INDUSTRY DEVELOPMENTS:

COOLING COB LEDs

Heat generated by an LED, and how it affects its response time, makes cooling a primary concern. Because LEDs are semiconductor devices their light output is directly impacted by temperature. Up to 80% of the power for LEDs turns into waste heat, so if the thermal situation is not managed it will cause the LED to perform improperly, stop functioning, or shorten its expected life. [1]

How LEDs display colors and how long they can be expected to function puts proper thermal management at the center of their deployment. Across the full temperature range that most lighting is designed for, there is a swing in the relative light output. Each color is affected differently by temperature and the swing in light output is distinctly measureable and visible. This includes the low temperature ranges that are most common in today's lighting applications.

As the LED industry shifts to higher density, higher power LED arrays, more effective thermal management solutions are needed to maintain the LED junction level operating temperature. Although standardization is common at the junction and printed circuit board level, the variety of lighting applications and LED packages leads to highly customized thermal solutions across the industry.

COB PACKAGES

A widely used LED packaging type is chip-on-board (COB). With chip on board, several LEDs are mounted directly on the printed circuit board using wire bonds instead of pins associated with surface mounting methods. COB offers manufacturers numerous benefits such as space reduction – more than one LED placed tightly together without the corresponding pins; reduced costs since several LEDs comprise a single part, faster time to market, and desirable heat distribution. This has been a boost for lighting manufacturers, who can put more emphasis on traditional industrial design process such as forming metal and molding. Thermal Management

Figure 1. The Bridgelux VERO LED Array is One of Many COB Options that Simplify the Design and Application of LED Lighting [2]

The tight spacing between the LEDs and small light emitting surface that make chip on board LEDs attractive also present high heat fluxes that must be addressed -- the natural convection cooling that is present in more traditional solid state lighting is hindered with the small surface area of COB. The greatest challenge is the power density. COBs create a tough cooling challenge in terms of Watts per square centimeter. These high lumen packages just keep the heat coming.

To address thermal management with COB-based solutions, lamp manufacturers have to consider a number of variables. There are many cooling options out there, and designers will have to choose between passive cooling strategies – those that spread heat over a large surface area without adding more power to the design, or active cooling strategies involving fans or synthetic jet technology. The environment in which the lamp will ultimately reside should be a consideration (ex. a spotlight in an ambient room, or a high bay many meters above a factory floor), the power involved in the solution, and cost should be a factor. A metal core printed circuit board will provide a low thermal resistance, allowing heat generated by the LED chips to be transferred to a heat sink via the shortest possible thermal path. The chip-on-board packages are mounted directly onto the back metal (with thermal compound at the interface), so that the heat generated by the LED chips spreads efficiently on the large metal frame for efficient dissipation without additional heat sinking. [1]

Figure 2. Igloo FR210 and 210HP Cold Forged Heat Sinks Provide Optimized Passive Cooling to COB and Spotlight LED Applications [4]

Glacialight Inc. [4], an experienced technology manufacturer, recently introduced a new cold forged thermal module, the FR210HP (fig 2), which is suitable for 80W applications. The Igloo FR210HP is optimized for COB and spotlight applications. GlacialTech's cold forged heat sinks are suitable for 30W to 100W applications, the range where most LEDs fit in. Cold forging produces heat sinks that have better heat dissipation than die-casting and aluminum extrusion. The Igloo FR210HP uses AL1050 aluminum. Its thermal conductivity reaches 227 W/mK compared to 96 W/mK from die cast sinks. [4]

Figure 3. The BJB LED Star Cooler Offers a Passive Cooling Platform for COB Luminaires up to 5000 lm [5]

Many manufacturers have introduced heat sinks for specific COB LED luminaires. The BJB LED star cooler GH36d from MechaTronix is specifically designed for LED thermal management in luminaires using the BJB GH36d series LED modules and different brands of COB LED modules mounted by BJB Zhaga Book 3 or Zhaga Book 11 LED holders (fig 3). The compact module GH36d consists of a based and encapsulated LED lamp with suitable twist and lock lamp holder. The pre-tensioned leaf springs are fixed with two standard screws to ensure a defined contact pressure of the light source to the heat sink and thereby a constant heat dissipation and stable LED thermal management.

With an attractive thermal resistance of 1.1°C/W in a 99 mm diameter and 80 mm height, the BJB LED star cooler offers a perfect passive cooling platform for luminaires up to 5000 lm. Through a modular mounting pattern the GH36d LED cooler offers a wide platform of mechanical exchangeability – including Zhaga Book 3 and Zhaga Book 11 mounting platforms.

There has been advances in active cooling of LEDs. One of these advances is the synthetic jet, such as a module

offered by Nuventix (fig 4). The SynJet device is based on an oscillating diagram that creates a turbulent airflow which then pulls air within its wake, further increasing the airflow while improving heat transfer out of the heat sink. The air from the wake then “sweeps” the hot air out of the system.

Figure 4. Nuventix’ Synthetic Jet Engine with Oscillating Diaphragm [5]

As the LED industry continues its rapid growth, thermal management solutions are trying to keep pace. There is no shortage of cooling solutions, even with the fast emerging COB LED applications. Best results may lie in personal research and partnering with thermal management experts at the LED manufacturer or a qualified thermal solutions engineering resource.

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