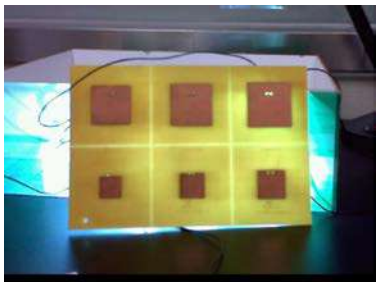

Figure 1

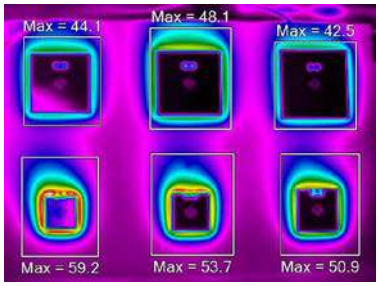

Figure 2

temperature. In this example, it is clear that the design at the upper right corner has the worst heat dissipation effect, and the lower left corner shows the best heat dissipation effect.

Before an infrared camera, what was used to measure the temperature during heat dissipation R&D of an LED chip?

Before the introduction of infrared cameras, a thermocouple was the most popular way to measure temperature during heat dissipation.

In Figure 3A the LED chip (circular part) uses a strip-like heat sink, and Fluke SmartView® desktop reporting and analysis software is used to perform linear analysis for the temperature distribution at different distances as seen in Figure 3B.

In Figure 4A there are metal bands (purple color on the heat sink) segmented on the strip-like heat sink. This is causing the temperature of these segments to be low due to the low emissivity. This is seen on the graph (Figure 4B) where the temperature drops down, highlighted by the black circles.

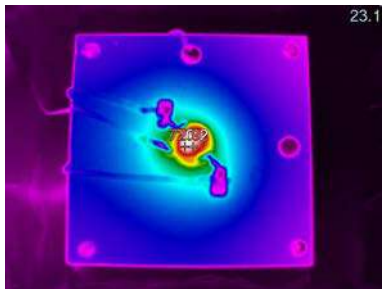

Figure 3A

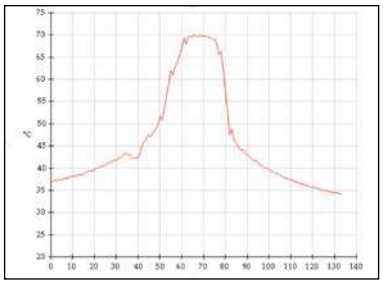

Figure 3B

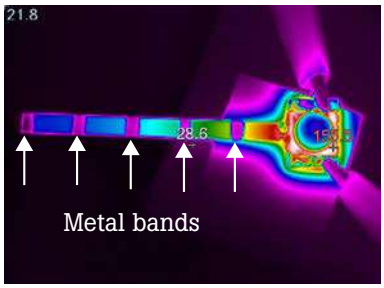

Figure 4A

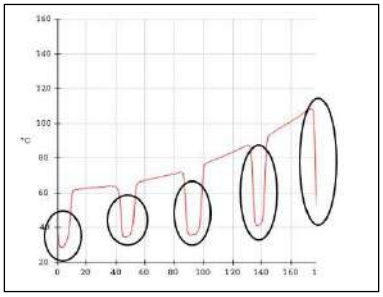

Figure 4B

What are the disadvantages of using the thermocouple for testing?

The thermocouple has a few limitations. The first disadvantage of using a thermocouple is that it must make contact with the surface to take a measurement. To be able to make contact there must be a surface placed over the heat sink using glue which can alter the temperature reading. In addition when using a thermocouple you can only take a point measurement. This means that only a singular point of the heat sink is tested which does not provide an accurate reading for the whole heat sink.

What are the advantages of the infrared camera?

The infrared camera can quickly test the performance of the radiation fin. The online monitoring and real-time shooting thermal map features can be used to conduct specific temperature analysis of the fin on a PC. An infrared camera is a non-contact form of temperature measurement which decreases the time it takes to measure the apparent temperature and is more accurate. The temperature profile of the heat sink with other related analysis functions is of major importance to help optimize the heat sink design thus prolonging the LED chip life.

When you are performing tests make sure to keep accuracy as a priority. Here are three things to keep in mind for better LED inspections.

1. The metal material emissivity of some heat sinks leads to a low temperature reading. To avoid incorrect measurements, apply silicone grease or paint to the radiation fin.
2. Given the different sizes of various LED heat sinks, an add-on macro lens can help provide more detailed and accurate readings.
3. When using the camera for LED inspections look down upon the items being inspected and not from an angle.

2. Fluke Corporation. LED Chip Heat Dissipation Detection

See what you're missing

Whether you're designing the next mobile device, scaling down passenger vehicles, or developing a new stronger, lighter polymer, make sure you have the best thermal data you can get. For accurate and efficient R&D infrared testing, we recommend the Fluke RSE series—RSE300 and RSE600 Infrared Cameras. With down to 40mK thermal sensitivity, and up to 640 x 480 resolution, these mounted cameras stream data to your PC for R&D and quality assurance analysis.

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