Light Emitting Diode

Heat dissipation performance according to the adhesion strength of COB and housing

Contents

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1. Overview

COBs have been recently introduced in LED lighting applications and expanded into the market.
It is very necessary to consider heat dissipation to design the lighting fixture installing COBs.
A single COB can achieve a high output power. Moreover, the design of COBs allows the heat to be concentrated in a narrow space, because the multiple dice are closely mounted. Thus, it is necessary to verify the heat dissipation when designing the lighting fixture, not to degrade the performance by heat (e.g. decrease in the luminous flux according to the temperatures) or not to deteriorate the reliability performance.
This document shows the evaluation results of the heat dissipation performance according to the adhesion strength of COBs and the housing (heat sink).

2. Relation of the Tightening Torque and the Heat Dissipation

Nichia recommends that the specific holder should be used to fix a COB to the housing (e.g. heat sink). Enhancing the adhesion strength of COBs to the housing can result in better heat dissipation performance. In general, screws are used to fix the holder; thus, the tightening torque significantly affects the adhesion strength.
We evaluated the heat dissipation performance according to the tightening torque.

2-1. Evaluation Method

A COB waattached to the heat sink with holders. We changed the tightening torque for the screws to evaluate the relation of the torque and Tj (cf. Figure 1). We used NSCWL036A (5.8W) and NSCWJ216A (34.8W) for the evaluation.

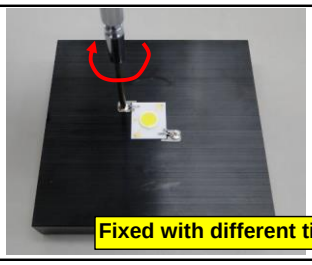
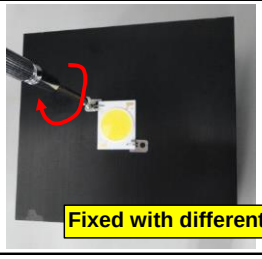
	Condition 1	Condition 2
Overview		
COB Model	NSCWL036A	NSCWJ216A
Power	5.8W (Rated Power)	34.8W (Rated Power)
Holder	Made by Tyco Electronics Corporation	
Screw	M2.6 (Pan Head Screw, no washer)	
Heat Sink	17mm×98mm×L100mm (Heat Resistance: 3.0℃/W)	60mm×110mm×L100mm (Heat Resistance: 1.3℃/W)
Heat Dissipating Seat	t=0.25mm , Thermal Conductivity: 1.0W/mK	

Figure 1 Evaluation Method

After attaching the COBs to the heat sink as seen in Fig.1, each COB was operated at the rated power. We measured the Tj after 30 minutes when the heat was saturated, and compared the Tj according to the tightening torque.

2-2. Evaluation Result

Figure 2 shows the evaluation results.

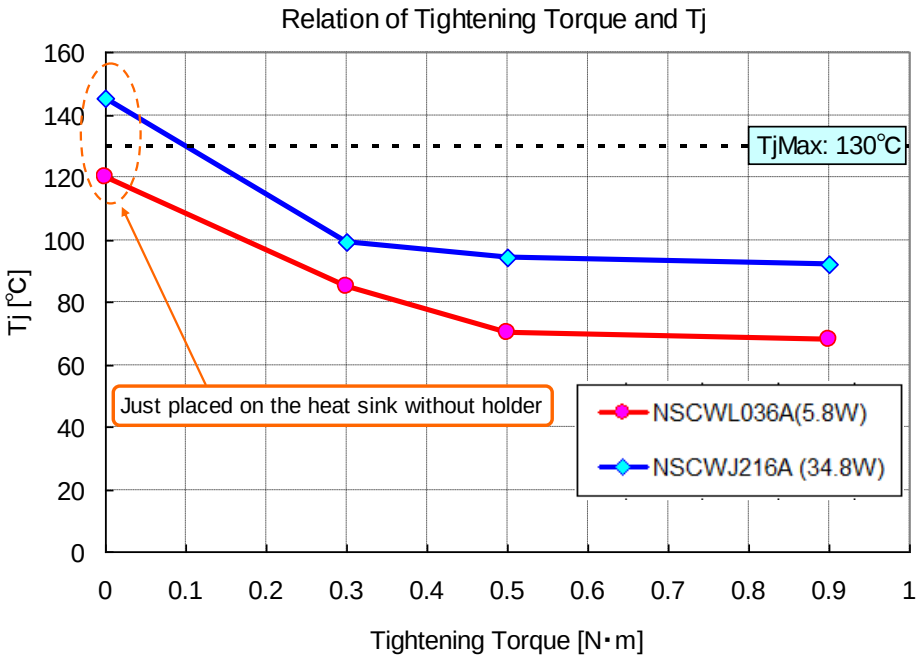


Figure 2

Relation of the Tightening Torque and Tj

Based on the measurement results above, it is determined that increasing the tightening torque, i.e. increasing the adhesion of the COBs to the heat sink, significantly affects the heat dissipation performance. To achieve better heat dissipation performance, it is necessary to control the tightening torque during the holder attaching process.

3. Relation between the Amount of Heat Dissipating Grease and the Heat Dissipation

Heat conductive materials are often used between the COBs and the housing (heat sink) to ensure uniform heat dissipation. When the heat dissipating grease is used as the heat conductive material, the adhesion of the grease to the housing depends on the amount of the grease, affecting the heat dissipation performance.

We evaluated the heat dissipation performance according to the amount of the grease.

3-1. Evaluation Method

We prepared the three kinds of samples with different amount of the grease (cf. Figure 3) to evaluate the relation between the amount of the grease and the Tj.

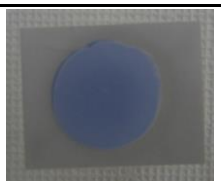
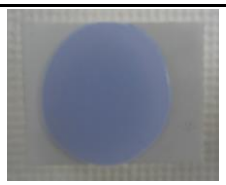
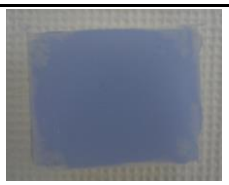
	Grease: 30%	Grease: 50%	Grease: 100%
Sample			

Figure 3

Samples with Different Amount of Grease

We prepared the samples under the following conditions:

COB	NSCWJ216A (34.8W; Rated Power)
Holder	Made by Tyco Electronics Corporation
Screw	M2.6 (Pan Head Screw, no washer), Tightening Torque: 0.9N・m
Heat Sink	60mm×110mm×L100mm (Heat Resistance:1.3℃/W)
Heat Dissipating Grease	Thermal Conductivity:1.5W/mK

3-2. Evaluation Result

After attaching the COBs to the heat sink, each COB was operated at the rated power. We measured the Tj after 30 minutes when the heat was saturated, and compared the Tj according to the amount of the grease. Figure 4 shows the evaluation results.

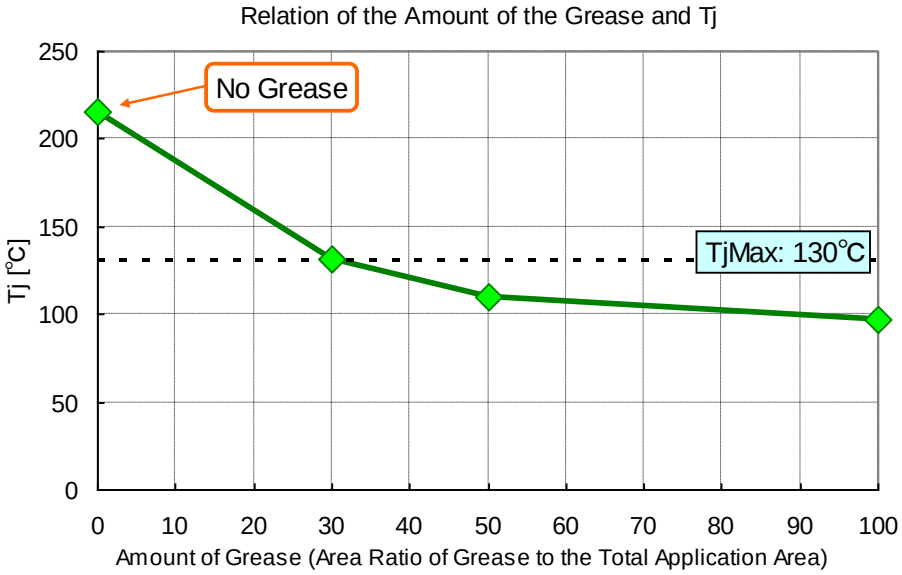


Figure 4

Relation of the Amount of the Grease and Tj

Based on the measurement results above, it is determined that, as the amount of the grease is increased up to 100%, the heat dissipation performance is enhanced. To achieve better heat dissipation performance, it is necessary to ensure that the reverse surface of the COB is in full contact with the heat sink by confirming the spreading behavior according to the amount of the grease in advance.

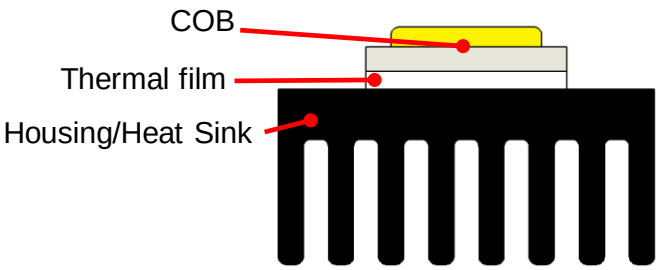
4. How the Thermal Film Thickness Affects the Heat Dissipation

If a thermal film is used for the interface between the COB LED and housing/heat sink to dissipate the heat effectively, thermal films with low thermal resistance should be chosen. The thermal resistance of thermal films varies depending on the film thickness. If the film thickness is excessive, the thermal resistance between the die junction and TC measurement point (i.e. Rthj-c) may be larger than the Rthj-c indicated in the specification. Refer to the following sections for further details.

4-1. Evaluation Method/Conditions

LED Part Numbers: NFCWL060B-V1

Evaluation Conditions: The LEDs were attached to heat sinks. Thermal grease (for comparison purposes) and thermal films of three different thicknesses (i.e. 0.5mm, 1.0mm and 1.5mm) were used at the interface between the COB LED and heat sink.



4-2. Evaluation Results

Refer to Figures 5 and 6 below for details.

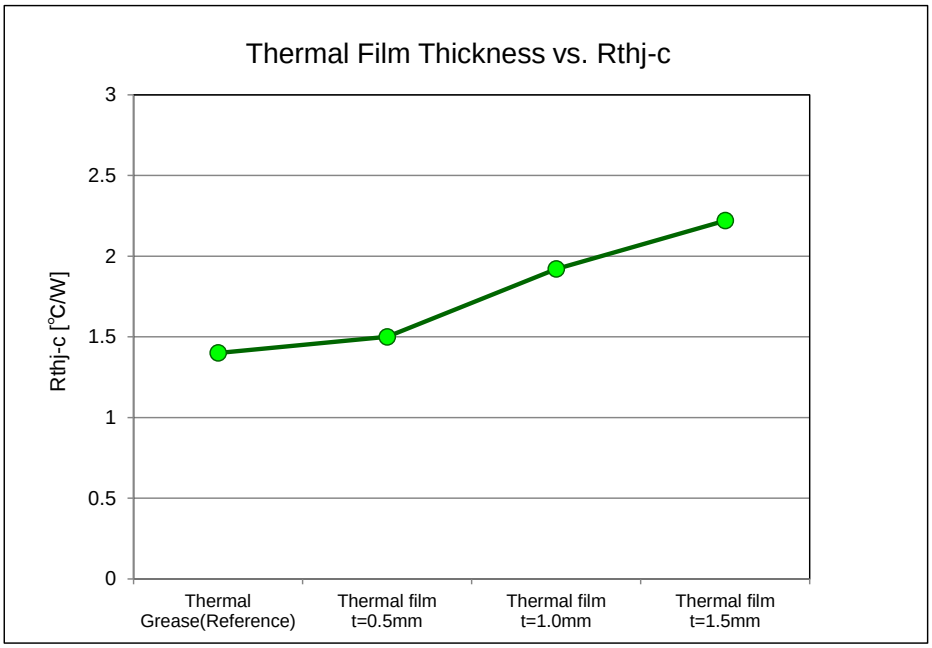


Figure 5. Thermal Film Thickness vs. Rthj-c

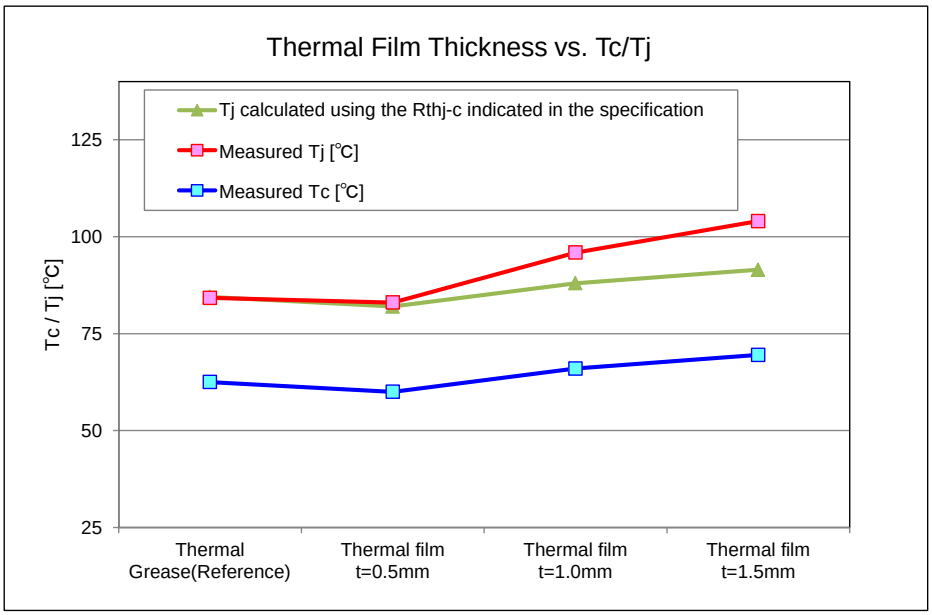


Figure 6. Thermal Film Thickness vs. Tc/Tj

As shown in Figures 5 and 6 above, the evaluation results confirm that:

- The thicker the thermal film was, the higher the Rthj-c.
- When the thermal film thickness was excessive, the actual Tj became larger than the Tj calculated using the Rthj-c indicated in the specification.

Since the actual Rthj-c may vary depending on the thickness of the thermal film and this uncertainty factor is not included in the calculation formula indicated in the specification, another method to determine the Tj should be used at the same time when a thermal film is used for the chosen application: A non-contact temperature measuring instrument (e.g. thermal imaging camera) should be used to review the temperature distribution.

There is another uncertainty for thermal films (i.e. film compressibility). The thermal resistance of thermal films varies depending on the film compressibility: The more the thermal film between the COB LED and heat sink is compressed, the lower the thermal resistance will be. If the tightening torque used to attach the COB LED holder to a heat sink with screws varies, it may cause the film's thermal resistance to change and the Rthj-c to become larger than the Rthj-c indicated in the specification. To prevent this from occurring, regular monitoring/control of the tightening torque should be performed.

5. Summary

The adhesion strength between the COB LED and housing/heat sink has a strong correlation with the heat dissipation. To improve the product quality for the chosen application, using the evaluation results provided in this application note as a reference, ensure that thermal simulations are performed to verify the chosen thermal design is sufficient.

Note that the data/values provided in this application note may vary depending on the COB LED model and/or the operating conditions/environment where the COB LED is used; the content of this application note should be used for reference purposes only.